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Vesna Spasojević-Brkić
Mirjana Misita
Dragan D. Milanović

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Editors
Vesna Spasojević-Brkić
Mirjana Misita
Dragan D. Milanović

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PREFACE

Since the first symposium in Belgrade, Serbia nearly two decades ago, in 1996, International Symposium on Industrial Engineering - SIE has been held regularly every 3 years. It represents an opportunity for researchers in the Industrial Engineering community to review and evaluate their scientific achievements over the period since the previous SIE, share their most recent results and ideas, and discuss possibilities for new directions in research, joint experiments and observing campaigns.

The aim of the 6th International Symposium on Industrial Engineering – SIE 2015 is to contribute to a better comprehension of the role and importance of Industrial Engineering and to point out to the future trends in the field of Industrial Engineering. The Symposium is also expected to foster networking, collaboration and joint effort among the conference participants to advance the theory and practice as well as to identify major trends in Industrial Engineering today. According to these goals the Symposium addresses itself to all experts in all fields of Industrial Engineering to make their contribution to success and show capabilities achieved in the work that has been done are very welcomed. SIE 2015 provides an international forum for the dissemination and exchange of scientific information in industrial engineering fields through the large number of multidisciplinary topics.

The book brought together 80 papers and more than 220 authors from 19 countries, namely from Serbia, Germany, Portugal, Spain, France, Iran, Finland, Switzerland, Israel, Hungary, Canada, Lybia, China, FR Macedonia, Italy, United Kingdom, Taiwan, Russia and Bosnia and Herzegovina. The submitted full length manuscripts were peer-reviewed, and selected for publication by experts in their respective fields. The authors ranged from senior and renowned scientists to young researchers. Only unpublished papers were accepted and the first author is responsible for the originality of the paper. All papers are classified into seven chapters:

- Plenary Lectures,
- Risk Management,
- Human Factors,
- Production and Quality Management,
- Information Technologies,
- Engineering Management and
- Other Technologies in Industrial Engineering.

We expect that papers and discussions will contribute to better comprehension the role and importance of Industrial Engineering in this and other countries, both in domain of scientific work and everyday practice.

Our efforts in organizing would not succeed without the considerable help of the members of Scientific Program and the financial help of Ministry of Education, Science and Technological Development was greatly supportive for the success of the entire project.

At the end, the editors hope, and would like, that this book to be useful, meeting the expectation of the authors and wider readership and to incentive further scientific development and creation of new papers in the field of Industrial Engineering.

Welcome to the 6th International Symposium on Industrial Engineering – SIE 2015! We wish to all participants a pleasant stay in Belgrade and are looking forward to seeing you all together at the 7th Symposium on Industrial Engineering – SIE 2018.

Belgrade, September 2015

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Plenary Session

SIE2015

EFFECTS OF MANAGEMENT AND ORGANISATIONAL VARIABLES IN RISK ASSESSMENT

Maria Francesca Milazzo
Dipartimento di Ingegneria Elettronica, Chimica e Ingegneria Industriale (DIECII), Università degli Studi di Messina, Italy

Abstract. *The standard Quantitative Risk Assessment approach includes the estimation of accidental frequencies; these are a function of various parameters such as components failure rates, probabilities of human error, equipment damage and managerial factors. The availability of general values from the literature for such parameters simplifies the risk analysis, but unfortunately provides standardised results which do not permit taking into consideration the plant specificity. If managerial and organizational factors are neglected or not proper assessed, risk analysis for two identical establishments, characterised by totally different management systems, gives the same results and this appears absolutely unacceptable especially when risk analysis is used as a tool for risk-based decisions. This paper aims quantifying the effects of managerial and organisational variables on the frequency of losses of containment in pipeworks, by using a simple and flexible method developed by Milazzo et al. Such a methodology has been tested on a new case-study and results have been evaluated from both the sensitivity and uncertainty point of views.*

Key words: *Industrial safety, Quantitative Risk Assessment, Loss of containment, Cause of failure, Pipework.*

1. INTRODUCTION

Safety in major hazard plants involves a complex interaction amongst human elements, hardware or technical elements and the environment/climate where each worker operates [1-2]. Organisational and management aspects affect the human behaviour and ultimately influence system performances. In this frame, the role of management is central to the safe functioning of plants, in particularly in the process industry, where reactions are not always easy to be managed or controlled.

To quantify the effects of management and organisational variables on safety, Davoudian et al. [3] suggested assessing the impact of such factors on plant safety by modelling the system as a whole and, then, quantifying and incorporating management and organisation impacts into Quantitative Risk Assessment (QRA). After this, several interesting approaches were suggested to describe the formal organisation of processes and the various previously mentioned interactions at different levels. A review of these approaches was given by Nivolianitou and Papazoglou [4], which was more recently updated by Milazzo et al. [5].

Approaches for the quantitative assessment of management and organisation impacts mainly derive from the nuclear field [6-7]; specific methods for the quantification of management-related safety problems in chemical industry are the MACHINE (Model of Accident Causation using Hierarchical Influence Network) [8], the ISM (Integrated Safety Method) [9], the WPAM (the Work Process Analysis Model) [3,10], the SAM (System Action Management) approach [11], the Omega Factor Method [12], the I-Risk (Integrated Risk) approach [13-14], the ORIM (Organizational Risk Influence) [15] and, finally, the ARAMIS methodology [16]. As suggested by the literature, the modelling of such interactions is essential, mainly because Quantitative Risk Analysis (QRA) provides useful information to support decisions.

This work aims quantifying the effects of managerial and organizational factors on the frequency of *loss of containment* of pipeworks using a simple and flexible method suggested by Milazzo et al. in 2010 [5], which has been updated in the present work, by using more recent data related to the percentage of the causes of failure, and tested on a new case-study.

The paper is organised as follows: in the first part, the proposed approach is briefly described; in the second part an application to case-study is given; in the third part results are discussed and some comments about the sensitivity and the uncertainty associated with the results of the proposed method are also presented, based on the approach suggested in Milazzo and Aven [17].

2. METHODOLOGY

The approach suggested by Milazzo et al. [5] for the quantification of the frequencies of *loss of containment* (or *random rupture*) from pipeworks is based on two steps: (i) the definition of the relationship between the measures of prevention of incidents, adopted by a Company, and the causes of failure leading to *loss of containment* and (ii) the estimation of the weight coefficients for the causes of failure, to modify the frequencies by including the effects of managerial and organizational factors. Subsequently, the frequencies of breakage/rupture, obtained from the literature and commonly used in QRA, are modified according to the equation derived by Papazoglou et al. in 1999 [18].

Thus the proposed method of Milazzo et al. consists of an examination of the whole plant (as suggested by Davoudian et al. [3]), to define how the measures of risk prevention adopted inside the establishment can influence the frequency of rupture. To make this an auditing of each unit of the establishment is needed, this allows identifying the causes of failure which can occur and the measures which can prevent them. The weight coefficients for the causes of failure are the percentages of failures, which must be determined for each unit of the establishment.

By analysing the *loss of containment* data, Papazoglou et al. in 1999 showed that the frequencies of release from various equipment of chemical plants spans two orders of magnitude and has a certain symmetry around the average values. Thus, the frequencies of failure can be modified using the following equation, whose application needs the weight coefficients a_i (percentage of the cause of failure i) [18]:

$$\log f_{\mathrm{mod}} = \log f_{av} + \sum_i a_i \cdot x_i / 100 \qquad (1)$$

where: f_{mod} = modified frequency of failure (frequency of the *loss of containment*); f_{av} = average frequency of failure (average frequency of the *loss of containment*) based on world-wide experience; a_i = weight coefficient for audit area i (percentage of the causes of failure); x_i = parameter indicating the judgement of the effectiveness of the prevention measure related to the cause of failure i (following the audit).

The parameter x_i assumes the following values:

- \- 1 if the plant is judged GOOD,
- 0 if the plant is judged AVERAGE
- \+ 1 if the plant is judged POOR.

As highlighted by Milazzo et al. [5], the use of the same statistical data for each installation under analysis does not permit to take into account plant-specific information. Different installations may differ from the point of view of the percentage of causes of failure, thus it is necessary to correct the weight coefficients taken into account their specificity. To achieve this scope, the proposed approach consists, firstly, of the exclusion of the causes of failure that can be prevented through the adoption of appropriate prevention measures and, then, of the application of the mathematical model represented by equation (1) using installation-specific information to support the calculation of the percentage of the causes of failure.

3. CASE-STUDY

The approach, described in Section 2, was applied to the quantification of the frequency of the *losses of containment* of pipeworks of an alkylation unit included in a confidential refinery.

3.1. Alkylation unit

The alkylation unit of a refinery aims obtaining gasoline with a high octane number, starting from the gaseous by-products of other processes, especially from the cracking and reforming units. These gases are generally constituted by mixtures of isobutane and olefins having 3÷5 carbon atoms. To obtain acceptable reaction rates without reaching high temperatures, acid catalysts are employed. Thus due to the acid environment, this unit is considered the most critical from the point of view of the prevention and management of random ruptures.

3.2. Failure causes and preventive measures

The application of the approach of Section 2 aims at the estimation of the influence of prevention measures on f_{av}, which were judged *a priori* GOOD (x_i = - 1). Thus the problem is to determine which causes of failure can be prevented by certain measures adopted by the Company. To identify the causes of failure, the preventive measures and their effectiveness, an audit was made.

Table 1 provides an overview of the relevant causes and their contribution, in terms of percentage, to the failure of process pipes; this data was extracted from the handbook of failure frequencies [19] (a European database of DVN, Det Norske Veritas) and was used for the elaborations necessary in the present work.

The weight coefficients of Table 1 needed to be corrected to account for that modern design and manufacture might reduce the number of failures due to certain causes and to assess the effects of managerial and organizational factors. The way to correct the weight coefficients was defined in agreement with the plant management of the establishment.

The measures, adopted by the Company to prevent failures (such as corrosion, erosion, pipe defect and other structural damages) are the following: radiographic testing, ultrasonic testing, liquid penetrant testing, magnetic particles testing and visual inspections. Regarding the case-study, phenomena and maintenance activities, which characterised the equipment's past life, were collected from a database managed by a specific software developed by the Company, this was essential to identify and assess the causes of failure occurring in each pipework.

The corrosion phenomenon was analysed more in detail, based on data of Lees [20]. Such data allows distributing the corrosion cause of failure of Table 1 in several sub-causes (a complete description is given in [5]). A detailed analysis of the fluid flowing in the piping and the process conditions were necessary in order to define which sub-causes occurs. Secondary causes, which were considered not credible, were excluded and the percentage of failure modes for corrosion was corrected.

Then, in order to estimate the effect of measures of risk prevention on f_{av} through equation (1), it was necessary to formulate a judgment x_i for each adopted measure. Each one was assessed in terms of efficiency in identifying a given failure causes.

Table 1. Percentage of causes of failure, source [19].

Failure cause	Partial cause	[%]
Corrosion	Wrong material	1.68
	Corrosive contamination	0.38
	Exceptional conditions	1.01
	Aggressive environment	1.03
	Poor protection	0.74
	Zinc embrittlement	0.06
	Cooling water circuit	0.06
	Galvanic corrosion	0.33
	Unknown	4.11
Erosion	Turbulent flow	0.01
	Unfavourable flow path	0.22
	High flow speed	0.14
	Erosive external environment	0.05
	Unknown	0.27
	Erosive contents	0.11
External pressure	Removed pipe supports	0.28
	Failure of pipe supports	0.98
	Poor design of supports	1.14
	Unknown	0.11
	External pressure	0.48
Temperature	Insufficient material specification	0.87
	Thermal pressures	0.38
	Change of contents	0.60
	Thermal shock	0.38
	Poor pipe specification	0.02
	Domino effect	0.54
	Unknown	1.01
Wrong installation	Wrong parts' placement	0.16
	Installation error	2.64
	Insufficient equipment	1.09
	Unknown	0.11
Procedural error	Pipe not cleaned before opening	4.38
	Wrong pipe worked on	0.87
	Wrong equipment status	3.62
	Wrong operations' order	2.90
	Wrong (dis)connection	0.76
	Pipe insufficient insulated	1.56
	Equipment not brought back to normal status	0.33
	Unknown	3.78
Impact	Impact of a nearby installation	1.68
	Human impact	0.85
	Falling object as a result of a natural cause	0.22
	Vehicle impact	1.57
	Unknown	0.43
Total		**100**

3.3. Average frequencies

In this paper, only one incidental hypothesis is described, as the aim is to show how the proposed approach works. The event is a random breakage of a pipe coming from the alkylation plant and three cases were considered as shown in Table 2. Related average frequencies of occurrence (f_{av}) were collected from the Safety Report of the establishment (the document refers to the frequency data from HSE [21]).

Table 2. Cases of breakage/rupture and related frequencies, source [21].

ID	Event	f_{av} [event/y·m]
Rn1a	Hole size 3 mm diameter	$1\ 10^{-5}$
Rn1b	Hole size 25 mm diameter	$5\ 10^{-6}$
Rn1c	Guillotine rupture	$1\ 10^{-6}$

The *a priori* exclusion of some causes of failure requires also the modification of the mean frequency (f_{av}) obtained from the literature. This value was reduced by a percentage equal to the excluded causes of failure. Then equation (1) was applied to the *a priori* modified frequency.

4. RESULTS

Table 3 shows the frequencies of *loss of containment* modified by the application of the method. Several applications showed that the frequencies of *random events* generally decrease by about an order of magnitude or more in some cases (Figure 1).

Table 3. Modified frequencies.

ID	Event	f_{mod} [event/y·m]
Rn1a	Hole size 3 mm diameter	$9.75\ 10^{-7}$
Rn1b	Hole size 25 mm diameter	$4.87\ 10^{-7}$
Rn1c	Guillotine rupture	$9.75\ 10^{-8}$

In Figure 1, the entity of the risk reduction is visualised by using risk matrixes, where the *x* and *y* axes respectively give the consequence and the frequency of the events. The consequence axis shows four classes of effects defined as follows: D high percentage (50 %) of fatalities, C low percentage of fatalities (1 %), B irreversible effects and A reversible effects (see details in [22]). Three levels of risk are also indicated in the matrix to be used for the risk-based decisions, these are the acceptable level (white zone), the ALARP level i.e. As Low As Reasonable Possible (grey zone) and the unacceptable level (red zone).
The results of Figure 1 allow verifying that the Company through the adoption of certain preventive risk measures reduces the risk level for these events from the ALARP zone to the acceptability.

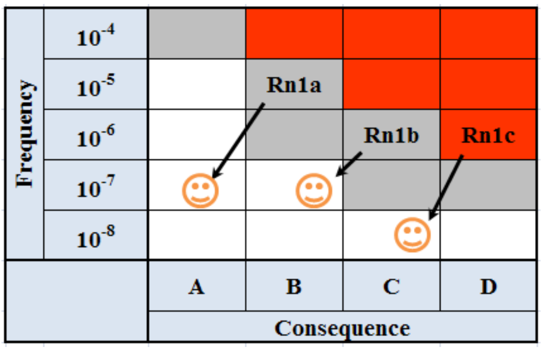

Figure 1. Risk matrix

4.1 Discussion

Given that some steps of the assessment include subjective judgments by the risk analysts, it must be known how to make the risk assessment as less as possible affected by subjectivity. A subjective evaluation implies that different analysts may provide different assessment for the weight coefficients (a_i) and, also, different judgments for the risk prevention measures (x_i). A sensitivity analysis showed the subjective parameter which is the most significant for the final evaluation [5]. The variables with the highest influence on the f_{mod} resulted the average frequency f_{av} and the weigth coefficients a_i. This conclusion is not sufficient to consider at what extent the modelling corresponds to the reality and where implementations are needed, indeed the risk analyst has to comment about its results also based on the uncertainty associated with the assumptions made in modelling to simplify the process.
To this purpose, in this paper the sensitivity and the uncertainty were evaluated, as suggested by Milazzo and Aven [17]. Their method allows the assessment and categorisation of the assumptions (so-called *uncertainty factors*) with respect to both the uncertainty and the sensitivity scores (U and S) proposed by Flage & Aven [23] (Table 4).
Table 5 gives results of the uncertainty and the sensitivity assessment; *uncertainty factors* were determined for each steps of the proposed approach of Section 2.

Table 4. Uncertainty and the sensitivity scores [22].

Aspect	**Score**	**Interpretation**
U	Low (L)	One or more conditions: – The assumptions made are seen as very reasonable. – Much reliable data are available. – There is broad agreement/ consensus among experts. – Phenomena involved are well understood; the models used are known to give predictions with the required accuracy.
	Medium (M)	Conditions between those characterizing low and high uncertainty.
	High (H)	One or more conditions: – The assumptions made represent strong simplifications. – Data are not available, or are unreliable. – There is lack of agreement/ consensus among experts. – Phenomena involved are not well understood; models are non-existent or known/believed to give poor predictions.
S	Low (L)	Unrealistically large changes in base case values needed to bring about altered conclusions.
	Medium (M)	Relatively large changes in base case values needed to bring about altered conclusions.
	High (H)	Relatively small changes in base case values needed to bring about altered conclusions.

Table 5. Uncertainty and sensitivity assessment.

Uncertainty factors (Assumptions)	**U**	**S**
Representative fluid are able to describe all fluids characteristics	L	L
Average frequencies and failure causes are based on literature data.	H	H
Efficiency of the inspection techniques	L	M
Only one failure occurs during a certain interval of time	M	M
The failure is quickly detected	M	H
Company and industry requirements are followed	L	L
Pipeworks are tested and inspected before and during the installation	L	M

The first assumption is the common use of representative classes of fluids to describe all fluid characteristics. Substances, having the same hazard typology, are usually grouped to reduce the number of cases of release, anyway both the degree of uncertainty and sensitivity are low.

The greatest difficulty in assigning frequencies of breakage and percentage of failures is due to lack of appropriate data (second assumption). Uncertainties in this field are due to the adoption or to the adaptation of data derived from other context. This assumption leads to high degrees of uncertainty and sensitivity (see also [24]); this result is in agreement with the sensitivity assessment given in [5]. The third and forth uncertainty factors are related to the assumptions that only one failure event or failure mode occurs during a certain interval of time and failures are immediately detected when they occur. In real life the assumptions may not always hold. The fifth and sixth uncertainty factors address the assumptions that the installed pipeworks are adequately tested and inspected prior to production start up and that production is within the design criteria and requirements/recommendations. In practice, however, it is questionable whether these assumptions will be true.

The sensitivity and the uncertainty scores showed that the use of average frequency and failure causes from the literature is the factor mostly affecting the assessment. Thus the analyst must be care in selecting data.

4. CONCLUSIONS

Given that the main cause of accidents in pipeworks are often due to deficiencies in the corporate structure, many techniques have recently been developed and allow estimating managerial and organisational factors. The most common risk analysis approach conservatively includes the influence of measure of risk prevention and mitigation. This work has permitted to apply a simple and flexible approach for the calculation of *loss of containment* frequencies taking into account managerial and organisational variables.

Results showed that the frequencies of *random events* generally decrease by about an order of magnitude or more in some cases. Moreover, given that the proposed method is affected by several subjective judgements, it was possible to comment on how to make the assessment as less as possible affected by subjectivity. The sensitivity and the uncertainty were evaluated, as suggested by Milazzo and Aven [17], and the results showed that the use of generic frequency and failure causes from the literature is the factor mostly affecting the assessment. Thus their selection must point to more reliable data.

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COST BENEFIT ANALYSIS AND DEVELOPMENT BANKS

John Weiss[1]
[1]Emeritus Professor of Development Economics, University of Bradford, UK.

1.INTRODUCTION

The important role of finance intermediation in economic growth is now widely accepted. Poorly developed financial markets and institutions can hold back economic growth and in turn this will retard efforts at poverty reduction [28].There is a long tradition in development studies which argues that at early stage of development state ownership of banks can be an important catalyst in mobilizing and allocating savings [10]. Experiences both in Europe and North America in the nineteenth century and in Japan and Korea in the early post 1945 period provided evidence in support of this position. In the era of privatizations and a shrinking state in the 1980's this view was challenged, in large part because of the fiscal drain poorly performing state banks were creating. Since then a research literature based on cross country studies has suggested that state ownership of a banking sector is negatively associated with economic growth and financial depth [15].

The evidence on this negative link is less robust than is sometimes stated and subsequent analyses have found conflicting results, although here is little evidence that state-owned banks positively support financial development in lower middle and low income economies. Part of the problem is that in such economies weak institutional development is associated with high state ownership, low financial depth and slower growth. Isolating the impact of state ownership alone is difficult and the negative association with growth may be caused by the association with poor institutions, which are the key causal factor. Re-working the original analysis by La Porta et al shows that once differences between countries in institutional and financial development are allowed for universal generalizations on the negative effects of public bank ownership do not hold and that the negative impact is only in countries with very poorly developed financial sectors and very weak institutions [14]. However, aside from the doubts about the econometric results a more profound point is that with improvements in their operations there may be scope for reformed Development Banks to play a more positive role in growth as they appear to have done in some countries in the past.

State ownership of banks remains significant in some parts of the developing world and many governments (not just of those of developing countries) are looking again at the potential role of Development Banks, which are a subset of the wider category of state-owned banks. Part of the interest stems from the recognition that private sector banks need not be the best institutions to fund long term strategic projects or to expand financial sector outreach to small firms or low income borrowers. In addition, after the economic crisis of 2008-9, there is now a wider appreciation of stabilizing macro-economic role that state owned banks can play by lending counter-cyclically, boosting demand in the downturn and dampening in the upturn of the cycle.

Although there is no agreed definition of a Development Bank, a simple broad definition is of a financial institution with state capital (which need not be a majority share) and with a mandate to pursue developmental as opposed to solely commercial objectives in its operations. This differentiates a Development Bank from State-owned commercial banks.

State-owned banks in general were estimated to have around 22% of all banking system assets in developing countries in 2009. This is a very large reduction relative to 1970 where the comparable figure is put at 67%.This large reduction is due to the wave of privatizations in the 1980's and 1990's. However the impact of privatization has been very uneven and in a number of large economies (for example, China, India, Egypt and Syria) state-owned banks still dominate taking over half the assets of the banking system in 2010. In others (for example, Argentina, Brazil, Indonesia, Korea, Poland, the Russian Federation and Turkey) they play a significant role accounting for between 20% and

50% [27].[1] In Latin America an alternative source puts the change in state owned bank assets from 46% of the total for the region in 1970 to 15% in 2010 [4].

These figures do not separate Development Banks from state-owned commercial banks and other state-owned financial institutions. However, Development Banks tend to be some of the largest state–owned banks and some are very large. Three of the best known Development Banks - China Development Bank, the Brazilian Development Bank (BNDES) and the German Development Bank (KfW) - each have assets larger than the World Bank group. An estimate from a few years ago suggests there are about 750 national Development Banks globally in addition to a number of multilateral banks like the World Bank and the regional banks in Asia, Latin America, Africa and Europe [24].

There is considerable heterogeneity within the category of national Development Banks, which is revealed by the survey reported in Luna-Martinez and Vicente (2012). Important differences between banks in the survey were found in ownership structure, policy mandate, funding sources, targeted borrowers, lending models, interest rate policy, form of regulation and governance practices. In terms of operations a key distinction is between first tier banks, lending directly to end-borrowers and second tier banks, lending through other financial institutions which deal with the end borrower. The first tier or retail approach allows the bank to assume the risk and to act strategically in identifying key projects to support. With this approach it is more difficult to reach large numbers of disbursed small borrowers unless the bank has its own branch network. The second tier model allows the bank to draw on the branch network and lending and credit scoring expertise of the financial intermediary.

This paper explores the question of how such banks can assess the viability of the investment projects that it considers for financing. Prior to that a second section looks at the economic theory that rationalises the role of these banks and highlights how they can be used to meet development objectives – investing in and supporting strategic activities, funding SMEs and small borrowers, linking with and helping to develop financial intermediaries, as well as boosting demand at critical points in the economic cycle. The third section discusses the role of project economic analysis in aiding Bank decisions and a fourth section offers some conclusions.

2.ROLE OF DEVELOPMENT BANKS

Development Banks are typically rationalised in terms of filling gaps in the financial market that commercial banks whether privately or publicly-owned cannot fill. The three key roles that have figured in recent policy discussions are

- Lending to or investing in strategic or innovative high –risk activities with external benefits and projects requiring long-term funding
- Contributing to financial inclusion objectives by lending (and possibly providing other financial services) to disadvantaged or low income borrowers
- Lending counter-cyclically to boost demand in recessions.

The theory underlying the first of these points is illustrated graphically in Figure 1. The right hand segment I shows the demand and supply of loanable funds relating the market interest rate R to the demand Dl and Sl in the market. Demand is based on the marginal productivity of the investment the funds will finance and Dl reflects the private returns to the borrowers. It is downward sloping as more funds are demanded at lower interest rates and the profit maximizing investor will invest up to the point at which r equals the expected return on additional investment. The supply curve for loanable funds is shown as rising with the interest rate up to interest rate R* at which point it bends backwards with the supply of funds falling at rates beyond R*.

The rationale for this backward bending supply curve stems from the analysis of an imperfect credit market under uncertainty [22].The supply offer of banks will be based on expected returns from a loan portfolio which is the product of the interest charge and the probability of repayment aggregated over all borrowers. The probability of repayment is likely to be negatively associated with the interest rate due to 'adverse selection' (as the riskier borrowers accept loans at high interest rates) and 'incentive effects' (any individual borrower will tend to make the project more risky to generate a sufficiently high return to pay the higher interest rate). This relation is shown in the left hand segment II, which has the expected return on loans on the horizontal axis. Beyond R* the increase in the probability of default due to the increase riskiness of the loans outweighs the impact of a high R on expected returns. Risk aversion by commercial banks will magnify this process by causing the curve to shift further backwards by reducing banks' perception of expected returns. Hence due to uncertainty in a competitive financial market banks would set R* as the interest rate and not the market-clearing rate of R^1. There will be an unsatisfied private demand for funds of Q^2Q^1due to the banks' attitude towards risk. If positive externalities from investment are introduced into the analysis there will be a new demand curve Dl*, which reflects the marginal economic productivity of investment. At an interest rate of R* there will be a second unsatisfied economic demand for funds Q^3Q^2 reflecting the fact that externalities by definition are not taken into

[1] The definition of state owned banks used in this source is not clear.

account in the borrowing decisions of investors.[2] In total therefore left to themselves commercial banks will undersupply the credit market by the sum of these two credit gaps or the distance Q^3Q^1.

In practice it is not possible to isolate these two gaps but they provide a rationale for a Development Bank to lend to both high risk, but high return projects, and to projects which benefit not just the investor, but others in the economy. External benefits are typically innovation and knowledge spillovers, which the innovator or pioneer does not capture in monetary charges and the benefits from various forms of physical infrastructure, like roads or water systems, which have public good characteristics, so private providers cannot charge fully for these benefits. In principle, it is possible to incorporate the other two objectives into this framework by treating outreach to target groups and counter-cyclical lending as a form of external benefit which are incorporated into Dl*.

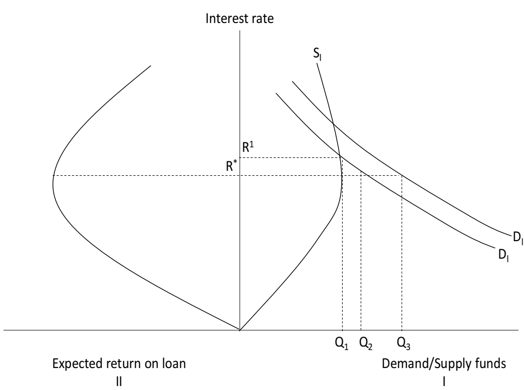

Figure 1. Credit market

High risk lending

The role of Development Banks in stimulating new activities in low and lower middle income countries has been stressed in recent discussions of industrial policy [12], [20]. The argument is that innovation creates external benefits as followers can learn from the first-movers and this innovation justifies support and a subsidy, in the sense of a loan at an interest rate that does not reflect the risks involved. By pooling their risk and investing government funds across a wide portfolio Development Banks can afford to fund some loss making projects, provided successes outweigh failures. This is an illustration of a Development Bank both ignoring risks that would dissuade a commercial bank and at the same time supporting an externality-generating activity. Furthermore, as part of a wider industrial policy, this approach suggests that Development Banks should take a pro-active not a passive role. This implies researching market opportunities, taking an equity stake in projects, helping to initiate a dialogue between the government and prospective investors and pointing out to the government bottlenecks to investment that need to be addressed.[3] The more established development banks such as BNDES and GfW already play an 'intelligence role' as a guide to policy makers in Brazil and Germany, respectively [4].

The alternative means of addressing the risk issue is for a Development Bank not to lend directly but to provide funding to or guarantee lending by other institutions in a second tier role. As noted above this has the advantage of drawing on the credit assessment skills and branch networks of the intermediary, but the disadvantage that it leaves final decisions on who receives the funds to the intermediary. Where the aim is to reach large number of borrowers and the Development Bank does not have a large branch network working on a second tier basis seems inevitable. Guarantees have become a popular tool for supporting risk and best practice advice on how to apply these suggests that where private financial intermediary institutions are the recipient that Development Banks should not offer too high a coverage ratio of a loan portfolio (for example, no more than 80% of a portfolio of loans to SMEs) to give the intermediary adequate incentive to apply a sound loan assessment. In addition, the guarantee should be priced so that the charge to the intermediary is high enough to ensure the financial viability of the Guarantee Fund so that it does not become a drain on the Development Bank's budget, but low enough to attract participation from intermediaries and ultimate borrowers.

Financial Inclusion

In theory, due to the market failure caused by lack of information on the part of banks illustrated in figure 1, at interest rate R* that there will be some potential borrowers who are indistinguishable from those who receive credit, who could afford to repay at R* , but who do not receive funds. Development Bank lending is one means of addressing this lack of inclusion. As noted part of the mandate of many

[2] Dl reflects ex ante perceptions of returns by investors whilst Dl* can be interpreted as probability weighted outcomes. In theory the optimal level of investment will be determined by the intersection between Dl* and the supply of funds from savers, so the marginal economic productivity of investment equals the social time preference cost of saving.

[3] For example, in relation to their proposals for industrial policy in South Africa, [12] discuss development banks as 'sources of ideas about high return activities and about the obstacles that need to be addressed to increase chances of success of projects that attempt to realise those ideas. This is particularly useful for strategic projects where the relevant actors will not come knocking at your door.'

Development Banks is lending targeted at small firms who would otherwise have difficulty in accessing finance either because of a perceived high risk, a lack of credit history or lack of collateral. However, the mandate can also be extended to excluded low income households who do not receive financial services, like savings accounts and insurance, because of the high cost (for example due to the small size of individual transactions or the remoteness of their locations). Development Banks can be used to address both these client groups of small firms and poor households.
Access to finance has been cited widely as a key constraint on firms in low and middle income countries [3] and exclusion from financial services is also seen as a major barrier to poverty reduction [28]. Development Bank lending and financial services are by no means the only way of overcoming these problems and are not the approach favoured by the 'Aid consensus' led by the World Bank, on the grounds that they are more likely to be 'politicized'[28]. Whilst the Aid Consensus favours private sector solutions and past state interventions have been associated with the leakage of funds to non-target groups there is nothing inevitable about this and in principle well run and closely targeted schemes are possible within a Development Banking framework.
Microfinance has emerged as a segment of the financial sector geared towards small borrower clients. Microfinance can be delivered by different types of institution, such as NGOs, co-operatives, regulated non-bank financial institutions and commercial microfinance banks. In addition lending can be on a group or individual basis. In principle a Development Bank can also offer a microfinance lending window, as well providing a range of financial services such as deposit and current accounts for small low income savers. Microfinance is a specialist operation which has proved highly profitable in commercial terms in many places and Development Banks deciding to move into this area would need to develop specialist skills. How far it has actually succeeded in reducing poverty amongst borrowers is the subject of considerable debate, in part because of the difficulty of assessing its true impact.[4]

Counter-cyclical lending
The tendency for private sector banks to become less risk averse in the upturn of an economic cycle and more risk averse in the downturn has been suggested after the global financial crisis of 2008-09 and if valid means that commercial banks can exacerbate the economic cycle. The recent financial crisis has stimulated interest in the role of state-owned banks, including Development Banks, in counteracting this tendency [27]. Many governments injected capital into their state-owned banks to fill the gap in the credit market left by commercial banks. In some countries this role was taken by Development Banks.[5]
The importance of the counter-cyclical role will vary between economies depending on the size of state financial institutions and how far the central bank can encourage commercial banks to lend to stimulate demand, for example through adjustments to the base rate or through direction or 'administrative guidance'. It is likely to be more of a significant role in high income and upper middle income emerging economies than for poorer countries.

3. INVESTMENT APPRAISAL
As institutions with a developmental as opposed to a commercial mandate it is critically important that Development Banks assess the projects they fund from an economic (and if appropriate) a social perspective. Whereas commercial banks will typically assess the credit worthiness of the borrower, Development Banks should assess the impact of the projects the borrower will undertake with its funds. Starting from the 1960's a large technical literature showed in detail how this could be done [16], [21],[25].[6]
The methodology follows discounted cash flow principles (so it calculates internal rates of return and net present values) but departs from financial analysis in that it replaces prices actually charged with alternative economic values that attempt to capture the economic benefits and costs created by a project. Key principles of welfare economics are applied to derive these economic values. Goods traded internationally are valued at their prices on the world market with any domestic logistics costs allowed for in calculating a value at the project site. Goods that are non-traded are normally valued on the basis of what consumers are willing to pay for them. Where project effects do not occur through a market transaction, so they are an externality, a value must be imputed. Transfers that simply reallocate funds within an economy are neither an economic cost nor benefit and are excluded. Any macro-economic distortion, such as a misaligned exchange rate, a wage that exceeds the productivity of workers in their alternative employment, or a

[4] The present author reviewed the evidence on lending by multilateral Development Banks in support of microfinance on behalf of the donor Evaluation Co-operation Group in ECG (2010).

[5] In Brazil BNDES expanded credit by 70% in real terms from September 2008 to December 2011 and offered credit at rates 7.5 percentage points below the market rate [28]. In Canada the Development Banks increased their loans by 2% of GDP in 2009 and Development Banks in Latin America increased their loans by around 30% (Gutierrez et al 2012:9).

[6] Textbook introductions are [19] and [5]. [26] review current issues in the application of these methods.

controlled interest rate, should be allowed for by using economic values for foreign exchange, labour or funds, based on their opportunity cost.

These adjustments are particularly important for infrastructure projects where many of the effects of a project arise as externalities. Many Development Banks specialise in lending for infrastructure and here a financial analysis can understate (or sometimes overstate) net benefits depending on the nature of the externality.[7] For example, road projects may charge a toll but the revenue collected will typically grossly understate the full benefits. These are usually estimated based on projected traffic flows with savings in vehicle operating costs used as the basis for valuation, with a distinction drawn between 'normal' and 'generated' traffic (with the later valued at half vehicle operating cost savings). Similarly water supply and sanitation projects may charge for their services, but these charges may not fully reflect the value of the services to consumers. The difference between willingness to pay and actual charges is a consumer surplus that should be included as benefit of a project.

A significant level of rigour has been introduced to estimates of willingness to pay by contingent valuation approaches that apply specially designed surveys. In a closed-ended approach the respondent is asked whether they are willing to pay a specified amount presented as the value of the improved service. Prices for the service, or 'bids', are set within a range and distributed randomly to respondents. The yes/no answers to the question of willingness to use the service become the dependent variable in a probit regression model where they are related to household, area and service characteristics as well as the bid price.[8]

In a number of countries Development Bank funding is going increasing towards 'green industries' where wider social returns may be high, whilst commercial returns are low as environmental benefits are not priced adequately in the market and are thus external to individual projects. On the cost side projects which damage the environment and are not required to fully mitigate this effect will be imposing an economic cost that must be included as a negative external effect. The full cost of increased CO_2 emissions, for example, in principle should be included in an economic calculation, either on the basis of damage caused or of abatement expenditure necessitated, although empirical estimates have suggested a wide range of possible values [23].

These economic adjustments will give an economic measure of what a project is worth - an economic internal rate of return (EIRR) and economic net present value (ENPV). Development Banks should strive to ensure that their funds are used as productively as possible. This means that a cut-off or minimum acceptable return should be stipulated to ration funds. This is usually done through a test discount rate reflecting the opportunity cost of funds. In principle this should vary between economies, but a typical figure is either 10% or 12%.

Application of this approach also requires the calculation of the financial return on a project, not because this is taken as its worth to the economy, but because project sustainability requires that a project will generate sufficient funds over its working life to maintain operations and repay debts. If inadequate funds are generated the Bank or the government will have to provide a further injection of funds and this will need to be allowed for in a financing plan.

In addition, where the inclusion objective is important the social dimension of lending must be incorporated. This can either be through lending to small borrowers or indirectly through benefits from large projects spreading to low income households. The methods for economic analysis of projects discussed above are most directly applicable to large projects (such as infrastructure investments or industrial investments in an innovative product or process) funded on a first tier basis, where the Development Bank itself does the detailed project assessment. It will clearly not be practicable to do this analysis for large numbers of small project loans, even where lending is on a first tier basis. One approach to this problem is to do sample calculations on 'representative' small projects. An alternative is not to attempt ex ante assessments, but to do sample ex post surveys using impact evaluation techniques to assess how far loan recipients have benefited from the loans.[9] Where

[7] For example the multilateral Development Banks the European Investment Bank and the Asian Development Bank have loan portfolio that is dominated by infrastructure projects. The Government of China is currently in the process of setting up the Asian Infrastructure Investment Bank.

[8] The probit model will be of the form

$$Y = \alpha + \beta_1 X + \beta_2 B + \varepsilon$$

Where Y is the yes/no response, X is a vector of variables reflecting household, area or other characteristics, B is the bid price and ε is an error term.

Mean willingness to pay (WTP) is derived from the expression $(\alpha + \sum(\beta_1 * X^a)/\beta_2)$*-1

where X^a is the mean value of X variables.

Mean WTP is thus derived by first summing the product of the mean value for the explanatory variables and their coefficient from the probit analysis ($\sum(\beta_1 * X^a)$) and then dividing this by the coefficient on the bid price (β_2) and adding the constant in the probit model (α). This expression is then multiplied by minus unity to give a positive number. ADB (2013) explains this approach with detailed case studies.

[9] Best practice requires an initial baseline survey with a treatment group of borrowers and a control group of

inclusion effects are to be achieved through the distribution of project benefits the initial project plan should include a market survey of users to allow an assessment of how far particular user groups will benefit. Distribution analysis, as a subset of project economic analysis, can then be applied to estimate the 'first round' distributional effects of a project.[10]

In practice the application of these techniques has been very mixed, even in multilateral Development Banks, where there is a formal requirement that economic returns be assessed.[11] The methodology is well developed for most sectors, although obtaining realistic values for environmental externalities is a challenge. Benefit transfer approaches apply or adapt monetary estimates of environmental value or damage estimated in one context to another similar situation, but there are always questions of how comparable the cases are.

Adjustments for the macro-economic parameters relating to the exchange rate and unskilled labour remain relevant. Wherever there are some controls or taxes on foreign trade combined with instability in real exchange rates there is a case in theory for applying a foreign exchange adjustment (which will be positive where the national currency is overvalued relative to its long-run equilibrium value or negative where it is undervalued) through use of a shadow exchange rate.[12] Similarly wherever there is significant structural unemployment in the labour market there is a case for applying a shadow wage factor of below unity, since labour's opportunity cost will be below the wage paid.[13]

Where there is perhaps most difficulty is in the area of 'strategic bets' - the risky innovative projects where a Development Bank is funding a first mover innovator and where there is considerable uncertainty about the future market.[14] As noted earlier, this is highlighted as a key role for these banks in the industrial policy literature. Applying the methodology discussed above requires putting numerical values on future benefits and costs over a project life of say 20 years. If the project succeeds in the market benefits may be very high, but conversely if it fails they may be very low.

As noted, the literature recommends banks should play an active role in removing bottlenecks thus aiding success. However this does not remove uncertainty. The technique of risk analysis can be applied by putting probabilities on different outcomes to generate an expected EIRR or expected ENPV, as well as a measure of the risk of failure (defined as the probability of a negative ENPV at the test discount rate). The difficulty is that in the presence of uncertainty by definition accurate probabilities will not be known, so the analysis will be based on little more than a hunch about outcomes. An alternative is to apply a form of scenario analysis setting out two or three alternative future scenarios in terms of project sales and costs and their implications. The realism of the scenario needed to justify the project can then be assessed on the basis of judgement.

In practice probably the best way to address this problem is to accept that there will be some high risk activities that Development Banks should fund, possibly as a form of venture capital, so the Bank will benefit from project success as a shareholder. A separate funding window could be set aside for these strategic bets and whilst the project proposals would need to be examined carefully for their realism, the techniques discussed here would be treated as no more than illustrative and would be only one input into the final decision on the project. The final decision would need to assess the potential of the borrower, the realism of the assumptions about the market and the bottlenecks to be faced.

Subsidies

The issue of subsidies offered by Development Banks has been discussed widely with critics warning that credit subsidies can distort financial markets crowding out private sector financial institutions, whilst at the same time encouraging inefficiency in the activities of borrowers and making the banks dependent on government funding. It is accepted as good practice that a Development Bank should not rely heavily on budget transfers from the government as this will make it vulnerable to political interference in lending policy, which has been blamed for past mistakes in lending in many countries. Furthermore setting a financial target makes the Board of a bank accountable for operations. None the less financial objectives should be seen as a constraint not an ultimate goal and the aim should be to achieve a bank's developmental mandate subject to a minimum financial target. The main alternatives are either aiming for a breakeven financial position over a given period or setting a return on capital equal to

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similar non-borrowers, selected randomly. After a few years from receiving a loan a double difference approach can be applied.

[10] [9] illustrates this approach in the case of a number of projects from the Asian Development Bank.

[11] The Asian Development Bank is unusual in publishing formal Guidelines for the application of this approach [1]. In addition it has also produced detailed best practice cases for water, sanitation, power and transport [2].

[12] [17] discusses this in detail.

[13] EU (2008) discusses different measures of the shadow wage based on different assessments of the labour market in the context of EU Member States; see also [28].

[14] The early stage funding of the Chinese solar photovoltaic industry by the China Development Bank is an example of a strategic bet [18].

the government's cost of capital (such as the long-run Treasury Bill rate).[15]

A breakeven target is most compatible with the risk-taking and inclusion mandates discussed above and requiring a Development Bank to act in too commercial a manner both undermines these mandates and forces a bank into direct competition with commercial banks. Balancing developmental objectives with a minimum financial target raises the issue of how far borrowers should be subsidised by Development bank lending. There can be different concepts of a user subsidy, but the most obvious is where the loan rate is below a commercial rate for the category of borrower, typically set at the bank's cost of capital plus administration costs plus a risk premium for the borrower. The role of Development Banks is to provide long-term funds to borrowers at a charge which does not set such a high risk premium that borrowing would not occur. Hence there will be a subsidy element whenever funds are lent at an interest rate or for a repayment period that is more favourable than those a commercial bank would offer, but which covers the direct costs of the Development Bank. The interest charge will then be the bank's cost of capital plus administration charges plus a non-commercial borrower charge, which in some instances could be zero, but at any rate would be a non-commercial charge.

Lending without regard to the risk profile of borrowers can lead to financially unsustainable outcomes and Banks may need to segregate categories of borrower and to take equity stakes in some of the most innovative to ensure the Banks benefit from favourable outturns. The provision of management advice and technical assistance to borrowers can help to reduce risk, but will raise Banks' operating cost. The most obvious candidates for significant rates of subsidy in terms of low risk premiums are those where there is the strongest evidence of externalities and those small firms to be supported on distributional grounds. The academic literature has stressed that innovators should be subsidised due to the demonstration effect they create, whilst size in itself does not justify favourable treatment, although it may do so due to employment or other social as opposed to efficiency considerations [13].

Where Development Banks operate on a second tier basis through financial intermediaries they may wish to impose an interest rate ceiling on this lending, since otherwise the subsidy component will accrue to the intermediary not the ultimate borrower. However, where there is competition between institutions to intermediate the funds it may be possible to allow discretion in setting rates.

[15] The Mexican Development Bank NAFIN has a target to preserve its capital over a five year period, which is equivalent to a zero real rate of return. BDC in Canada is required to generate a return on equity equal to the long-term cost of government funding [11].

4. CONCLUSIONS

Development Banking is not a new phenomenon with public banks playing a role in nineteenth century Europe, and having a major role in post 1945 developments in some parts of the world. Past experience has been mixed with high rates of NPLs for some banks amidst the charge of widespread 'connected lending'. None the less despite the wave of bank privatizations in the 1980's and 1990's in response to these results, Development Banks remain important parts of the financial sector in many countries. They are far from homogenous, however, and whilst the traditional model of a fully government owned bank offering subsidised long-term credit remains accurate in many cases, it is far from the full story. Many banks have private capital, some take deposits and others act as second tier rather than first tier institutions collaborating closely with private sector intermediaries. A majority are regulated in the same way as commercial banks. The new focus is on streamlined, more efficient and financially aware operations.

To avoid misdirected lending it is important to establish some form of financial independence from governments. The traditional roles of lending long-term to relatively risky projects, which promise high economic returns – whether in terms of infrastructure, innovative products or technologies or environmentally friendly investment – remain valid. There is an extensive technical literature discussed here which sets out how economic costs and benefits can be assessed and this should be drawn on, as far as possible. The subsidy structure used to fund these activities needs to balance the incentive effect for investors against the viability of the Bank. Ideally the Bank's cost of funds should be covered plus an allowance for borrower risk, but not at a commercial rate. These strategic loans are best handled through first tier lending. Where second tier lending is involved there is scope for using financial intermediaries to reach large numbers of small borrowers and to use Bank guarantees to support these.

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SIE 2015 | 6th International Symposium on Industrial Engineering | 24th-25th September 2015 | FACULTY OF MECHANICAL ENGINEERING | STEINBEIS ADVANCED RISK TECHNOLOGIES | INNOVATION CENTER FME

REVIVING KNOWLEDGE ON EQUIPMENT FAILURES AND IMPROVING RISK MANAGEMENT AT INDUSTRIAL SITES

Paolo Bragatto, Patrizia Agnello, Silvia Ansaldi, Emanuele Artenio, Corrado Delle Site.
DIT Technological Innovations Department, INAIL Italian Workers' Compensation Authority, Rome, Italy

Abstract. *The knowledge about pressure equipment failure modes and rates is essential for the risk management. In the Seventies an incomparable effort was made by National Authorities, which at that time controlled the pressure equipment, aiming at providing the industry with trustable reliability parameters, which are still in us, even though repeatedly amended by experts. In order to revive and update the knowledge on this matter, the judgment of the experts is not enough and much more data on the field must be gathered. Experimental studies on a large scale are now impossible, thus the only way is to exploit potential of semantic search and the huge data in the public domain. The information scattered in the web, tied together, may provide industry and authorities with the knowledge they need to make the right decisions.*
Key words: *Pressure equipment, Failure Modes, Semantic Search.*

INTRODUCTION

The new Seveso III Directive, in force in European Union since July 2015, requires the operators to assure a safe management of equipment throughout the entire lifecycle. According to the Directive the operator of risk plants must take into account available information on best practices for monitoring and controlling, with a view to reduce the risk of system failure. The present study focuses just at the pressure equipment as critical for all industries falling in the scope of Seveso Directive, including gas, oil and chemical processing, as well as for other industries, which are out of Seveso scope, including food, textile, paper and healthcare industries. The knowledge about the pressure equipment failures is essential to manage process plants. In particular the failure rates FRs and failure modes FMs are critical to plan inspection and to safely manage the ageing of pressure plants [4]. Authorities, furthermore, use FRs for making decisions on new plants and land use planning in the framework of the Seveso legislation.

Just major companies have adequate resources to manage proprietary knowledge about pressure equipment failures and update parameters about FRs and FMs, whilst minor companies, including small and medium ones, trust on public domain resources. Shared knowledge resources on equipment reliability are essential to promote dialogue between operators and authority, in a framework of transparency and equity. Unfortunately, the knowledge in the public domain is out of date. As discussed in a recent paper by Pittiglio & al. [7], in many cases both operators and authorities are still trusting in the results of studies forty years old and more. In that age a strong command and control system was in force and ruled all safety matter, including pressure equipment, and the scholars had the chance to collect and compare data on million items in service and thousands of events, as discussed by Spencer H. Bush [5] in a valuable reviewed published a few years later.

Recent researches

The need of updating and sharing knowledge on this matter is recognized, but at now even most trusted sources, including FRED[12] and API 581[1], are based much more on experts' judgment than on experimental data. Nobody in recent years has continued the large studies of the Seventies, because the era of command and control is passed away and it is impossible to monitor at the whole "population" of equipment in a wide area, as the matter of pressure equipment is ruled by a much more flexible and liberal legislation, without strong central control bodies. A couple of years ago an attempt was made by exploiting open access databases [6]. Even though FMs were not included and success was partial, at now, it is the only serious attempt made by Authorities for updating shared knowledge on pressure equipment failures.

OBJECTIVES

In order to meet the needs of updating FRs and FMs parameters, it is essential to collect updated much more data on failures that occur on known population of pressure equipment. The goal of the present research is to provide credible and updated FRs and FMS and eventually revive the knowledge on pressure equipment reliability. In most European countries, including Italy, all phases of pressure systems life-cycle are driven by national regulations, but the duties are spread by a number of control bodies (both public and private). A valuable source of knowledge could be provided by collecting and exploiting the control bodies' experience. The first objective is to experiment the gathering of data at a couple of control bodies, in order to evaluate the feasibility of a larger campaign. The second objective is to evaluate the potential of the information on pressure equipment failures, spread in the web. An extensive search on the entire web is outside the scope, rather it is important matching data collected in the districts with data in public domain.

EXPERIMENTAL DISTRICT

The present study was performed with a local agency, which inspect all equipment in a small industrial district in northern Italy. Failure records were collected for 11 years, until 2013. The equipment population was 6000 items in service, including some 400 steam generators. This data has been assumed almost constant in the observation time. In the observation period there were 53 recorded events. The recorded events include both major failures with severe consequences (e.g. loss of the equipment, injuries or death, environmental damage) and minor fixable failures, which just downtime as consequence. For each event has been produced a detailed sheet, describing the type of failure, the type of equipment, the material and the age of the equipment, the affected part, the consequences, the assumed causes. Further details and photographs, as relevant, have been enclosed too. For the purpose of comparison was analyzed also a collection of recorded faults present in the public domain [11]. It contains 53 events collected in 7 years (1995 - 2001) in a highly industrialized Italian area (Emilia-Romagna), with a population of about 46,000 in equipment pressure.

PHASES AND METHODS

We divided the work in 4 phases.

Phase 1 Reports' collection. Reports about breakdowns, incidents and accidents related to pressure equipment have been duly collected for a number of years by the local inspectors and provided to the research team. The collected reports include basic information about type of event, involved equipment and materials, type and amount of loss. At the end there is a text describing more in detail damages, investigations and assumed causes. The texts are of different lengths, from a few lines up to five pages and more. They may include also photographs of the accident scene and evidences of metallographic tests. The number and type of pressure equipment in service in the competence district of each participating inspectors is known with a low uncertainty degree, because the obligations to authorities by the plant operators.

Phase 2 Basic Statistic In this phase the goal was providing parameters, namely FRs and FMs, trustable for risk based decisions and management. The calculation of FRs is quite simple and has been faced using trivial statistical methods. The FMs are more challenging and results obtained by trivial methods may be unsatisfactory. As a large diversity of equipment is involved, with many types of fault; the statistical analysis of the documents had to balance two conflicting needs: the different classes of membership (e.g. types of activities, types of equipment, types of damage, class of age) should be discriminated to have interesting and detailed results; but the sample cannot be fragmented too much, to avoid a loss of statistical significance. This problems hinder also a profitable use of advanced methods such as Bayesian belief network.

Phase 3 Semantic phase. The goal is to distil as much knowledge as possible from the collected reports. The idea was to assume the consistency between report stories and actual events, so to measure the "distance" (or better the vicinity) between events through the "semantic distance" between reports.

According to the MinHash algorithm proximity is defined as:

$$P_{a-b} = \left(\frac{K^a \cap K^b}{K^a \cup K^b}\right) \qquad (1)$$

where pa-b = proximity of event records a and b; K^a and K^b key sentences singled out respectively in the event records a and b by the search engine.

In order to apply the proximity index, automated summaries are essential. For trustable summaries the possible keywords should be organized a priori. Synonyms should be duly considered. Furthermore the taxonomy of equipment, parts, industries, degradation mechanisms, processes, materials, damages and consequences are essential to discriminate general words (representing higher level classes) and detail words representing lower level in the taxonomies. The organization of the taxonomies of the equipment under pressure in relation to safety was developed a time ago by Ansaldi & al. [2] and recently updated by Bragatto & al. [3]. The set of possible key words may be considered as a n-dimensional space where each event may be placed. Proximity index define a metric for this space, thus it is possible to build a set of similar events, which may be considered "frequent failures". A cluster of failures is eligible as "frequent failure" if the number of events is > 3 and all proximity are higher than 0.67. The minimum of the proximity index is defined “radius of the cluster”. The tool used in phase 3 is IBM Omnifind©, which provides: advanced search, multi language and semantic distance. Automated summaries are also produced [13]. Using the strength of advanced search, a number of clusters may be obtained, which may be considered typical or frequent cases.

Phase 4 Extension

In the process industries, the need to share information on incidents to learn from past mistakes and improve the future has been recognized for decades. To the first times most information was proprietary, but at now there are a number of national and international authoritative sources of information on accidents in the web, open to the public access. The reports included in those sources are focused on accidents happened in different industries. As many accidents in a few industries (e.g. oil industry) are caused by a failure in pressure equipment, the accidents’ databases are a valuable source of free information on failure modes of pressure equipment. In the present paper the following websites have been considered: Barpi/Aria a general accident database for all industries in French language [9]; eMars a database on major accidents in chemical industry, in English language [10]; INAIL/Informo an occupational injuries database in Italian language [14]. A further source included was CCPS/Beacon, which provide, for teaching purpose, the description, in different languages, of a number of accidents [8]. The sources named above were extracted a small number of sheets, which were supposed relevant with the equipment failures. The capabilities of Omnifind© has been stressed to overcome the language differences as well as even the inconsistencies and fragmentation of those sources.

RESULTS

Statistics

The failure rates are accordance with International bodies. Boilers have been discriminated by other types of equipment as the frequency is much higher but consequences much lower. FRs are reported in Table 1. Rates are in accordance with FRED [12] and API [1] official data, but for steam generators.

Table 1 Failure rates

	minor / repairable	non repairable	major
Other Emilia	6.6E-05	3.8E-05	6.9E-06
Steam Emilia	4.7E-04	2.5E-04	3.1E-05
Other Varese	8.9E-05	5.4E-05	1.8E-05
Steam Varese	9.0E-03	1.3E-03	-

An integrated and very general picture of the failure modes is shown in table 2. The prevalence of failure to the steam generators is also due to the industries prevailing in the two territories (textiles and food). Of course the prevailing types of equipment determine the type of failed part. Under the name “cracks” are included multiple cracks, spread cracks, cracks through and holes, whilst a single crack was not considered a real failure. Regarding the age, equipment with less than 3 years has been considered new, within 3 and 30 years medium, within 30 and 45 years mature, more than 40 obsolete. The assumed causes have been clustered in three generic types of physical causes and three procedural causes.

The cause in table 2 are intentionally naïve, as the understanding of the actual or root causes needs a deeper discussion. The investigation about causes depend on the type of damage mechanism, which, in turn, depend on the type of process and on the type of industry. An attempt of understanding of the cause has been made by using a Bayesian Network, which has provided a number of probabilistic relations between industry, type of equipment, part, damage and causes.

Table 2 Failure modes

a) Industry	
Process	33%
Manufacturing	25%
Health	22%
Trans	9%
Waste	7%
Other	5%

b) Type of equipment	
Steam gen.	56%
Tank	14%
Column	7%
Autoclave	6%
Cylinder	5%
Reactors	3%
Piping	3%
Furnace	2%
Exchanger	2%

c) Affected part	
Tube -sheet -bundle	38%
Shell & End	28%
Full	12%
Nozzles &Manifold	10%
Firebox	5%
Opening	4%
Valve	2%
Other	2%

d) Type of damage	
Cracks ..	58%
Structural	15%
Blast &fire	14%
Damaged Surfaces	9%
Occlusion	2%
Fouling	1%

e) Class of age	
New	6%
Medium	69%
Mature	22%
Obsolete	3%

f) Assumed cause	
Corrosion	39%
Thermal stress	6%
Mechanical stress	5%
Operation control	26%
Construction	14%
Design	10%

Something may be found in table 3 and 4, where the percent probability of each major cause for each type of major failure is plotted. Less frequent causes are not included. Table 3 refers just to process industries, whilst table 4 refers to manufacturing industries. The greatest difficulty is the diversity of events and the limited number of comparable cases, which spread too much the uncertainties of the results.

Table 3 the causes for process industries

Root Causes	Types of Damage					
	Crack Thru	Defor med	Multi Crack	Rup ture	Pee ling	Blast
Improper Operation	13.2	10.9	13.9	10.6	5.5	11.2
Inadeqaute Design	10.2	13.2	9.0	9.4	7.0	11.2
Improper Welding	15.3	-	20.9	8.5	-	10.1
Inadeqaute Material	9.0	-	10.6	-	14.1	-

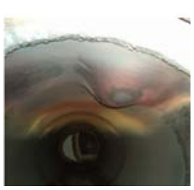
Table 4 the causes for manufacturing industries

Root Causes	Types of Damage					
	Crack Thru	Defor med	Multi Crack	Rup ture	Pee ling	Blast
Improper Operation	15.3	22.4	15.0	10.0	-	32.4
Inadeqaute Design	8.7	15.6	9.6	10.0	-	12.6
Improper Welding	15.5	-	27.4	7.3	14.9	9.5
Inadequate Material	9.0	-	10.6	-	-	-

Frequent failures

The essential results of semantic search are shown in Table 5. The key sentences describing the typical or "frequent failure" are shown in the first column. for each frequent failure shows a photo shot as taken by inspectors on the spot investigation. On the right column of the table the number of similar sentences in the cluster and the minimum proximity radius of the cluster, as defined in eq. 1.

Table 5 Major "frequent failures.

FREQUENT FAILURES	Number of Items ------ Proximity Radius
 **Deformation for Thermal Stress** Steam boilers in the textile or food indu-stry: plastic defor-mation of parts (tube plate, tube shell, furnace) due to excessive thermal load (e.g. fault of water supply)	4 — 91%
 **External Corrosion of buried tanks** Shell and bottoms of buried tanks may be affected by fast corrosion and peeling due to ingress of water it inside the trench. Consequnces include gas leakage and accdents.	3 82%
Reactor and Aggressive Chemicals  Batch reactors in the chemical industry. Dete-rioration and breakage of parts - stress corrosion due to the use of aggressive substances (e.g. chlorides)	3 — 80%
 **Corrosion Under Insulation.** In Heat Exchanger, and reactors, a little leakage cause an accumulation of fluid under insulation, which remain undetected for a long time until cause major damage.	3 — 79%
Fouling & overheating.  Rust and sediment accumulated on the tube during service reduce heat exchange capacity. In reactors uncontrolled temperature may lead to runaway phenomena with severe consequences	3 - 76
Inappropriate Pressure Tests.  In tanks and in cylinders "Hydraulic or Pneumatic Tests" made without complying the good practices causes catastrophic blasts of vessels with possibly with severe consequence.	3 — 73%
 **Untreated Water into boilers** Steam boilers, autoclaves or heat exchangers. Corrosion and fouling spread over various parts (shell and tube, tube sheet, valves) due to water treatment inadequate or absent.	6 — 73%

FREQUENT FAILURES	**Number of Items ------ Proximity Radius**
Liquid Hammer In heat exchangers, steam generators and other types of equipment recurrent “liquid hammers” on tubes cause fatigue and ruptures possibly with severe consequence. 	3 — 71%
 **Switching Fuels** In steam boilers the change of fuels or the use of unconventional fuels causes thermal stresses and cracks.	3 — 70%

It has to be stressed that the searches that have produce the “frequent failure” summarized in table 5 have involved some 120 sheets coming from inspectors on the field and some 30 sheets picked from open access sources. Although this is a limited sample, the fact that certain faults will be repeated three or more times, it leads to trust that they are actually "frequent". There is no room here to discuss in detail each “frequent failure” in table 5. Some of these are known problems, for which recommended good practices could be found in the technical literature, including Corrosion Under Insulation, Liquid Hammers. Unfortunately practitioners forget quickly and after a time past mistakes return. Other results are less obvious. For example accidents caused by pressure tests are worrying. Hydraulic and pneumatic tests are dangerous; if they cannot be avoided must be entrusted to aware and skilled persons. In previous paragraphs the FRs of steam generators have been discussed, as much higher than other equipment. A couple of frequent failures, including untreated water and switching fuels, highlight serious problems in the management of the boilers. These incidents were recorded in the textiles, food, waste and health sectors, where at the time of the events management systems were not yet present. More frequent inspections and accurate, conducted within a safety management system, are able to avoid many of the frequent failures, as well as accidents deriving from them.

CONCLUSIONS

The efforts made by generations of scholars who came before us to define a very solid base of knowledge on failure modes and rate of pressure equipment are impossible to this day, as based on the “command and control” approach, where every technical issues were directly controlled by one national authority. Now technical duties are spread to many public and private bodies, independent each other. The increasing number of data on failures, accidents and incidents, which are becoming available in the space of the public domain, and the power of semantic search, as demonstrated by this paper, are the only possible alternative for reviving and updating the knowledge on pressure equipment failure and achieve a level again comparable to that described by the article by S. Bush, cited in the introduction.

Obviously there are many problems that in the past were not present. In particular, the data are completely different, fragmented and disaggregated. The different languages and even jargons contribute to the difficulties. Also the level of detail is extremely different. According to various sources there are very precise details on materials and processes, or only feedback of organizational management. In some cases the reports are that have been reported within modules, which obviously must not be included in the search. It is precisely the strength of the semantic search engine that can help, but obviously they must be used by experts who know very well the rules that underlay the matter.

In the present experiments just a few sheets have been retrieved from open access database and processed with the proprietary data. As the purpose of the experiment was just explorative, that is adequate, but for a larger campaign the issue of synchronizing with different open access accident databases should be faced and it is not easy at all.

A even major obstacle to the development of a shared knowledge on pressure equipment safety is the ownership of data on failures. In some cases these data may have a competitive value and reasonable confidentiality, but in many cases the data can be purified and be shared to the benefit of all. It is therefore important that regulators encourage companies to publish the non-confidential data that may be significant for improving safety.

In case of accident, with or without victims, institutions that can intervene are different from one district to another and, more importantly, from country to country. For this reason it would be useful define the requirements on the minimum information that must be collected and shared. Something like that already exists at EU level for reporting serious accidents in Seveso establishments and could inspire a very simplified model, suitable for all industries.

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SAFE AND SUSTAINABLE INNOVATION IN GERMANY - THE STEINBEIS APPROACH

A. Jovanovic[1], M. Löscher[2] F. A.Quintero[1]
[1]Steinbeis Advanced Risk Technologies,
[2]EU-VRi Germany

Abstract. *The paper deals with the new concept of safe and sustainable innovation proposed by Steinbeis in Germany. The concept is based on three main premises. Firstly, the innovation can be considered safe only if both designed as such (also over the life-cycle), and perceived as such by the stakeholders. Secondly, the innovation is sustainable only if it is designed in such a way that it will be resilient when facing also new and emerging challenges (even the unknown ones). In other terms, it is sustainable if resilient. Thirdly, modern innovation should be smoothly embedded into the "shared economy" and "Industry 4.0".*

Such a concept is developed and implemented by Steinbeis as a bottom-up approach. The paper explains the above principles and show their application in the example of the Steinbeis Advanced Risk Technologies Group, as a subset of the large Steinbeis Network (over 1,000 centers word-wide).

Keywords: *risk, resilience, sustainability, innovation, share economy, indicators.*

1. INTRODUCTION –THE INNOVATION PARADOX

In declarative terms, there would be hardly possible to find today a company or institution ready to admit that "their innovation is not safe". And yet, the industrial safety records clearly show that the modern innovation is often not safe, or at least not perceived as such. Examples of technologies like fracking, nanotechnologies, autonomous driving, internet of things, unmanned drones, underground storage and similar, big data, or genetically modified food technology, show that concerns among the stakeholders are significant and the accidents do happen. Improved safety, on the other hand, normally implies higher costs, and this higher cost can hamper the competitiveness of industrial products or technologies. Therefore, there are always some trade-off made.

Europeand the EU in particular have consistently promoted their technology as responsible and inherently safe, making out of it a marketing advantage. But faced with the fierce global competition and pressured by the agreements like TTIP[1] the European companies consider shifting the trade-offs from the precautionary principle to the evidence-based approaches [1],[2]. But the evidence for a new technology or new products is normally not available – the years are often needed to note the creeping or hidden adverse effects of a new technology (e.g.asbestos).

The above leads to a paradox: everyone is for the safe innovation in the declarative terms, but insisting on safe innovation can hamper the innovations as such, by making it more expensive and less competitive.

2. STEINBEIS – THE INNOVATION AS THE CORE BUSINESS

Steinbeis[2] is one of the several large network organizations in Germany. It is positioned in the technology transfer (innovation) part of the bridge connecting the fundamental research (in Germany covered by organizations like Helmholtz[3] or Max Planck Institutes[4]), over the applied research (e.g. the research performed in Fraunhofer Institutes[5]), and the direct industrial application (i.e. full-scale technology transfer).

Steinbeisis one of the world's most successful providers of know-how and technology transfer.The Steinbeis brand stands for the successful transfer and sharing of know-how and technology for over 30 years. Steinbeis builds made-to-last bridges between

[1] *http://ec.europa.eu/trade/policy/in-focus/ttip/*
[2] *www.steinbeis.de*
[3] *http://www.helmholtz.de/en/*
[4] *http://www.mpg.de/short-portrait*
[5] *https://www.fraunhofer.de/en.html*

the source of knowledge and the area of application. Steinbeis operates in dependently of state backing, always adhering to market rules with all the services it provides. The organizational foundation of our success is based on entrepreneurial transfer processes for which Steinbeis assumes personal responsibility, underpinned by decentralized operations that are coordinated through a centralized framework.

Steinbeis has currently an international network including over 1,000 so-called transfer enterprises (Steinbeis units) worldwide, in 46 countries[6], each operating at the same time as an independent organization/company and a part of the overall system. This network encompasses 6,000 experts, each contributing to the network with their specialist knowledge and working on individual challenges in interdisciplinary teams to genuinely add value and thus facilitate the success of Steinbeis. As such, Steinbeis offers technology and management competence from a single source across a unique spectrum of fields, making its services available to partners and clients of all sizes in all kinds of areas. In doing so, it acts as a troubleshooter or service provider in the fields of consulting, research and development, training and continuing professional development.

3. STEINBEIS ADVANCED RISK TECHNOLOGIES GROUP

Steinbeis Advanced Risk Technologies Group (R-Tech) is the cluster of units belonging to and/or linked to Steinbeis. The group of Steinbeis units working in the area of "Advanced Risk Technologies" deals with multiple aspects of risks, risk engineering and risk management appearing, for instance, in:

- petro-chemical and process plants
- power plants and energy supply
- material technologies, especially advanced material technologies
- new & alternative technologies.

Main aspects of risks dealt with are:

- risks in/of innovation (e.g. risks of unexpected side-effects)
- risk of non-performance or performance below expectations (e.g. risks of system or component failures)
- risk of adverse/unexpected effects and impacts(e.g. on public health and/or environment)
- risks over the life-cycle of products and technologies (e.g. unexpected problems in decommissioning or recycling phase)
- project risks, especially ininnovation, R&D and new technologies oriented projects.

Organizing Europeanand national stakeholders, promoting and supporting technology transfer, introducing new approaches to the risks and their management, developing specific methods and tools are examples of these activities. R-Tech is also one of the founding members of European Virtual Institute for Integrated Risk Management EU-VRi. The institute (www.eu-vri.eu) is an EEIG (European Economic Interest Grouping). The group is capable to cover the above topics either on its own or in close co-operation with Steinbeis network, European Virtual Institute for Integrated Risk Management (EU-VRi), Virtual Institute of Knowledge-based Multifunctional Materials (KMM-VIN), European Technology Platform Industrial Safety (ETPIS) and other networks (all involving over 2,000 persons and over 500 companies). The activities of the R-Tech group involve projects and activities on industrial, national, EU, and international level,tackling,e.g.:

- integrated management of risk related to new technologies (FP7 project iNTeg-Risk)
- risks of impacts and/or non-performance of nanocontainer technologies, new bio-fuels in aerospace industry (Alfa-Bird), slurry coating technologies (FP7 projects MUST and Particoat), etc.
- governance and regulatory aspects of risks in industrial plants falling underthe EU Seveso directive (EU project F-Seveso).

In order to provide the optimal service and results, the R-Tech group has dedicated units for specific area of "advanced risk technologies"such as:

- technology transfer
- education
- R&D
- industrial services ("business-oriented")
- EU-related issues

Large web-based system such as iRiS (Integrated Risk Management System) and its derivatives have been developed for the petroleum and power industries and have been applied worldwide.

R-Tech has participated in many international standardization activities yielding a number of innovation standardization documents, the most prominent of these probably those leading to new EN standards in the area of risk-based inspections, risks of new technologiesand patents in the area of nanotechnologies [4],[5].

4. BASIC PRINCIPLES OF SAFE AND SUSTAINABLE INNOVATION

The new concept of safe and sustainable innovation proposed by Steinbeisin Germany is based on three main premises.

- Firstly, the innovation can be considered safe only if both designed as such (also over the life cycle), and perceived as such by the stakeholders.
- Secondly, the innovation is sustainable only if it is designed in such a way that it will be resilient

[6] *In Serbia, there are currently two Steinbeis franchise units, in Novi Sad and Kragujevac, dealing with modern energy technologies ("Steinbeis Energy Technologies", Novi Sad) and education in the area of Risk Engineering and Management (The Steinbeis Transfer Institute Kragujevac, a franchisee of the Steinbeis University, Berlin, Germany).*

when facing also new and emerging challenges (even the poorly known or even the unknown ones). In other terms,it is sustainable if resilient.

- Thirdly ,modern innovation should be smoothly embedded into the “shared economy” and “Industry 4.0”. Such a concept is developed and implemented by Steinbeis as a bottom-up approach.

5. ENGINEERING SAFETY VS. RISK PERCEPTION – THE RISK PARADOX

Looking at the safety of known and widely used technologies (e.g. those used in process and production industry) one can see the general tendency of decreasing of direct accidents. This decrease generally follows the same pattern (Figure 1):

i. The risks reduced thanks to the maturation of the technology itself – faster in the beginning, slower later;
ii. The risks are reduced thanks to better management – the processes in which the technology or products are used are better managed;
iii. The risks are reduced thanks to the improvement of the safety culture–the employees accepting safety as the normal constitutive part of the process (and not,e.g., as an imposed measure);
iv. The risks are reduced influencing the cognitive capacity of the stakeholders –defaults in the process are defined in sucha way that the “right (also unconscious) behavior” is promoted and cognitive biases promote, not hamper, safety.

The final results of the above steps is the de facto reduction of accident rates and related risk. As a paradox, this reduction, especially in developed societies like EU does not lead to higher acceptance of innovation and new technologies. Instead the public aversion towards some of the risks (e.g. many risks related to terms as “chemistry” or“nuclear”) increases.

The usual solution, used often in the past, to promote communication and “explain” the facts, does not lead to more trust and better acceptance.

The question is often then posed: how to solve the problems of aversion and rejection of communication? No panacea is available, but at least on the technical side, it helps to show that “no matter what happens” the new technology and the systems using it or being based on it will behave safely and even in a case of an accident recover quickly. This concept is nowadays largely accepted as the “resilience analysis”, accompanying the process of risks governance and risk management.

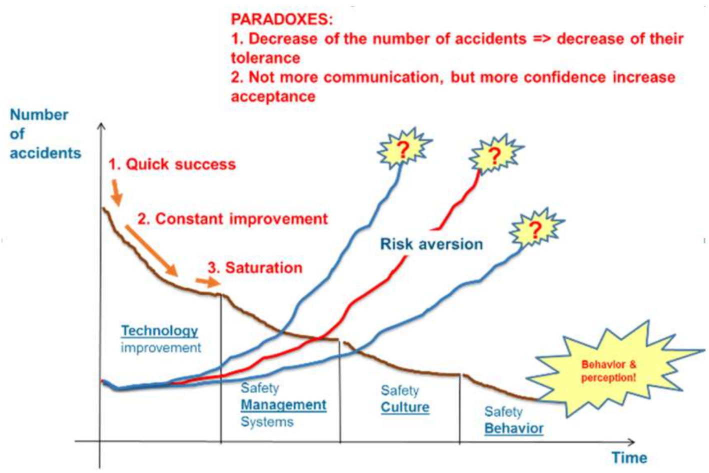

Figure 1. The risk perception paradox

6. RESILIENCE –THE ONLY WAY TO MANAGE THE “POORLY KNOWN THREATS”

The resilience concept is essentially understood as “the ability of a system to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions”[6].

A resilience management framework (Figure 1, Figure 2) includes risk analysis as a central component. Risk analysis depends on characterization of the threats, vulnerabilities and consequences of adverse events to determine the expected loss of critical functionality.

The risk is, thus, placed in the broader context of a system’s ability to plan for, recover from and adapt to adverse events over time. In the system functionality profile, risk in a system is interpreted as the total reduction in critical functionality and the resilience of the system is related to the slope of the absorption curve and the shape of the recovery curve — indicating the temporal effect of the adverse event on the system.

The dashed line in Figure 2 suggests that highly resilient systems can adapt in such a way that the functionality of the system may improve with respect to the initial performance, enhancing the system’s resilience to future adverse events.

For the area of innovation, the implication is clear: no matter the degree of “unknowns” the indicators must be established which would early enough signal not only possible risks, but also indicate the resilience of the (new) system, product, technology. Only that can be a “sustainable innovation”. This “indication” is obviously based on the concept of the so-called resilience indicators, a concept still under development.

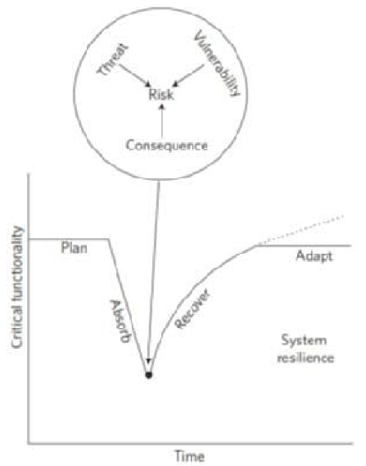

Figure 2. Risk and resilience [6]; Resilience of innovation - What we know about resilience, we know thanks to indicators

7. INNOVATION IN THE CONTEXT OF INDUSTRY 4.0 AND SHARED INNOVATION

In the concept of Industry 4.0 (see Figure 3 and details in [7]) the practical implementation of the Steinbeis concept, in the area of risk related technologies, very much looks at the issue of innovation in the "shared economy". In that sense the new franchising concept has been introduced, enabling also the geographically distant nodes of Steinbeis network to participate in the global innovation properly dealing with the challenges related to disruptiveness, inherent (un)safety of innovation and safety-related aspects of the share economy.

8. CONCLUSIONS

The "real innovation" is and should be disruptive (e.g., one cannot "order to disobey"). The "safe innovation" is often seen as something which can and should be embedded into the existing systems of institutions and regulation in charge of safety, which are, per definition, designed for and deal with known issues and apply agreed acceptance standards (e.g., the aviation safety regulation was not designed and built for the "Amazon delivery drones"). The "innovation on demand" (the share economy oriented innovation) is expected to go beyond the classical open innovation scheme sand lay an important role in the future economy. But, if the on-demand technology can work well for Uber, can the innovators, researchers, risk analysts and scientists perform equally well if reduced to the 19th century dockers crowded on the quayside waiting to be hired by the contractors? Hence, more than ever before,the success or failure of innovation will depend on successor failure of innovation risks management, but our current risks management approaches cannot fully cope with this requirement. We need new developments, possibly leading to a broadly accepted innovation risk governance framework, particularly those related to the management of time and context dependencies of innovation risks, abundances and uncertainty of the scenarios and cognitive science aspects governing the human risk perception and safety-relevant behavior in front of the "new technologies".

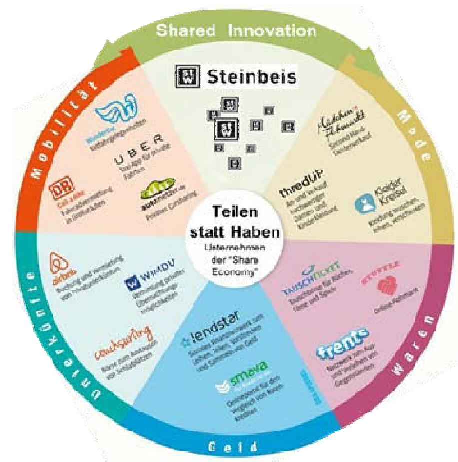

Figure 3. Shared economy innovation

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EDUCATION 3.0 AND SOCIAL NETWORK-BASED EDUCATION FOR EFFECTIVE LEARNING AND INTEGRATION WITH INDUSTRY[1]

Goran D. Putnik
Department of Production and Systems Engineering & Research Centre ALGORITMI,
University of Minho, Portugal

Abstract. *Emergent education paradigms of Education 3.0 and Social Network-based Education (SNE) are presented, as these are seen by many authors as drivers for the required change in education. Education 3.0 and Social Network-based Education (SNE) are inspired by several emergent disciplines, such as: chaos and complexity management in organizations, learning organizations, semiotics framework for system and organization integration and complex network theory. Further, the concept of Learning Factory (LF) is presented as well, as the instrument for innovative and effective true alignment of education with industry, especially for education and training for a large variety of advanced manufacturing concepts and emergent business models that re expected to characterize the 21st century manufacturing and related businesses.*

Key words: *Education 3.0, Social Network-Based Education, Learning Factory, complexity, industry*

1.INTRODUCTION

One of the main priorities of Europe 2020 agenda is smart growth, which (the smart growth) is presented by many authors as the growth based on knowledge and innovation on levels that require a shift in quality of education. In other words, the strategy of the Europe's economy growth is defined in a way that the (virtually) main instrument for its realization is seen in a shift in education paradigm, considering that the actual education paradigms could not provide required levels of knowledge and innovation.

Thus, the question is, why the actual education models cannot provide the required shift in knowledge and innovation, i.e. are effective knowledge and innovation creation processes parts of the traditional education processes (obviously not, as if it would be the case the problem would not exist) and does implementation of these processes would imply a new education paradigm ? And the answer is yes, the implementation of the processes that are perceived as more effective in creation of innovative knowledge and innovation itselfimplies a new educational paradigm.

Thus new educational paradigm is named Education 3.0 paradigm, in contrast to the traditional approaches which are classified in two large groups named Education 1.0 and Education 2.0 paradigms (of which the Education 1.0 represents older models than Education 2.0). (Curiously, some of the nowadays education models very recently developed and implemented, and presently under implementation at many universities under the label "advanced", could be already classified as "traditional" too, when comparing with the Education 3.0 paradigm features).

The subject ofthis paper is emergent education paradigms Education 3.0 and the Social Network-based Education (SNE) model (that belongs to the Education 3.0 paradigm).

Further, the concept of Learning Factory (LF) is presented as well, as the instrument for innovative and effective true alignment of education with industry, especially for education and training for a large variety of advanced manufacturing concepts and emergent business models.

There is also discussedconceptual framework for education 3.0 implementation.

2.EDUCATION 3.0

Education 3.0 is characterized in [1] *"by rich, cross-institutional, cross-cultural educational opportunities within which the learners themselves play a key role as creators of knowledge artefacts that are shared, and where social networking and social benefits outside the immediate scope of activity play a strong role"*.

According to [1], three aspects of Education 3.0 are of particular importance:

(1) The freedom of students in making their own choices;

(2) The concept of students as producers of reusable learning content;
(3) Institutional arrangements permit the accreditation of learning achieved, not just of courses taught.
In Table 1, a level of transformative capabilities and practices for education 3.0 in the 21st century are described, in accordance with some authors.

Table 1. Education 3.0 features (extracted from [1], Table 1: Educational generations in higher education)

Features	**Education 3.0**
Primary role of professor	Orchestrator of collaborative knowledge creation
Content arrangements	Free/open educational resources created and reused by students across multiple institutions, disciplines, nations, supplemented by original materials created for them
Learning activities	Open, flexible learning activities that focus on creating room for student creativity; social networking outside traditional boundaries of discipline, institution, nation
Institutional arrangements	Loose institutional affiliations and relations; entry of new institutions that provide higher education services; regional and institutional boundaries breakdown
Student behavior	Active, strong sense of ownership of own education, co-creation of resources and opportunities, active choice
Technology	E-learning driven from the perspective of personal distributed learning environments; consisting of a portfolio of applications

3. SOCIAL NETWORK-BASED EDUCATION

Social Network-based Education (SNE) basic features are described shortly in [2], as follows:
"*SNE is inspired by several emergent disciplines, such as: chaos and complexity management in organizations (e.g. [3]), learning organizations (e.g. [4]), semiotics framework for system and organization integration [5] and complex network theory (e.g. [6]).*
In SNE, students and teachers are seen as participants that form a network, in which the network structure, communication, learning process and behaviourexhibit features of a social network.
Social network is a kind of complex network. Complex networks are distinct from regular networks by several features: heterogeneity, self-organization, modularity, "emergent architectures with unexpected properties and regularities", "communities, motifs, hierarchies and modular ordering" [7] and similar.
The SNE implementation according to [2]provides "*a collaborative environment where participants have freedom to choose and work on the assignments they find more relevant and stimulating for their own objectives. They can interact with each other and edit documents at the same time, fostering their development in terms of collaboration, agility and self-organization*".

4. LEARNING FACTORY (LF)

The concept of Learning Factory (LF) is not new, it has appear about 25 years ago- However, the interest in this concept has increased significantly over the last years. LF could be considered as one of the most modern advanced instruments for enhancing education and training especially when addressing the dimension of "real-world problem solving", which is intrinsically related to industry, implying integration of the education system with the industry. LF represents a "*paradigm shift to industry-partnered, interdisciplinary, real- world problem solving in engineering education*" [8]. The goal is to "*integrate design, manufacturing and business realities into engineering education*" and this can be accomplished by providing a "*state-of-the-art, hands-on active learning laboratory, a practice-based curriculum, and real (industry-driven) projects*" [9].

A general model of a LF environment is represented in Figure 1 [10]. The orange arrows represent enterprises' orders (tasks, assignments), the green ones the execution of these orders and the blue ones some solutions provided by students and researchers. Implementation of LF logical general architecture could be realized in a number of concrete physical settings different learning objectives. However, addressing Education 3.0 and SNE, a specific LF model could be of interest. One of these specific LF models is a model developed at the University of Minho, in cooperation with a start-up company, presented on Figure 2. It is an Internet-based environment capable to integrate with industry in real-time providing capability to the industry to put their real-life tasks as work-assignments for students as well as for many other objectives.
In other words, the LF model developed – presented on Figure 2 – represents the instrument for innovative and effective true alignment of education with industry, especially for education and training for a large variety of advanced manufacturing concepts and emergent business models, such as:

- Internet-based work (design, management, operation);
- Product/Service Systems (PSS);
- cloud and ubiquitous manufacturing systems and enterprises;

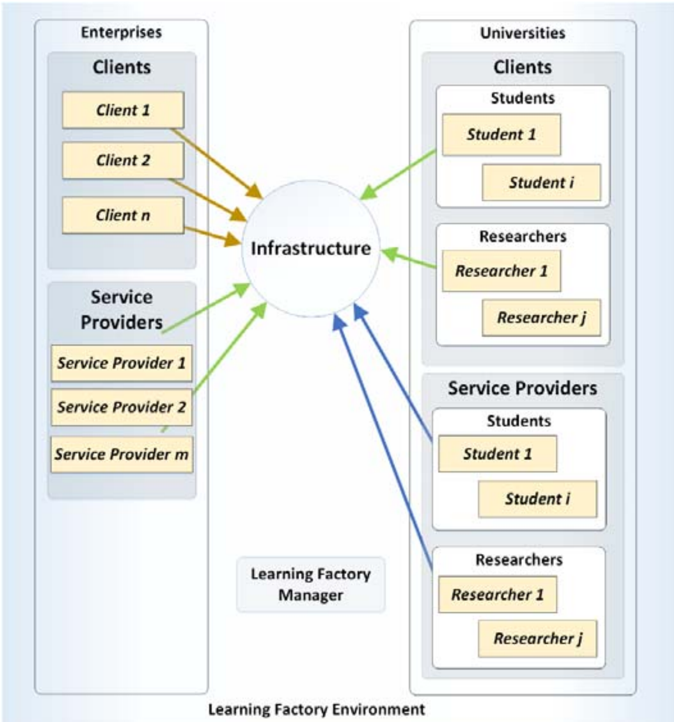

Figure 1. Informal view of Learning Factory environment logical general architecture [10]

- virtuality;
- agility;
- networked organization/ networking (supply-chain);
- social network-based and community-based manufacturing/production;
- crowdsourcing;
- open system architecture-based organization;
- learning organization;
- entrepreneurship;
- advanced ICT;
- complexity management in organization;
- integration and interoperability in organizations;
- Cyber-physical system (CPS);
- negotiation;
- human-centred view of organization vs technology-centred;
- game theory and use of serious games for organization management, decision making and design;
- competition-based environments (markets) and organizations (concurrent engineering);
- collaboration-based environments (communities) and organizations (collaborative engineering);
- large-scale open-ended projects;
- open-source projects;
- Web 3.0 & 4.0 –based organizations;
- Industry 4.0; and similar,

as virtually organizational and business models that will characterize the 21st century manufacturing and related businesses.

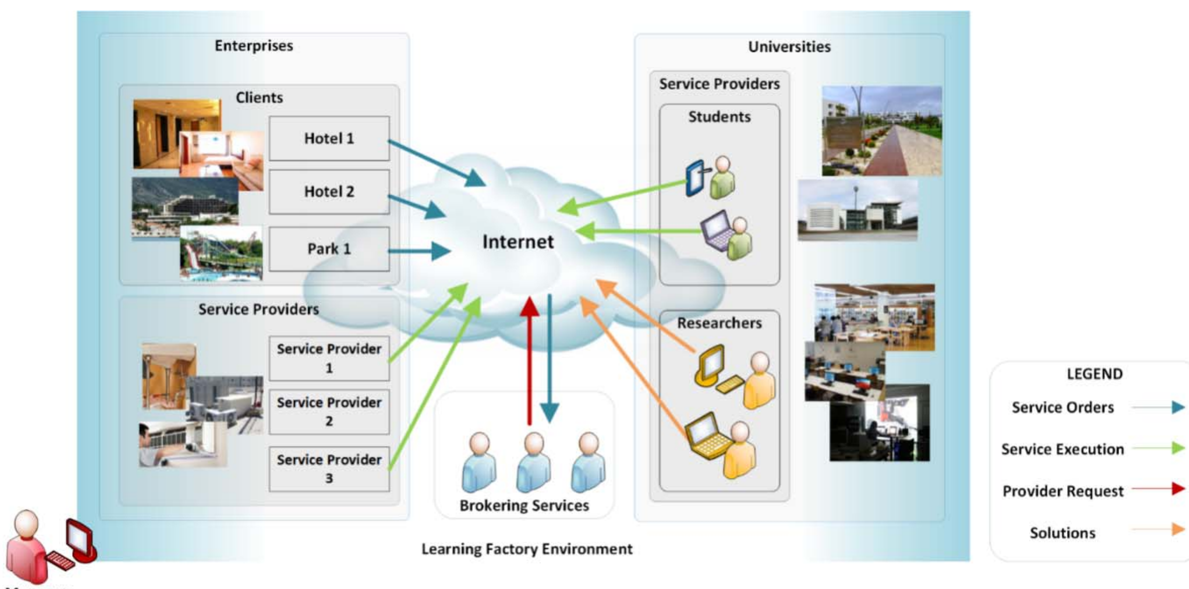

Figure 2. Learning Factory logical architecture with Internet-based platform [10]

5. CONCEPTUAL FRAMEWORK FOR EDUCATION 3.0 AND SNE IMPLEMENTATION

A conceptual framework for education 3.0 and SNE implementation should address several domains (dimensions), including interaction architecture, management, teaching and learning methodologies, curricula development, space and time[2].

Table 2, presents one of the frameworks developed for Education 3.0 and SNE implementation, addressing several Education 3.0 and SNE dimensions, with a comparison with the actualeducation models, such as Education 1.0 & 2.0 today widely used in European education systems.

Table 2. Framework for Education 3.0 Implementation (modified according to [2])

Dimensions	Implementation	
	Education 1.0 & 2.0	**Education 3.0**
System Thinking	Linear	Complexity
Learning	Individual Group	Generative Collaborative Proactive Unlearning
Teaching Method	Direct instruction PLE Seatwork	Blended Game based Co-teaching Hands-on activities
Interaction architecture	Client/server	P2P Cloud Hybrid
Management	Coordination	Semi-coordination Collaborative Self-organization
Curricula construction	Pre-defined	Open Semi-open
Space	Colocated Distributed (global)	Colocated Distributed (global)
Time	Syncronous	Syncronous Asyncronous
Population	Individual Group	Group Massive
Access	Closed	Open Conditioned
Knowledge base	IP Copyright	Open source
Supporting ICT technology	Proprietary	Open source Proprietary
Supporting ICT license	Open source Comercial	Free Open source
Business model	Subscription	Free Freemium Service-based

The conceptual framework presented providescriteria for differentiation between traditional Education 1.0 & 2.0models with Education 3.0 models and alternative implementations forms and technologies that could be employed in proposed Education 3.0 model.

6. SNE AND LF EXPERIMENT AT THE UNIVERSITY OF MINHO AS AN EDUCATION 3.0 EXAMPLE

SNE and internet-based LF platform are introduced at University of Minho as the Education 3.0 prototype implementation, and as further advances of the PLE (Project Led Education) experience that (PLE) has run successfully already for several years.

SNE and the Internet-based LF platform are implemented for the areas of CAD/CAPP and CAM already since the 2^{nd} semester of scholar year 2012/2013 and from the beginning of scholar year 2014/2015 their use was extended additionally for two additional subjects, namely for the subjects/areas of 'Advanced Quality Management' and 'Reliability and Maintenance', all subjects within the Integrated Master course on Industrial Engineering and Management. As an illustration, it could be referred that for the 4 subjects involved in the prototype implementation was launched about 900 tasks, i.e. work assignments for students, among which they could choose freely which tasks to work on, in which number of tasks, when and where, and in which manner to acquire necessary knowledge.

In other words, students are allowed to study independently new conceptual material before it is exposed in classroom by professor [2]. Even professor's (traditional) lectures could be seen as a service that are launched only upon students requests when they need it for faster tasks execution or problem solving .In that way the students can learn intended contents faster and in a more agile manner. The methodology promotes development of a number of veryimportant technical and soft skills, such as work agility, problem-solving and self-organization.

In Table 3, the implementation of the SNE and the Internet-based LF platform is specified according to the implementation framework presented in above.

Table 3. Specification of the experiment at the University of Minho using the Education 3.0 implementation framework (modified according to [2])

Dimensions	Implementation at the University of Minho	
	Education 1.0 & 2.0	**Education 3.0**
System Thinking	-	Complexity
Learning	Individual Group	Generative Collaborative

		Proactive Unlearning
Teaching Method	-	Blended Game Based Hands-On Activities
Interaction Architecture	-	Cloud
Management	-	Self-Organization
Curricula Construction	-	Semi-Open
Space	-	Distributed (Global)
Time	-	Asyncronous
Population	-	Group Massive
Access	-	Conditioned
Knowledge Base	-	Open Source
Supporting ICT Technology	-	Open Source
Supporting ICT License	-	Free Open Source
Business Model	-	Service-Based

7. CONCLUSIONS

The prototype implementation of the Education 3.0 paradigm in the form of SNE and with use of the internet-based LF platform as its model, at University of Minho, is already running for three school years and its quality, advantages and benefits, comparing with traditional education methodology is systematically tested through the questionnaires given to students at the end of each teaching semester. The results of survey through questionnariescould be ratedas very positive and encouraging. Accordingly, they are giving a solid base for continuation and spreading of the proposed methodology.

However, the full implementation of the paradigm is still constrained by a number of constraints, such as, for example, teachers' awareness of the education paradigms, the required levels of agility to achieve, etc. One of the main constrains, which apparently will be most difficult to overcome, are the traditional "institutional arrangements" referring to the universities' traditional "business models".

The future workshouldaddresssurelyfurther methodology implementation, spreading, testing and improvement.

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FACILITATING PROBLEM-BASED LEARNING WITH AN INVERTED CLASSROOM

Teodora Rutar Shuman[1], Gregory S. Mason[1], Yen-Lin Han[1], and Kathleen E. Cook[2]
[1]Mechanical Engineering Department, Seattle University, USA
[2]Psychology Department, Seattle University, USA

Abstract. *This paper presents motivation, implementation, and preliminary results from a research project sponsored byaNational Science Foundation (NSF) grant titled "Facilitating Problem-Based Learning with an Inverted Classroom."The objective of this project is to develop an instructional framework that promotes self-directed learning and enhances problem-solving skills in undergraduate engineering students without sacrificing knowledge of fundamental engineering principles. The instructional framework uses an Inverted Classroom (IC) to facilitate Problem-Based Learning (PBL). To facilitate an IC, material traditionally covered in a lecture format is moved outside of class time, developed for an on-line format, and made available in an online learning management system. PBL uses engineering problems co-developed with industrial partners from aerospace, medical device, HVAC and process industries. The framework is implemented in a Heat Transfer course that is offered in traditional (control) and IC-PBL settings. Student self-directed learning and problem-solving skills indicate improvement in IC-PBL over traditional setting.*
Keywords: *Problem-based learning, inverted (flipped) classroom*

1. INTRODUCTION

One of the challenges of modern engineering education is that programs must address not only technical topics but also prepare graduatesfor real engineering practice. More often than not, engineering practice means solving open-ended and ambiguous problems in rapidly changing technical environment. Furthermore, industry is looking for graduates who require little-to-no on-the-job training in order to boost their profits. These trends present new challenges for engineering education and may require adoption of novel teaching methods.

One method for teaching problem solving is Problem Based Learning (PBL). In PBL, students are tasked with solving large open-ended problemsduring class-time and under supervision of instructor. Problems are crafted so that the students must address and learn technical content from the course. PBL has been shown to be an effective framework for teaching engineering fundamentals within the context of open-ended problems. Studies [1,2] show improved learning when classroom instruction is problem-based as well as an improved ability to solve open-ended problems [3].

PBL has two notable drawbacks. First, PBL students often perform poorer than those taught in a traditional class when tested using standardized tests on fundamental engineering principles [4]. This is especially true for self-paced and self-directed PBL activities [5]. This problem is usually overcome by creating a PBL environment that is structured, assessed, and supported [6]. Second, extra class time is necessary for solving open-ended problems, which leads to a reduction in the total number of concepts covered in a course [7].

An inverted (or flipped) classroom can free class time with minimal effect on content and so provides a promising framework for PBL instruction. In an Inverted Classroom (IC), lecture material is moved outside of the class, freeing in-class time for learner-centered activities. Course content is delivered through a variety of mediums including screen-capture videos, simulations, interactive problem solving and other online materials [8,9].

The Inverted Classroom approach has been shown to be an effective delivery method in several studies [10,11]. The IC does not negatively affect student performance on traditional class and standardized tests [12]. IC can promote self-directed learning and help develop professional problem solving skills because the format teaches the student to find and interpret the information needed to solve problems [13].

Challenges with the Inverted Classroom can be overcome by (1) requiring an online quiz before class to ensure preparedness, (2) keeping videos less than 30 minutes, (3) fixing student misconceptions by spending the first 10 minutes of class answering questions or holding mini-lectures, and (4) using multi-media for online content to engage students [8,9].

Those results suggest that an IC and PBL could be successfully integrated to improve student self-directed learning and problem-solving skills without sacrificing a strong understanding of fundamental engineering principles.

This paper is a continuation of a paper presented at the 2015 ASEE Annual conference in the NSF Grantee's Poster Session [14]. The new material includes implementation details and preliminary results obtained after applyingindustry-supplied PBL assignments in a heat transfer course that is taught using an IC framework.The project, funded by the National Science Foundation [15], began in 2014 and is expected to conclude at the end of 2015. The remainder of this paper describes the project and progress to date.

Projectoverview

The goal of the project is to improve self-directed learning and students' problem-solving skills while maintaining the number of engineering concepts taught in a course and student understanding of fundamental engineering principles. This is accomplished by using an IC to facilitate PBL. This instructional framework is being implemented in a Heat Transfer mechanical engineering course. Screen-capture video lectures, tutorials, and classic homework-style example problems is moved outside of the classroom. In-class time is used primarily to solve authentic engineering problems supplied by industrial partners. The partners supply problem statements, documentation, experimental data, and vendor specification sheets. Course materials are available to students in a web-accessible Learning Management System (Canvas) [16].

Two essential project goals are to:

1. Develop and implement an instructional framework using an Inverted Classroom to facilitate Problem-Based Learning, and
2. Evaluate the effectiveness of this instructional framework on student performance and attitudes.

2. IMPLEMENTATION

The instructional framework was developed and then tested in a Heat Transfer course. The framework is loosely based on Bloom's Taxonomy. By inverting the classroom, knowledge and comprehension is attained through videos and other on-line resources outside of the classroom; application, analysis and synthesis is attained through PBL using authentic, open-ended engineering problems. The project is being implemented in two phases.

Phase I: Establishing a control for the study

In the first year of the study, the heat transfer was taught as a traditional course, using a classical textbook [17]. This serves as the control for the study and provides a reference for comparison with an IC-PBL course. Heat Transfer is taught in the junior year over a 10-week quarter. The course is taught in three 65-minute classes per week with a 90-minute laboratory session once per week. Table 1 lists the topics covered in the course.

Table 1: Heat Transfer Topics

Conduction	Convection	Radiation
Conservation of energy	Newton's law of cooling	Planck's law
Conduction rate equation	Convective heat transfer coefficient	Wein's displacement law
Heat diffusion equation	Boundary layers	Blackbody radiation
Boundary and initial conditions	External flow	Radiation geometry
1-D, steady-state conduction	Internal flow	Surface properties
Conduction with thermal generation	Natural (free) convection	Radiation exchange
Extended surfaces: fins and pins	Heat exchangers: Basic design	
2-D conduction	Heat exchangers: LMTD method	
Transient conduction	Heat exchangers: Effectiveness/NTU method	

During Phase I, detailed assessment data was collected on student performanceon all individual exam, quiz, and homework problems. These will be mapped to specific course topics, see Table 1, and used as a baseline for comparing student learning in the traditional course versus the IC-PBL framework.

Two open-ended design problems were assigned, one early and the other late in the quarter. Students were given a week to solve each. The instructor acted as the client for the problem and so did not provide any technical assistance. At the end of the project each student gave a five minute presentation to a panel of three faculty members. They were graded, using a rubric developed specifically for this assessment.

Students in the traditional course completed the Heat and Energy Concept Inventory (HECI) test [18]. This test is designed to evaluate the following four concepts: a) temperature vs. energy, b) temperature vs. perceptions of hot and cold; c) factors that affect the rate vs. amount of heat transfer; d) thermal radiation. Data from this assessment will be compared with test results from students in the IC-PBL course and used to determine differences in student's understanding of basic heat and energy concepts.

Three original assessment tools were developed and applied end-of-term to: a) discern students' understanding of real-world engineering activities. b) measure students' interest in, commitment to, liking in, and identification with engineering programs and careers, and c) measure students' confidence and efficacy in their engineering skills. Data from this assessment will be compared with test results from students in the IC-PBL course.

Phase II: IC-PBLImplementation

In Phase II of the project, the heat transfer course was taught again by the same instructor. This time the course was taught with an IC and PBL. The course was implemented in the following way:

1. Open-ended, authentic engineering problems, designed by faculty and industrial partners, and evaluated by academic partners, were introduced in class to provide motivation and context for self-directed learning assignments. See Table 2 for an example of an authentic engineering problem.
2. Students were given 4 to 5 class periodsto solve the problems in teams. The course instructor facilitated a discussion among students and guided them to determine the knowledge they must gain and information they must gather to solve each problem.
3. Students learned the needed fundamental engineering principles outside of class time through the ICby identifying and watching 8-12 minute videos and studying other materials on Canvas. This scaffold approach is expected to help to develop students' ability to self-direct their learning. An online quiz associated with each topic encouraged students to watch the videos and study other database materials in preparation for PBL sessions and exams in class.
4. In-class activities include occasional mini-lectures, demonstrations, and questions/answer sessions to correct student misconceptions and build upon knowledge acquired from self-directed learning. In class exams were given periodically to assess the engineering fundamentals.
5. Detailed assessment data was collected on student performance on all individual exam, quiz, and homework problems.
6. Other assessment tools included the HECI and the same original end-of-term assessment tools as those applied in the traditional setting (see above). Additional assessment tools were developed to evaluate project performance and student problem-solving skills.

Table 2: A PBL with learning objectives and on-line resources

PBLProblem Statement	Cells and tissue are sensitive to heat and will die if they become too hot. The time for 90% of cells to die at 46degC is approximately 10 hours while at 70degC is approximately 1 minute. Some medical devices capitalize upon this fact and attempt to selectively heat tumor tissue to inactivate the malignant cancer cells.If a tumor that is 2 cm in diameter is heated with electrical energy, emanating from a probe in the center of the tumor that is 2 mm in diameter, how much electrical power is needed to inactivate (90% cell death) the tumor? **Industrial Partner:**Spiration Inc. (d.b.a. Olympus)
Objectives	Student will be able to: 1. Identify necessary inputs to the systems 2. Research and understand appropriate Arrhenius curve for the system 3. Research thermal properties for cells 4. Conduct an energy balance on the system 5. Determine power needed to inactivate the cells 6. Compare times to inactivate the cells for different inputs 7. Calculate heat transfer to surrounding tissue 8. Compare calculated results to experimental data supplied by industrial partner
On-line Resources	Video Topics: 1. Conservation of energy 2. Conduction with thermal generation 3. Transient heat transfer Support Information: 1. Example problems 2. Experimental data

3. PRELIMINARY FINDINGS

A key component of this project is the research measuring the effect of the teaching framework on student self-directed learning and problem solving, understanding of fundamental engineering principles, and knowledge of and attitudes towards the engineering profession. The data analysis has only just begun, so the following findings are only preliminary at this time:

- Using the IC-PBL format, the instructor was able to cover the same amount of content as using a traditional format.
- Students in the IC-PBL performed better on exams than those in the traditional course, although these results have not been adjusted for potential differences in the class populations.
- Students in IC-PBL performed better on open-ended design problems. That is, they presented solutions that were more realistic.
- The IC-PBL format needed to be administered carefully. It's easy under this format to overwhelm students with work.

4. CONCLUSIONS

The goal of this project is todevelop an instructional framework that addresses students' ability to solve open-ended design problems and their knowledge of fundamental heat transfer topics. The framework uses an IC format to disseminate fundamental course concepts, freeing class time for PBL activities. The project studies this new framework in the context of a Heat Transfer course. Learning resources, a description of PBL activities and assessment toolswas completed in June 2015. Preliminary results indicate that students in IC-PBL learn deeper and can solve open-ended problems better than those in traditional settings. The anticipated completion date for the project is the end of 2015.

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SAFETY IN CRANE OPERATIONS: AN OVERVIEW ON CRANE-RELATED ACCIDENTS

Maria Francesca Milazzo[1], Giuseppa Ancione[1], Vesna Spasojevic Brkic[2]
[1]Dipartimento di Ingegneria Elettronica, Chimica e Ingegneria Industriale (DIECII), Università degli Studi di Messina, Italy
[2]Faculty of Mechanical Engineering (FME), University of Belgrade, Serbia

Abstract. *Moving large and heavy loads in manufacturing and construction industries is made by means of cranes. Until now, much technology has been developed for these operations, but there are significant safety issues to be considered. Cranes are amongst of the most dangerous equipment used in both the industry and construction sites. Despite the risk awareness, incidents in crane's operations have not substantially decreased; most of them arise from wrong load handlings, poor visibility in moving loads, etc. Their dangerousness has special relevance in the chemical process industry and the intermodal transport, where accidental events could also generate the release of hazardous substances. This paper focuses on safety in crane operations, the main causes of accident will be identified and a statistical analysis is presented with the aim to drawn some conclusions and comment about future trends of research about this issue.*

Key words: *Industrial safety, Crane accident, Load displacement, Human error, Cause of failure.*

1. INTRODUCTION

Cranes are widely used in the construction industry to move materials, in the transportation to load/unload cargos, in the manufacturing industry to assemble heavy equipment, etc. [6]. When installed and properly used, cranes make operations easier and safer. Nevertheless, even if the technology and risk awareness have substantially increased, safety still needs to be improved, as underlined by many crane-related accidents occurring each year worldwide.

A tipped, dropped or mishandled load can directly injure workers or potentially upset the equipment. Databases show that accidents occur in each crane typology (such as tower cranes, overhead cranes, mobile cranes, etc.); however, the highest rate of incidents is usually associated to the mobile type.

Crane accidents could be more severe if they occur in the chemical process industry and intermodal transport, where hazardous substances are handling. As an example, in 2011 an incident occurred in the Orica Chemicals refinery at Kooragang Island, near Newcastle, in New South Wales; this event involved a mobile crane and was due to the overturn of the machine after that one of its outriggers punched through the ground into some sort of void [16]. In such case, the release of dangerous substances could also take place and, depending on the characteristics of the released substance, the event escalation could also generate fires, explosions and toxic dispersions.

Several crane-related incidents are also caused by the contact between the load and objects or other equipment; this is mainly due to the limited visibility for the crane operator. Significant are also incidents due to the contact with powerlines [7].

This paper is focused on safety in crane operations: the first part present the methodology adopted for the investigation of incidents, which is based on a short description of the risk factors (hazards or initial cause of accidents) and the identification of associated accident typologies; the second part gives the results of a statistical elaboration of the collected accidents; a brief discussion about the results concludes the work with the aim to comment about future trends of research concerning this issue.

2. METHODOLOGY

To investigate the issue of the safe in crane operations, the adopted methodology starts with the analysis of main related risk factors and, then, some databases of accidents have been analysed to collect data and identify the main initial causes of accident.

2.1 Crane safety issues

Cranes use one or more simple machines to create mechanical movement for the displacement of loads. The load movement is controlled either by an operator, placed in a cab that travels along with the crane through a push button pendant control station, or by radio type controls. The crane operator is ultimately responsible for the safety of the crews and the crane [13]. Another cause of failure can be found in crane design [2]. According to [5], crane issue reports show that poor human performance is increased over time as a cause of failure and it currently accounts between 70 and 80 percent of all detected problems. In U.S. nuclear industry, the human error rate for very heavy load transport accounts 56 % and is less than the human error rate observed when considering other crane uses (73 percent). The same report [5] gives data for the energy sector, it can be seen that the human error contribution is about 94% (the same value has been observed in navy cranes), where improper operation, improper rigging and procedure failures account approximately 88 %.

The trend of the poor human performance in period 1969-2002, as a cause of crane issues, is shown in Figure 1.

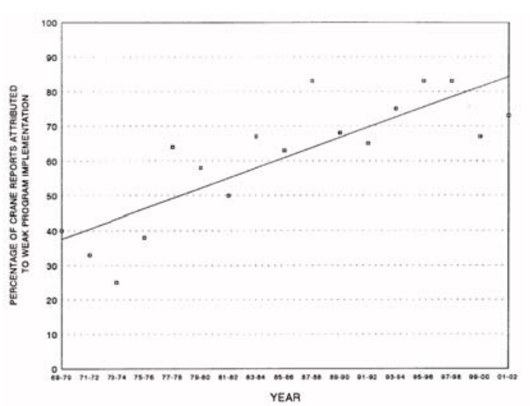

Figure 1. Trends of poor human performance as a cause failure in crane operations [5].

According to Shapira and Simcha [8], which paid special attention to tower cranes, human factor is a dominant factor, affecting the site safety due to tower-crane operations, within which operator performance has the highest weight. This has also been confirmed by the survey reported in [10].

2.2 Hazard types

There are multiple hazards that can arise during cranes' operations. Many accidents involve lift systems, such as in tower cranes and mobile cranes, but other hazards do exist by operating with all types of cranes and in all facets of crane operation [15]. According to the American Federal Agency OSHA (Occupational Safety and Health Administration) the major causes of cranes-related accidents are [11]:

- Contact with powerlines
- Overturns
- Falls
- Mechanical failures

The causes of accidents, listed above, could determine the following main causes of fatality for workers, which were identified by the CPWR (Center for Construction Research and Training) [4]:

- Electrocution
- Struck by crane load
- Crane collapse
- Struck by falling boom

There are also several near misses that should have the potential to escalate into incidents that incurred massive damages to both human lives and physical properties. The magnitude associated with such events increases with the decrease of the number of incident according to the Bird triangle [3].

Table 1-4 summarise the main initial causes of fatal accidents for each cause of fatality listed above. Data refers to the period 1992-2006 and have been collected from U.S. Bureau of Labor Statistics - Census of Fatal Occupational Injuries (CFOI) [12].

Table 1. Overhead power lines / Electrocutions

Causes of incident	**[%]**
Contact of workers with cable	52
Crane operations	25
Contact of worker with crane	13
Other / unknown causes	10

Table 2. Struck by crane loads

Causes of incident	**[%]**
Workers accidental involved in the accident (except crane operators)	32
Workers flagging/directing/guiding the load movement	14
Loading / unloading	32
Crane operations	7
Other crane-related work	15

Table 3. Crane collapses

Causes of incident	**[%]**
Uneven / unstable or icy surface	15
Crane cables / rigging / broken stabilisers	14
Crane load / boom shifted	9
Overloaded	12
Other / unknown causes	51

Table 4. Struck by Falling Booms

Causes of incident	**[%]**
Dismantling boom	56
Broken boom / broken boom cable	13
Lengthening boom	9
Other / unknown causes	22

3. RESULTS

The analysis of the available databases allows commenting about crane-related accidents. The graphical elaboration, given in Figure 4, highlights that in a reasonably long period (from 1992 to 2006) the number of fatalities in crane-related accidents (occurred in the construction industry) have not undergone a significant reduction. The trend could be considered constant.

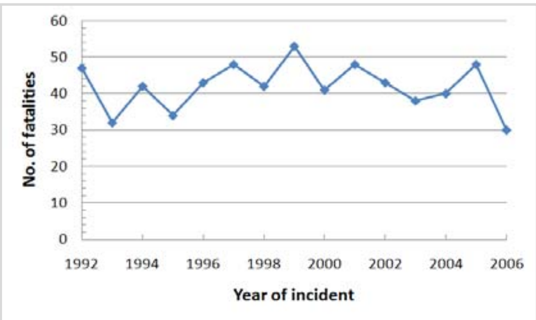

Figure 4. Trend of the number of fatalities associated with crane-related accidents in construction [4].

Figure 5 summarises the major causes of lethal accidents [4] and provides the overall percentages of fatality for each of them. Furthermore it is important to underline that several other crane accidents determine injuries and equipment damage and property losses. These consequences determine undesired stops due to the absence of operability (missed work days) and increasing insurance rates.
A study, done by OSHA in 1997, reported that the majority of crane accidents are non-fatal and most injuries do not involve crane operators but other workers (such as ironworkers, riggers, carpenters [11] and sometimes bystanders, rescue workers, etc.).

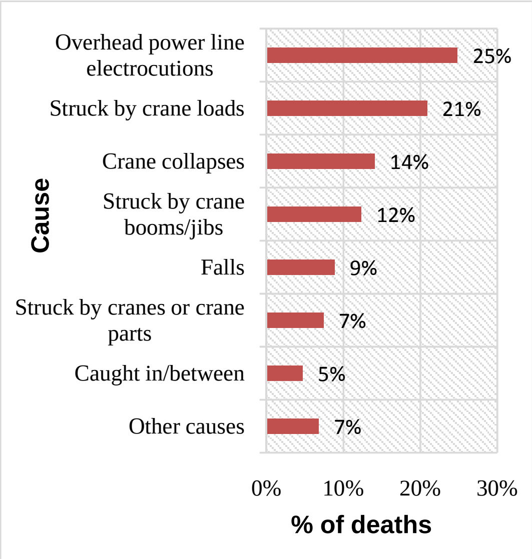

Figure 5. Causes of crane-related deaths [4].

3.1. Future trends of research

In order to minimise visual problems, improving safety and preventing crane related fatalities and injuries, some authors [9] identified the critical characteristics of existing crane cabins linked to the visibility and the posture by using users' opinions and Pareto analysis.
As highlighted by the literature [1], incidents due to impacts between the crane or its load and objects or other equipment are often due to limited or poor visibility of the surrounding workspace (from the crane operator point of view). The crane navigation system is an important and challenging phenomenon, with a great potential for safety improvement. Although the typical crane operator interface seems simple in terms of the number of controls to be manipulated, moving the spreader quickly and accurately, with or without a container, requires an exceptional sense of its dynamics, including how to effectively stop the moving mass often facing the "stabbing in the blind" scenario. To fill this gap a project, entitled *Smart PRocess Industry CranEs* (SPRINCE), was recently funded with the aim to improve the safety for crane operator by implementing an innovative real-time detection system of objects and developing a risk indicator for the implemented solution.

4. CONCLUSIONS

Accidents involving cranes can severely damage people and companies. Unfortunately these show a constant trend in term of number of fatalities over the years. By analysing the causes of accidents, the highest percentage is associated with the electrocution, but the contribution of impacts with the load and the crane (strikes) is also significant.
To further improve safety, there is the need of a more integrated approach, where design safety and safety in the use fields are considered as one entity [2], with more attention paid to human error issues. The literature has highlighted the main needs for crane design (capability to be safely operated, easy maintenance and reduction of typical human problem factors), but up to now worldwide research has not been focused on the crane navigation system. The need of a new solution for crane visual tension problems has emerged from this investigation of accidents and will be partly faced within the SPRINCE project.

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CRANE CABINS' SAFETY AND ERGONOMICS CHARACTERISTICS EVALUATION BASED ON SWEDEN PORT DATA

Zorica Veljković[1], Vesna Spasojević Brkić[1], Aleksandar Brkić[2]
[1] Faculty of Mechanical Engineering, University of Belgrade, Serbia
[2] Innovation Center, Faculty of Mechanical Engineering, University of Belgrade, Serbia

Abstract. *This paper presents an evaluation of crane cabins safety and ergonomics characteristics. It is based on previous research data collected for benchmarking analysis for crane cabins operating in one port in Sweden. Six crane cabin types are examined regarding eight characteristic divided in three groups: operator-control devices interaction, safety and anthropometric adjustment according to needs weighting data. Analysis of those data was conducted using indexes of characteristics performances, as well as Pareto analysis and final comparison. Taking into account all examined crane cabins only 52.5% of operator- control devices interaction, 75% of safety and 60% of anthropometric adjustment issues are satisfied in current designs.*

Key words: *crane cabin, operator-control devices interaction, safety, anthropometric adjustment, Pareto analysis, crane indexes of performance*

1. INTRODUCTION

Till today there is not large extent of research in the field of crane cabins convenience to the operator. One of rare research is the ergonomics field is conducted in steel plant in India on overhead crane showing large number of musculoskeletal disorders due to awkward work postures and insufficient vision angle [4]. Another study, which is in great extent connected to the subject of this paper was conducted in Sweden and they propose more user/friendly design [1]. The third research is based on anthropometric characteristic analysis to improve safety and prevent crane related fatalities and injuries [7]. Other authors mainly identify basic or individual characteristics of crane cabins without adequate analysis [2,3] such as sitting, visibility and noise issues, the existence of fire extinguishers, labeling the symbols, accessibility to cabin etc. [4,5,6]. In recent years slight shift is made toward serious research in order to design crane cabins with better ergonomic and safety characteristic which are economically viable [7, 8, 9]. However, the importance of studying of this problem greatly exceeds the number of published papers. Back and lower limb disorders occur very often to crane operators [10] and almost 30% of them feels extremely uncomfortable [7,11]. In construction and maintenance sectors cranes contribute to one-third of all fatalities, while large numbers of injuries and deaths is also encountered in transportation, manufacturing and warehousing industry sectors [7,12].

According to evident need this paper describes continuation of research on evaluation of crane cabin characteristics that operate in one Sweden port. It is based on benchmarking research data of Nordin and Olson [1] which is conducted in 2008. Results of their research are analyzed by Pareto method in order to obtain more precise data important for future crane cabins' design.

Table 1. Modified benchmarking table with grading criteria [1]

		characteristics	grading criteria	Lulea port	Liebherr	Krupp (LMG)	MHI	Tsuji	MacGregor GLB
1	USI	Understandable signals	5	4	4	2	1	1	4
2	USY	Understandable symbols	4	1	4	1	1	2	4
3	SCD	See the content of the display	4	4	3	1	1	1	2
4	SCC	See the cargo, wharf and closest surrounding	5	4	3	4	1	3	3
5	FIC	Fixed items in cabin	4	3	4	4	4	3	4
6	RSP	Robust and steady parts	4	4	4	3	3	3	4
7	LEI	Logical and ergonomically correct placement of indicators and regulators	5	4	2	2	1	1	2
8	AWP	Adjustable work posture	5	5	2	4	1	2	2

Basic table from Nordin and Olson [1] for benchmarking (Table 1) was the starting point of this research. Semi-structured interviews with experienced crane operators and design according to [1] have shown that the following needs have to be satisfied to fulfill ergonomics and safety features: (1) the operator must see the cargo, wharf and closest surrounding (2) the operator must understand signals and symbols in cabin (3) the operator has the need to see the display (4) all parts in cabin must be robust and steady due to often careless behavior of operators (5) the placement of indicators and regulators must be logical and ergonomically correct (6) the operator has the need for adjustable work posture and (7) there is a need to have all items fixed in cabin due to risk of theft.

As shown in table 1. this research is based on examination of eight criteria on six different crane cabins' design solutions. It is presumed that Lulea port cranes have the same cabins for all cranes regardless crane manufacturer or crane characteristics [1]. Grading criteria are based on Likert scales 1 to 4 and 1 to 5 depending of examined characteristic, where 1 represents that examined characteristics doesn't fulfill the operators' needs for required characteristics, while 4 or 5 represent that it fulfills all desired characteristic criteria.

Further distribution of characteristics (Table 1) is conducted by dividing them in three major groups [1]:

- operator- control devices interaction (Table 1, characteristics 1-3),
- safety (Table 1, characteristics 4 and 5) and anthropometric adjustment (Table 1, characteristics 6-8).

2. METHODOLOGY

2.1. Measurement of index of performance of characteristics

Purpose of this analysis includes comparison between characteristics, impacts of individual characteristics on types of crane cabins, as well as overall appraisal of characteristics of different crane cabin types and appraisal from group types point of view. In order to compare different types of crane cabins (Table 1), scores obtained by Likert scale were transformed and equalized by introduction of index of performance *IP* and crane index of performance *CIP*.

Index of performance of characteristics can be defined as:

$$IP_{ij} = g_{ij} \Big/ \max\left(c_j\right) \tag{1}$$

where IP_{ij} is the index of the single characteristic (i=1...6) for individual cranes (j=1...8) from Table 1, g_{ij} is grade for crane characteristics, while $c_{j,}$ is maximum value of Likert scale for observed characteristic.

Crane index of performance *CIP* is the sum of individual values of *IP* (1) for certain crane, i.e.

$$CIP_i = \sum_{j=1}^{8} IP_j, \mathrm{i} = 1,...,6 \tag{2}$$

where CIP_i is one of the cranes i=1,..,6.
Those results are presented in Table 2.

Table 2. Values of IP and CIP for observed cranes

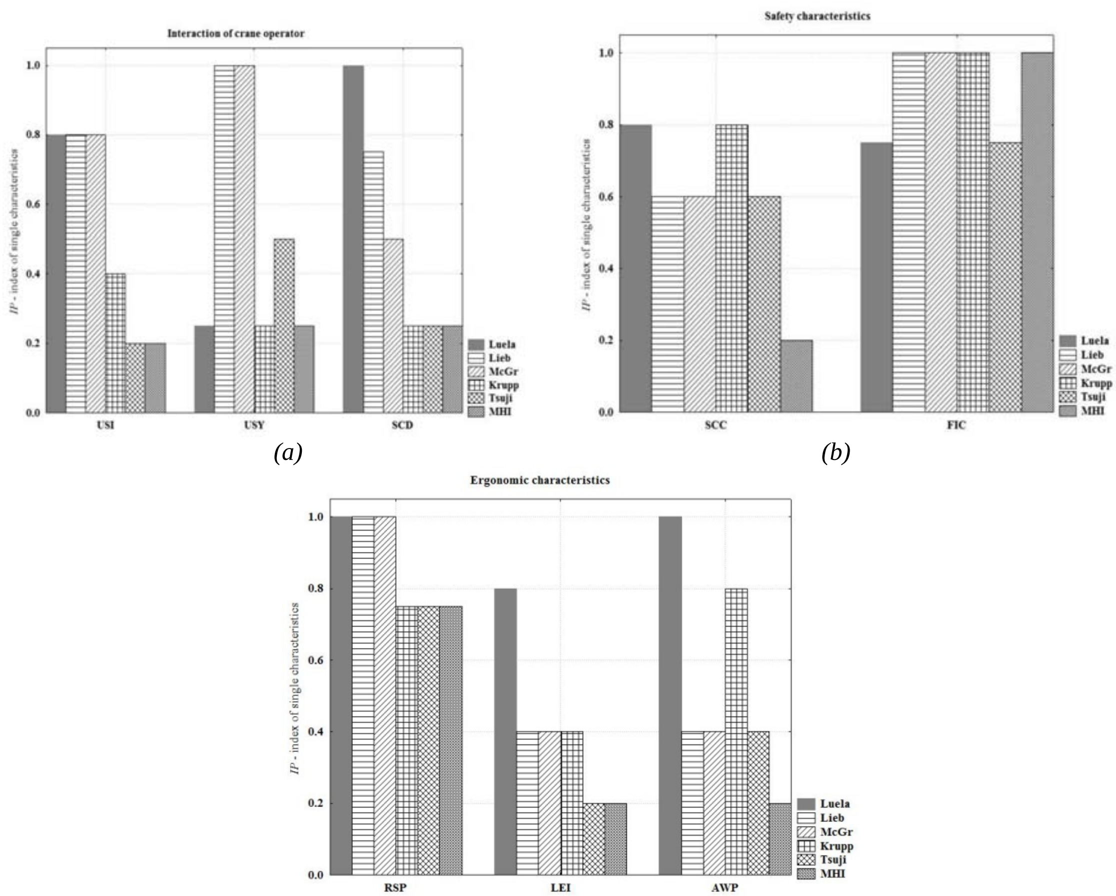
			Lulea port	Liebherr	Mac Gregor	Krupp	Tsuji	MHI
1	USI	Understandable signals	0.8	0.8	0.8	0.4	0.2	0.2
2	USY	Understandable symbols	0.25	1	1	0.25	0.5	0.25
3	SCD	See the content of the display	1	0.75	0.5	0.25	0.25	0.25
4	SCC	See the cargo, wharf and closest surrounding	0.8	0.6	0.6	0.8	0.6	0.2
5	FIC	Fixed items in cabin	0.75	1	1	1	0.75	1
6	RSP	Robust and steady parts	1	1	1	0.75	0.75	0.75
7	LEI	Logical and ergonomically correct placement of indicators and regulators	0.8	0.4	0.4	0.4	0.2	0.2
8	AWP	Adjustable work posture	1	0.4	0.4	0.8	0.4	0.2
		CIP	6.4	5.95	5.7	4.65	3.65	3.05

Based on examined criteria it can be concluded that crane cabins with best performances according to needs weighting are found at Lulea port (6.4), followed by cabins produced by Liebherr and MacGregor (5.95 and 5.95), while smallest CIP has MHI crane cabin (3.05). It can be also noticed that sums for all cabins show that only fixed items in cabin and robust and steady parts have marks above 5 of 6, that means that all other characteristics could be improved. Values of IP and CIP based on group characteristics: operator- control devices interaction, safety and anthropometric adjustment, are presented in Table 3.

From Table 3 it could be concluded that best interaction between control devices and crane operator has Liebherr crane cabin (2.55), following by MacGregor and Lulea port cabins (2.3 and 2.05). They are in the upper third of measurement scale while for the rest of examined crane cabins IP is significantly smaller. Regarding safety characteristics (Table 3) Krupp crane cabin has the best safety characteristics (1.8), followed by Liebherr and MacGregor cabins (1.6). As for anthropometric adjustment characteristics, the best results are obtained by crane cabins from Lulea port (2.8), followed by Krupp (1.95) and Liebherr and MacGregor (1.8). Only Lulea port cabins' anthropometric adjustment characteristics are on the upper third of measurement scale also with maximum estimate of CIP for surveyed characteristics. Results from Table 3 are presented on Figure 1.

Table 3. Values of IP for group characteristics - interaction, safety and ergonomics

	characteristics by group	Lulea port	Liebherr	Mac Gregor	Krupp	Tsuji	MHI
ICO	operator- control devices interaction	2.05	2.55	2.3	0.9	0.95	0.7
SA	safety	1.55	1.6	1.6	1.8	1.35	1.2
ER	anthropometric adjustment	2.8	1.8	1.8	1.95	1.35	1.15
	CIP	**6.4**	**5.95**	**5.7**	**4.65**	**3.65**	**3.05**



(a) (b) (c)

Figure 1. Measured characteristic for interaction between crane operator and control devices (a), safety (b) and anthropometric adjustment (c)

2.2. Pareto analysis

Influence of observed crane cabin characteristics is further conducted using Pareto analysis. In this case all characteristics are observed equally, regardless on type, starting from the characteristic that is least good. Pareto analysis for crane cabins in Luela port is presented at Figure 2.

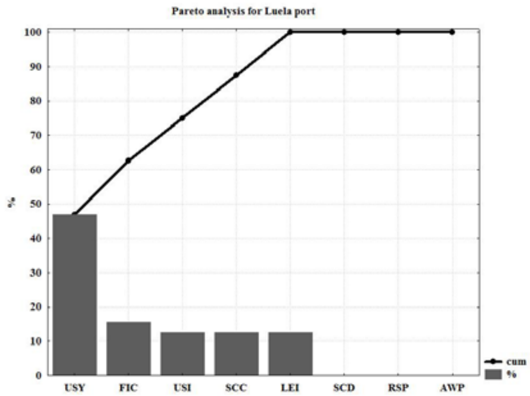


Figure 2. Pareto analysis for characteristics of crane cabins for Lulea port

Analysis of data for Lulea port crane cabins indicates that critical characteristic is symbols understanding with participation of 46.88%. Fixed item in cabin amount 15.63% followed by understandable signals or seeing the cargo, wharf and closest surrounding or placement of indicators with 12.5%. Mentioned characteristics represent 75% of problems in Lulea port crane cabins.

Liebherr crane cabin characteristics are expressed by Pareto graph as shown at Figure 3.

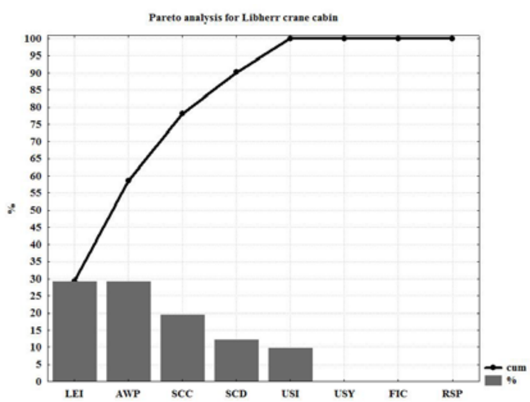


Figure 3. Pareto analysis for characteristics of Liebherr crane cabin

Majority of influence on Liebherr's crane cabin characteristics (80%) have placement of indicators and regulators and adjustable work posture with 29.67% each and seeing cargo, wharf and closest surroundings with 19.51% of influence.

For MacGregor's crane cabin characteristics Pareto graph is shown at Figure 4.

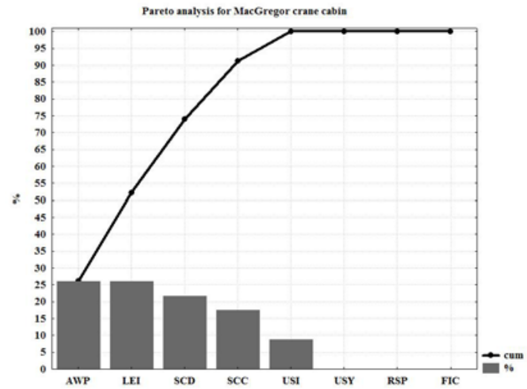


Figure 4. Pareto analysis for characteristics for MacGregor type of crane cabin

Influential characteristics of MacGregor crane cabin are adjustable work posture and placement of indicators and regulators with influence of 26.09% each, while visibility of content of display has an influence that amounts 21.74%. Those characteristics cover 73.92% problems in MacGregor type of crane cabin. If see cargo, wharf and closest surrounding is included with 17.39% of influence, than 91.31% of problems are covered.

Rest of observed types of crane cabins, i.e. Krupp, Tsuji and MHI are described together since their crane index of performance is significantly lower than above described types (Table 2). For Krupp crane cabin characteristics Pareto graph is shown at Figure 5, for Tsuji at Figure 6 and for MHI at Figure 7.

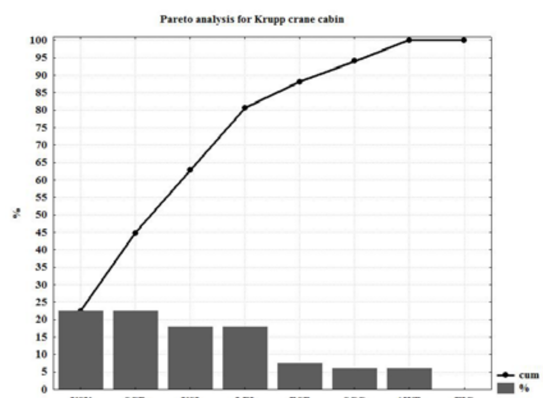


Figure 5. Pareto analysis for characteristics for Krupp type of crane cabin

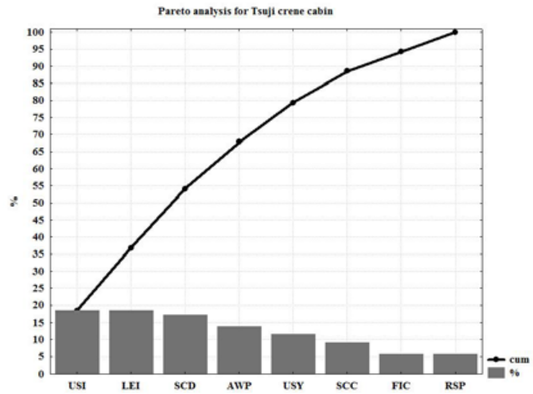


Figure 6. Pareto analysis for characteristics for Tsuji type of crane cabin

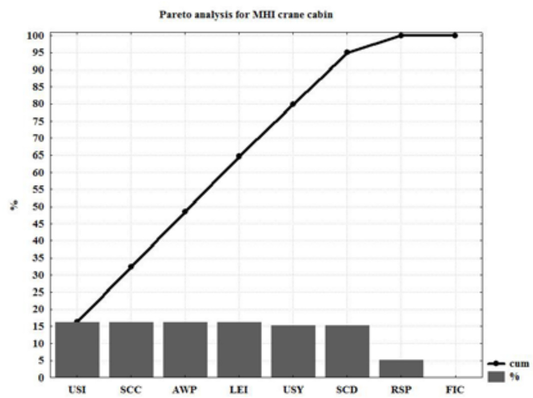


Figure 7. Pareto analysis for characteristics for MHI type of crane cabin

Krupp crane cabins have four influential characteristic, while Tsuji and MHI have 5 influential characteristics with 75% of influence.

2.3. Index of unsuitability

Beside Pareto analysis of characteristics, overall comparison was conducted using index of unsuitability of crane types.

Let index of unsuitability *IU* be

$$IUC_{ij} = 1 - IP_{ij}, i = 1,...,8, j = 1,...,6 \quad (3)$$

with overall index of unsuitability of crane cabin characteristic based on (3)

$$UCIP_j = \sum_{j}^{8} IUC_{ij}, i = 1,...,8, j = 1,...,6 \quad (4)$$

$UCIP_i$, values obtained from (4) for all crane cabins are shown at Figure 8.

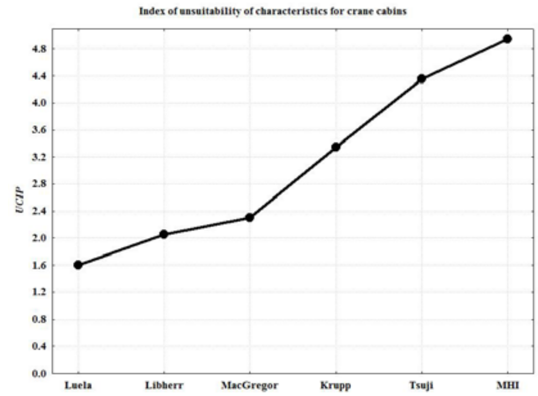


Figure 8. Indexes of unsuitability for considered crane types

3. CONCLUSIONS

Conducted analysis of the considered crane cabins and their characteristics according to operators' needs satisfaction given in [1] and according to analysis done in this paper leads to following conclusions:

- Taking into account all crane cabins only 52.5% of operator- control devices interaction, 75% of safety and 60% of anthropometric adjustment issues are satisfied in current designs.
- It is evident from Figure 8 that even the best rated Lulea cabins still have a room for 20% improvement, while MHI cabins have unsuitability that amounts 62.5%.
- Best characteristics have crane cabins at Lulea port and they are followed by Liebherr and MacGregor producers.
- Crane cabins at Lulea port and from Liebherr and MacGregor producers have significantly better characteristics than Krupp, Tsuji and MHI crane cabins regarding considered safety and ergonomics characteristics.
- Main problems for Lulea port crane cabins are in the fields of interaction between crane operator and controls followed by safety characteristics.
- Liebherr and MacGregor crane cabins could be improved by better placement of indicators and regulators and adjustable work posture, followed by the solution of visual problems of operator.

It is evident that contemporary crane cabins designs still do not satisfy operator needs in the fields of both safety and ergonomics and according to that future research are expected in those aims.

Acknowledgements

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RISK MEASURING WITH RISK ANALYSIS AND RESPOND TOOLS

Sanja Mandic,
Faculty of Technical Sciences, University Singidunum, Serbia

Abstract. *Any risk influencing not only one but all subjects of supply chain, must be treated with maximum seriousness. This paper is about to present ways of risk measuring and analysis, in order to make best decisions considering supply chain, as well as risk responding strategies suitable for any kind of risk.*
Key words: *Production management, ABC method, Cost-benefit analysis.*

1.INTRODUCTION

In the supply chain, risk of one of the participants in the supply chain represents a risk for all its participants. Its effect is cumulative and therefore the small risks for each participant in the chain,may occur as a major problem for the supply chain.
The risk in supply chains can occur in all events related to the movement of materials and the consequences of risk occurring may be shown as prevented delivery, late delivery or damaged goods. However, this is only an initial effect - for example, delayed delivery of raw materials can halt production, increase costs when engaging alternative modes of transport, badly affect the business relationships between the partners in the chain and so on. To prevent all this and to , if not completely eliminate, then at least reduce risk to minimum, it is necessary to measure risk, analyze and properly respond to it. The paper gives an overview of the most effective ways to do so.

2. RISK MEASURING

There are a few ways of risk measuring [5], best of them is:
The quantitative way- which is based mostly on two factors:
1. Risk probability,
2. Risk consequences.
Using these factors, it is possible to calculate expected value and on its grounds to evaluate risk:

EV=P X C[1]

But: when it comes to the risks, consequences of risk do not exist until a certain event does not realize -the question is how to find the probability of risk events and how to find the real value of the consequence of an event (for example, direct costs and other not so easily measurable results, such as loss of reputation and similar unwanted results).
So: expected value can be useful as a tool for risk measuring and ranking, but not for real consequence assessment. Real consequence assessment is to be done in a similar manner as the determination of the probability:

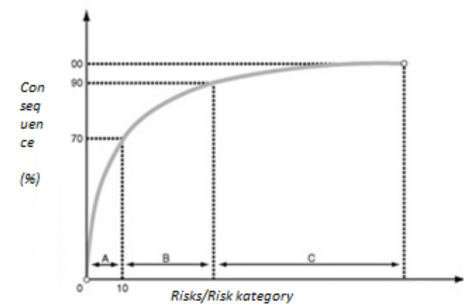
Intervals of values,
Description consequence, for example, categories:

K 1: Negligible (negligible effect on the supply chain);
K 2: Small (smaller disturbances, but the tool chain is not disturbed);
K 3: Medium (disorders that disrupt some functions in the chain, but the most important ones are still working normally);
K 4: Serious (major disturbances core activities in the chain);
K 5: Critical (cancel the whole chain at a time, but with the possibility of recovery);
K 6: Catastrophic (cancel the whole chain without the possibility of recovery).

Only when we predict consequence, it is possible to analyze risk, and to conduct risk ranking, and consequence prediction is shown in Picture 1:

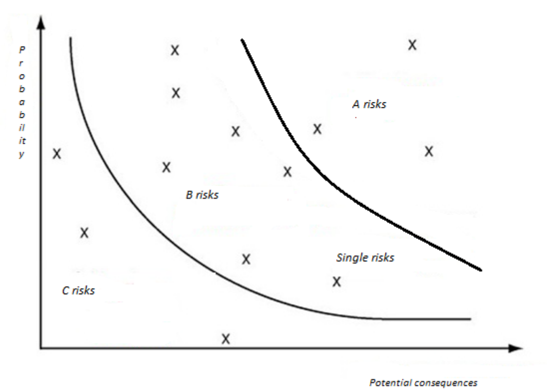
---
[1]EV=expected value
P=probability
C=consequences

Risk category		Risk %	Consequence	%
A	10	10	70	70
B	20	30	20	90
C	70	100	10	100



Picture 1: Risk and consequence

(at the top are the most important, at the bottom are of no significance)
Only then, risk classification (Picture 2) is done and it can be based on ABC (Pareto) analysis:
-A risks: high risk, special attention;
-B risks: average risks, normal attention;
-C risks: risks are small, little attention.



Picture 2: Pareto risk analysis

3. RISK ANALYSIS AND RESPOND TOOLS

Less than half of the companies surveyed have defined measures and risk assessment procedures. In order to better that, it is suggested to use some tools that help analyze risk and respond to it.
Common tools are:
-Failure mos and effects analysis
-Scenario analysis
-Simulation
-Network models
The big problem and a challenge is to choose the most appropriate response to identified risks [2]. There is a huge number of potential reactions. To overcome this, basic principle is used: the reaction depends on the magnitude of risks, mainly in terms of the potential consequences:
-C risks (unlikely, small effects) - ignore; react when the risk event is realized;
-B risks (higher probability serious consequences) - should change activities (to hold more reserves, adding reserves in time or capacity);
-A risks (the most serious risks), it is necessary to carefully consider responses.
Depending on a risk, different reactions are used. As a minimum, each reaction should provide:
-Normal operation of the supply chain (or with minimal interruptions);
-Effective risk management and efficient use of resources;
-Undisturbed implementation of regulations and rules.
Each reaction corresponds to different circumstances. In general, it is best to prevent the outbreak of risk events, then to reduce the size of consequence and eventually eliminate the consequences. "Walters" (2007) gives the following list of alternative reaction [3]:
1.Ignore or accept the risk (Using the risk register and risk-ranking managers can define the risks that will ignore those that will analyze in more detail).
2. Reduce the likelihood of risk events, for example take action to reduce the likeliness of risk and avoid activities where the risk can occur.
3. Minimize or limit the consequences, for example expected value: Take actions to reduce the likelihood of an outbreak of consequences (prevention: education, law, technical improvements) and as much as possible to reduce the consequences if the risk is realized.
4.Transfer, share, or avoid the risk [1]. methods:
Risk transfer - usually going from one member of the chain to the other, usually the one who is able to deal with the risk; it is used eliminate or reduce the risk, but in practice even this risk increases. The usual way: Insurance.
Risk sharing - depends on the relative power of the company (usually more powerful transfer of risk to the weak), attitude towards risk (acceptance or refusal of risk), control, expertise and experience.
5.Make contingency plans, (commonly known as "Plan B") [5] are applied after the realization of risks; Of course, these plans are prepared before the realization of risk event.
6.Adjust. Somewhat passive (reactive) response, as managers realize that the event is inevitable, so try to adapt activities to the new circumstances.
7.Fight the change. On shown change (for example, changing the law) the company can react to oppose changes: raising campaigns, forming support groups (pressure groups) and the like. This method rarely produces the desired results, and at a certain point the company should stop the opposition and begin adapting to the new conditions.
8.Move to a different environment. This is one of the most extreme option - means, for example, moving into new markets.

Options (strategies) [2], [4] which are the real ways to achieve the intended results, are:

- Adjust structure of the supply chain (shortening the horizontal structure and increasing the vertical chain structure, creating a parallel route for vehicles, the choice of several key suppliers, outsourcing);
- Diminish variability (grip performance values within the interval specification);
- Hold higher level of security stocks (raw materials, in order to protect the risk of the supplier, and finished products, in order to protect the risk of the user);
- Add spare capacity (operational equivalent to protective inventory; reserve capacity: a little more storage space, slightly larger number of vehicles in the fleet; it is common to incorporate a 10% excess capacity in acute cases);
- Increase agility (flexibility of the organization to adapt to change);
- Better planning and forecasting (use sophisticated methods for planning and forecasting and monitoring software);
- Increase cooperation between members of the chain (by applying various strategic alliances);
- Carefully evaluate suppliers (apply modern techniques for assessing the performance of the supplier);
- Produce according to orders;
- Apply the "make or buy" [3];
- Rationalize the product range;
- Implement binding contracts (contracts with penalties depending on performance);
- Use insurance.

The best reaction is one that ensures a free flow of materials through the supply chain thereby creating the lowest cost (or some other performance).

In order to gt to the optimal reaction, at this stage, it is necessary to use at least some of the method for decision support, such as system analysis or decision support tree.

4.CONCLUSION

With proper measurement, analysis and risk assessment, it is possible to predict the risk that a chain system can be exposed to. Proper and just-in-time reaction to the risk it is possible to respond to these dangers so that they should no longer be a threat to the functioning of the supply chain. All this contributes to more efficient operation of not just one but all the companies involved in the chain and as such, can be considered an important stage of deciding to which you should pay special attention and whose efficient performance can be crucial for business and financial efficiency of the company.

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RISK BASED AUDIT OF MANAGEMENT SYSTEMS

Srđan Vulanović[1], Vojislav Vulanović[1], Vladan Radlovački[1], Milan Delić[1]
[1]Faculty of Technical Sciences, University of Novi Sad, Serbia

Abstract. *Obligation of periodical internal and external audits is common for all management systems. Standard ISO 19011 provides guidance on auditing of management systems including the principles for auditing, managing an audit programme and conducting the management system audits. ISO 19011:2011 introduces the concept of risk in management system audits but it does not give specific guidance for the risk assessment and risk management process of the organization. This paper proposes a model for management system auditing based on risk assessment. The adopted model refers to the risks concerning the achievement of audit goals, together with risks of the audit to interfere with audited activities and processes of the organization.*

Key words: *Management systems, audit, risk management, risk assessment*

1. INTRODUCTION

It can be established that the purpose of implementation of international management standards is the reduction or elimination of certain risk groups, such as [1]:

- risks related to the process quality - ISO 9001,
- risks related to the environment - ISO 14001,
- risks related to the occupational health and safety - OHSAS 18001,
- risks related to the food safety - ISO/IEC 22000, etc.

All listed standards are subject to periodical internal and external audits, which are carried out in accordance with the requirements of ISO 19011 [2]. This international standard sets no requirements, but provides guidelines for the management of audit programs, planning and carrying out the process of management system audit, together with guidelines for competences of auditors and evaluation criteria for audit team.

The reliance on numerous principles is characteristic for auditing. These principles should be harmonized with the management system policy, and should help the management to conduct an effective and reliable audit, which provides information needed for the improvement of organizations performance.

Adherence to these principles is a prerequisite that the conclusions of an audit are relevant and sufficient, allowing auditors to come to similar conclusions in similar circumstances even if they work independently.

Six principles are listed below [2]:

- Integrity - the foundation of professionalism
- Correct presentation - the obligation to report truthfully and accurately
- Professional attention – required attention and judgment in audit
- Confidentiality - Information security
- Independence - the basis for the impartiality and objectivity of the conclusions
- Evidence-based approach - the rational method of achieving reliable and reproducible conclusions of systematic audit process

The authors of this paper argue that the risk management should also be one of the core principles of an audit, because risk management must be embedded in all the organization's practices and processes in order to be relevant, effective and efficient [3]. One more reason for this claim is the explicit requirement of standard ISO 19011:2011 for obligatory risk assessment of every conducted audit.

2. METHODOLOGY

Second edition of ISO/IEC 17021:2011 [4] that sets guidelines for auditing management systems, accepted the approach to perform simultaneous audit of two or more management systems *(combined audit)* so there is a need for establishing a universal method for assessing the risks of combined audit.

The process flow for the audit programme management, embedded in the PDCA (PLAN-DO-CHECK-AKT) cycle of continual improvement is shown in Figure 1 [2].

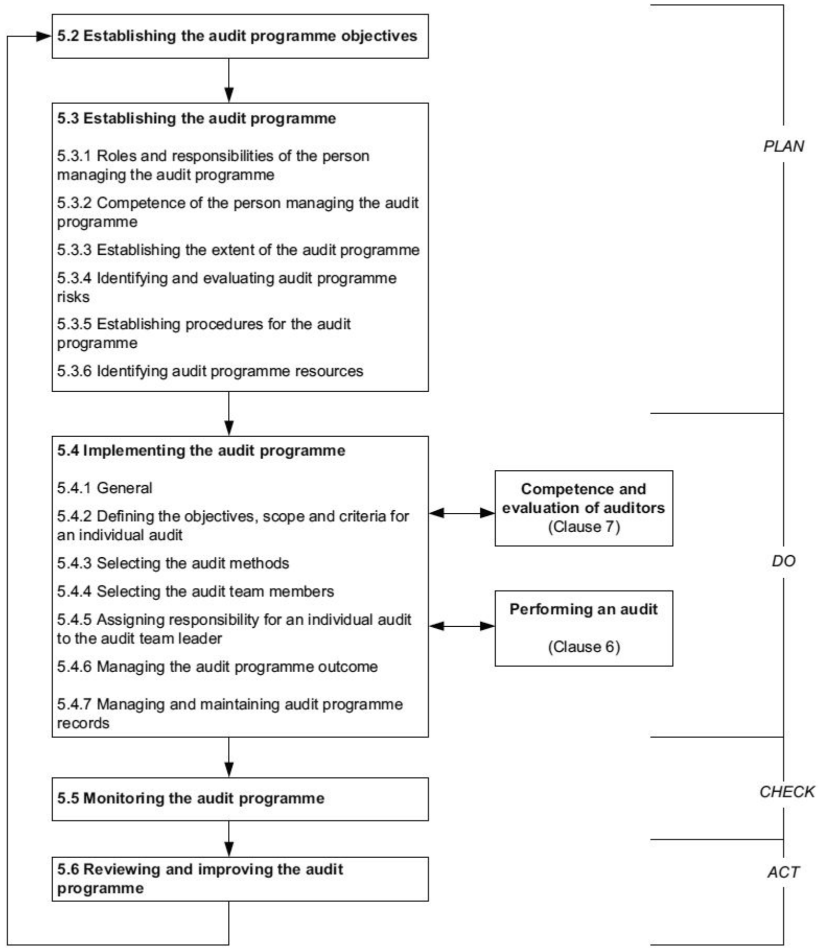

Figure 1: Process flow for the management of an audit programme

2.1 The audit programme objectives

According to the ISO 19011 [2] top management should ensure that the audit programme objectives are established to direct planning and conducting of an audit. Management should also ensure that the audit programme is implemented effectively. These objectives can be based on following:

- management priorities;
- commercial and other business intentions;
- characteristics of processes, products and projects, and any changes to them;
- management system requirements;
- legal, contractual and other requirements to which the organization is committed;
- need for supplier evaluation;
- needs and expectations of interested parties, including customers;
- auditee's level of performance, as reflected in the occurrence of failures or incidents or customer complaints;
- risks to the auditee;
- results of previous audits;
- level of maturity of the management system being audited.

2.2 Identification of audit risks

There are various risks associated with the planning, implementation, monitoring and review of audit programme that may affect:

- achievement of the objectives of an audit,
- audit results,
- effectiveness of the system and
- evaluation of the system ability.

When creating a program of an internal audit, one should consider the risks that may be associated with the following:

1. risks of inconsistency of the audit programme with the audit objectives,
2. risks in planning the insufficient time for audit programme realization,
3. risks of incompetence of the audit team for the effective audit realization,
4. risks of audit program realization (the absence of auditees, ineffective communication, etc.),
5. risks in disclosure of records during the audit,
6. risks in reviewing, monitoring and improving of the audit programme.

Other risks can be added to the list if management identifies them as relevant.

2.3 Assessment of audit risks

According to ISO 31000 [3] and ISO 31010 [5], almost all methods for risk assessment have two major criteria:

1. the likelihood of occurrence and
2. the significance of consequence

The authors of this paper adopted listed criteria and suggested a universal method for audit risk assessment that follows.

Six possible audit risks were identified in previous chapter. Each risk which is present in the particular organization should be assessed in terms of likelihood of occurrence. Each of the identified risks can cause a consequence with significance that also should be assessed.

Table 1 shows the criteria for evaluating the likelihood of occurrence and Table 2 shows the criteria for the assessment of significance of consequence.

Table 1

The likelihood of occurrence	Probability value	Grade 1
Almost impossible	< 0,001	1
Not likely	0,001 ÷ 0,03	2
Probably	0,03 ÷ 0,1	3
Quite likely	0,1 ÷ 0,3	4
Highly likely	> 0,3	5

Table 2

The significance of consequence	Consequence description	Grade 2
Slight	No impact on system functioning	1
Eligible	It does not affect the essential elements of system functioning	2
Unacceptable	Endangers the system functioning	3

The risk level (RL) should be calculated by multiplying the assessed grades for the likelihood of occurrence and the significance of consequence.

RISK LEVEL = GRADE 1 x GRADE 2.

2.4 The risk level matrix

The basic matrix for the evaluation of risk levels is given in Table 3, which shows that risk levels can be in the range from 1 to 15. There are 15 possible values for risk level (7 without repeating).

The authors suggest that risk levels should be grouped into three categories, which is shown in Table 4. It is assumed that if the unacceptable risk is present in a particular organization, the management representative must initiate a corrective action.

Table 3

Risk level (1 ÷ 15)			The likelihood of occurrence				
			Almost impossible	Not likely	Probably	Quite likely	Highly likely
			1	*2*	*3*	*4*	*5*
The significance of consequence	Slight	*1*	**1**	**2**	**3**	**4**	**5**
	Eligible	*2*	**2**	**4**	**6**	**8**	**10**
	Unacceptable	*3*	**3**	**6**	**9**	**12**	**15**

Table 4

The range of grades for risk level	1 ÷ 3	4 ÷ 6	8 ÷ 15
Risk Level Category (RLC)	Insignificant risk RLC 1	Acceptable risk RLC 2	Unacceptable risk RLC 3

2.5 Overall risk level of an audit

After the assessment, evaluation and categorization of all identified audit risks, one should calculate Overall Risk Level of an audit (ORL).

If the audit risks are independent of each other, then the ORL can be calculated by following formula:

$$ORL = \sum_{i}^{n} RL_i$$

The number of evaluated risks can go from 1 to n.

If the identified risks have mutual influence, they should be multiplied (RL_1 x RL_2), and independent risks should be added. ORL is an indicator of a system and can be used for setting the audit objectives and improving the audit results, or for the reduction of risks in subsequent audits.

3. Model testing

The universal method for audit risk assessment was applied in industry of processing and production of metal products and steel plates, surface protection by galvanizing and painting.

The chosen organization had quality management system and environmental management system implemented and certified since 2013.

Identification and assessment of audit risks

All six potential risks from chapter 2.2 were identified and assessed in terms of likelihood and consequence, as shown in Table 5.

Table 5

Audit risks	Likelihood	Consequence	**RL_i**	**RLC_i**
1. Risks of inconsistency of the audit program with the audit objectives,	1	1	1	**1**
2. Risks in planning the insufficient time for audit programme realization,	2	1	2	**1**
3. Risks of incompetence of the audit team for the effective audit realization,	1	2	2	**1**
4. Risks of audit program realization (the absence of audited party, ineffective communication, etc.),	1	1	1	**1**
5. Risks in disclosure of records during the audit,	2	1	2	**1**
6. Risks in reviewing, monitoring and improving of the audit programme,	2	1	2	**1**

All risk level values in the Table 5 are in the range of insignificant risk and it can be concluded that corrective measures are not necessary.
In this case the overall risk level of an audit (ORL) is calculated as:
$ORL = (RL_1 + RL_2 + RL_4 + RL_5 + RL_6) \times RL_3$
It is estimated that RL_1, RL_2, RL_4, RL_5 and RL_6 are independent of each other, and they add up; but the RL_3 (auditors competence) has an impact on all identified risks, and it is multiplied by the sum of other risks. In this example the result of overall risk level of an audit is 16.
$ORL = (1 + 2 + 1 + 2 + 2) \times 2 = 16.$
The overall risk level is a value that indicates the potentiality for reduction of risks by improving the design, review and implementation of the audit program in the next cycle of audits.

4. CONCLUSIONS

The risk as a category is present in all management systems (in expected ISO 9001:2015 there is a new requirement for risk assessment of all identified processes), so the risk management system must be treated as an integral part of all processes in organizations.
Risk management supports the organization to achieve its objectives and avoid potential threats and unintended consequences. It can be stated that there are no "a-priori risky processes" but the risk varies in the context of its impact on the organization`s performance, so it should be treated in accordance to its context.
The audit of management systems is a process that cannot be excluded from other processes in organization and its risks should also be treated in accordance to ISO 19011:2011 requirements.
This paper shows a model for identification, assessment, evaluation and categorization of audit risks, which is flexible enough to be applied in organizations of all types and sizes. The proposed model is simple for application and is based on assessment of two crucial components of risk:

1. The likelihood of occurrence and
2. The significance of consequence

The greatest advantage of this model is based on a fact that every risk can be considered separately and also can be combined with other risks. According to the holistic approach, the overall audit risk should be calculated differently if single risks have mutual impact to each other (where the resulting risk level is much higher if there is some kind of inter-relationship between the assessed risks).
The model suggests that each identified audit risk should be treated in accordance to assessed risk level values, and the audit itself should be treated in accordance to calculated overall risk level.
The proposed model was successfully tested and validated in praxis so it can be concluded that it offers the possibility for effective and efficient audit risk management in organizations of various types and sizes.

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RISK BASED INSPECTION PLANNING AND INSPECTION RESULTS EVALUATION

Emina Džindo[1], Uroš Lukić[2]
[1]Innovation Center of Faculty of Mechanical Engineering in Belgrade, Republic of Serbia
[2]University of Belgrade, Faculty of Mechanical Engineering, Republic of Serbia

Abstract. *Risk based inspection planning (RBI) is an application of the pre-posterior analysis from the Bayesian decision analysis. The analysis is based on the inspection decisions, the inspection outcomes, the repair and mitigation actions, the condition of the structure and the utility (cost or benefit) associated with each set of these variables.*

Key words: *risk reduction, Bayes theorem, inspection planning.*

1. INTRODUCTION

The effectiveness of inspection or monitoring is an important input for risk based maintenance and inspection (RBMI) analysis. Although consequence of failure is not influenced by inspection or monitoring, the assessment of likelihood of failure is.

Even if there is no change in the assessed likelihood of failure as a result of the inspection, uncertainties in the assessment will be reduced (e.g. no degradation predicted, none detected by inspection, increased confidence in predictions). It is important to recognize that inspection and monitoring only change knowledge of the likelihood of failure, and do not change the actual likelihood of failure unless followed up e.g. by remedial action if unacceptable degradation is occurring. Therefore although this report often refers to change in risk, this means change in the assessed risk, not in the actual risk. (It is our knowledge of the component which is changing, not the component itself).

When planning an inspection, or determining change in assessed risk after an inspection, it is therefore important to understand the relationship between inspection/monitoring and predicted likelihood of failure.

For example when using an RBMI approach to priorities plant for inspection and determine inspection intervals, the results of previous inspections or monitoring (and the confidence in these results) will generally have an important bearing on determining what defects are, or may be, present. This impacts directly on calculated likelihood of failure and hence risk of failure.

Similarly after an inspection is performed, or after a period of monitoring, it is important to determine the change in risk of failure. Generally there will be a reduction in the risk of failure, assuming remedial action is taken where appropriate. (If there is no change in risk e.g. no degradation anticipated and none found, there will still be the advantage of increased confidence in the prediction methodology and hence in the calculated risk of failure).

Monitoring the process conditions can also play an important part in checking that the process parameters remain within the envelope for which the RBMI analysis remains valid.

It is therefore necessary to have some metric for inspection/monitoring effectiveness, and to know how to use this metric in RBMI analysis. In this report “effectiveness” means the extent to which inspection or monitoring improves knowledge of a component’s integrity.

“Risk assessment integrates reliability with safety and environmental issues and therefore can be used as a decision tool for preventive maintenance planning. Maintenance planning based on risk analysis minimizes the probability of system failure and its consequences (related to safety, economic, and environment). It helps management in making correct decisions concerning investment in maintenance or related field.” [1]

Different approaches are described corresponding to different levels of detail. Note that a lower level of detail does not imply a lower quality. “The most appropriate level of detail can depend on a number of factors including:

- the importance of the inspection in reducing risk to an acceptable level;
- the degree of confidence which can be achieved from a given level of analysis;
- the effort required to determine risk change as a function of inspection effectiveness;
- the availability of existing information on inspection effectiveness;
- how detailed the rest of the RMBI analysis is." [3]

Note that since neither inspection nor monitoring can influence the consequence of failure, any change in risk determined after inspection is a result of change in predicted likelihood of failure.

It is also important to recognize that some contributions to likelihood of failure cannot be influenced by inspection or monitoring, such as failures due to human error in operating, inadvertent physical damage, sabotage etc. Even a "perfect" inspection or monitoring system will therefore not reduce risk of failure to zero.

Section above provided examples of measures of inspection effectiveness based on expert judgment. These are generally based on linguistic expressions (highly effective, poorly effective etc.) or a simple scoring system, with expert judgment used to determine which description or score applies to a particular inspection.

Expert opinion can also be used to judge the degree of risk reduction (or increase in confidence with which risk is determined) which results from performing the inspection. For example application of a highly effective inspection has the potential to reduce likelihood of failure from high to low (for a prescribed period of operation). It is important to recognize that the actual reduction in assessed risk will depend on other factors, with inspection being only one of a number of factors.

For example application of a highly effective inspection method is unlikely to result in a further significant reduction in likelihood of failure if there was already high confidence from knowledge of the process conditions, material, generic data etc. that there were no potential degradation mechanisms active.

On the other hand a medium effectiveness inspection method might result in a significant reduction in assessed risk (assuming no defects found) if there was little other information available on which to predict whether degradation was occurring.

Thus while there will be a tendency for the most effective inspection methods to result in the greatest reduction in assessed risk (and increased confidence in "knowing" the risk"), expert judgment is required to decide what weighting should be applied to the inspection effectiveness and results, taking into account all other factors which determine likelihood of failure.

Note that although this approach may be particularly appropriate for high level screening using a qualitative RBMI approach, it can also be used in conjunction with more quantitative elements of the RBMI process in accordance the overall RIMAP approach, by providing an input to the expert's qualitative modification factor applied to he calculated basic quantitative failure frequency.

2. APPROACHES BASED ON STATISTICAL METHODS

If the probability of detection (POD) for the defects of concern is known for the inspection procedure applied, then the probability of a given subset of these defects remaining (as a function of e.g. size) can be determined and the revised probability (and hence risk) of failure calculated. A weighting factor may need to be applied to allow for any additional uncertainties due to sampling.

"Bayes' theorem provides a logical way of updating incomplete knowledge (e.g. 75% confident no degradation present) based on a test or observation which may not be 100% reliable (e.g. inspection method detects degradation 90% of the time).

Bayes' theorem states that given that event B has occurred, the probability that it was due to cause Aj is equal to the probability that A_j should produce that event times the probability that A_j should occur in the first place, all divided by a scaling factor which is the sum of such terms over all causes." [2]

A_s an example let us assume that before inspection of a particular plant item we are 75% confident that no gradation is present.

Imagine that we now inspect using a method which detects degradation 90% of the time with no false calls, and it does not report any degradation.

We want to know the revised probability that no degradation is present, given that none was reported. In this case the event "B" is that no degradation is reported, and the "cause" A_j is no degradation present.

However another possible cause is that degradation is present (but missed). The notation p(A | B) means "the probability of A, given B". According to Bayes' theorem (probability no degradation present given that none reported).

$$\frac{(\text{prob. none reported} \mid \text{none present})\ \text{x}\ (\text{prob. none present})}{(\text{prob. none reported} \mid \text{none present x prob. none present}) + (\text{prob. none reported} \mid \text{present xprob. present})} = \\ = \frac{1\ \text{x}\ 0.75}{(1\ \text{x}\ 0.75) + (0.1\ \text{x}\ 0.25)} = 0.968 \qquad \ldots(1)$$

The confidence that no degradation is present has therefore increased from 75% to around 97%.

Note that Bayes' theorem can be used to support decisions based on expert judgement even if there is not precise quantitative data on inspection effectiveness or likelihood of degradation. For example expert judgement could be used to assign a category to inspection effectiveness such as "very high", "medium high", "medium" etc. where each category is taken to represent a band such as "better than 90%", "between 75% and 90%" etc. A similar approach could be adopted to describe initial likelihood of degradation (or degradation rate). The average within each band (e.g. 95% for very high) could then be used to apply Bayes' theorem. Depending on the band within which the "answer" lay, the revised likelihood of degradation (or degradation rate) could then be interpreted in the original linguistic terms (very high, high etc.).

Note that care should be taken when using probability of detection (POD) data in Bayes' theorem in cases where a number of discrete defects (e.g. cracks) may be present. A technique with a POD of 90% will have a 90% probability of detecting each individual defect, but a much lower probability of detecting all of the defects. A disadvantage of detailed statistical methods for determining risk reduction after inspection is that they generally require information on the probability of detection of the inspection procedure. As explained above, suitable POD data might not exist and can require a major exercise to generate it.

3. DECISION LOGIC APPROACH

Condition Monitoring is used to reduce risk by detecting damage at an early stage before the damage has caused a large consequence event. The condition monitoring equipment should be selected based on the consequence related to the event that should be prevented and the cost of installing and maintaining the equipment. In addition aspects like false calls and the probability of detecting the damage should be considered.

One of the main benefits when a condition monitoring system is installed is that the repair time is reduced. The reason is that the monitoring equipment reduces the diagnostic time, and the preparation for repair can then be done well in advance.

The decision logic or workflow related to the selection of condition monitoring as a maintenance method is shown in Figure 1.

The risk can be assessed, and if the risk is above a predefined limit, or if the cost associated with the failure is large, condition monitoring is one alternative solution to reducing the risk. The figure below sketches the decision path to derive to a strategy for risk reduction The prerequisite for condition monitoring is that the damage development can be detected by means of condition monitoring methods. This is obvious, but not always considered when condition monitoring equipment is selected.

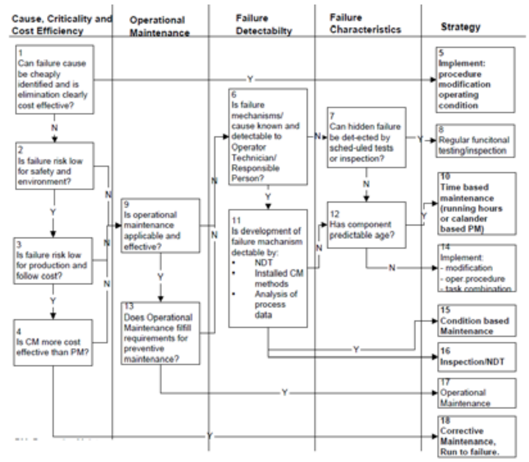

Figure 1. Decision logic for maintenance strategy

4. NUMERICAL MODELING APPROACH

This approach described above it is possible to define quantitative measures for the effectiveness of monitoring. The risk can be determined as the intersection of the Load and Resistance distributions. This is shown on figures 2 and 3.

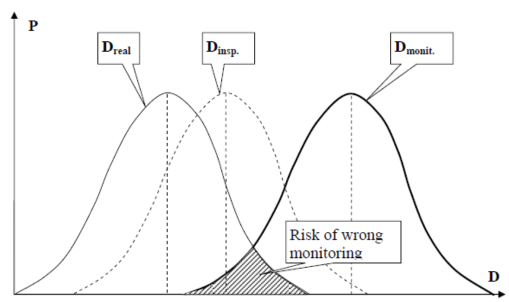

Figure 2. Failure risk due to monitoring

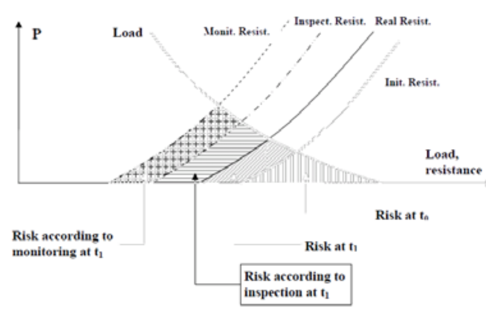

Figure 3. Explanation of different risks

It means that, assuming:

$$D_{real} \approx D_{inspection} \qquad ...(2)$$

$$D_{real} = D_{inspection} = D_{monit} \cdot E \qquad ...(3)$$

one can assess the probability distribution of D_{real} (or at least of $D_{inspection}$).

5. CONCLUSIONS

The proposed risk-based maintenance strategy aims at reducing the overall risk of failure of the operating facilities. In areas of high and medium risk, a focused maintenance effort is required, whereas in areas of low risk, the effort is minimized to reduce the total scope of work and cost of the maintenance program in a structured and justifiable way. The quantitative value of the risk is used to prioritize inspection and maintenance activities.

Risk-based maintenance strategies can be used to improve the existing maintenance policies through optimal decision procedures in different phases of the life cycle of a system.

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A HYBRID SECURITY RISK ASSESSMENT METHOD FOR SCADA NETWORKS

Jasna Markovic-Petrovic[1], Mirjana Stojanovic[2]
[1]CE Djerdap Hydroelectric Power Plants Ltd., HPP Djerdap 2, Negotin, Serbia
[2]University of Belgrade, Faculty of Transport and Traffic Engineering, Belgrade, Serbia

Abstract. *This paper deals with the issue of security risk in Supervisory Control And Data Acquisition (SCADA) systems. We propose an advanced risk assessment method tailored for SCADA systems by a suitable algorithm for determining weighting factors that quantify cyber attack conditions. We introduce a subjective component of the weighting factor based on the system experts' responses to a specific questionnaire. Results of the cost-benefit analysis indicate that return on security investment can be increased with the proposed method.*

Key words: *Information security, Infrastructure attacks, Risk assessment, SCADA, Weighting factor.*

1. INTRODUCTION

SCADA systems monitor and control geographically dispersed process equipment on multiple sites in power grids, water plants, oil refineries and natural gas distribution, and other critical infrastructures. Due to standardization and connectivity to the Internet, modern SCADA systems face with the increased risk of cyber attacks and failures that are inherent to enterprise IT systems [1]. Risk management has been recognized as an integral part of SCADA information security management. It comprises risk analysis, risk assessment methodology, selection of security mechanisms and making a decision on the implementation of appropriate mechanisms.

There are many security risk assessment methods and tools based on recommendations and standards [2]. The methods have been developed to be used mostly in business information systems, and their use for security risk assessment of control information systems in the industry is not straightforward.

This paper proposes an improvement of security risk assessment method for specific SCADA systems described in [3] by introducing a new component, the personal attitude of employees who have work experience in the respective industrial process, control system, IT system, etc. This approach can be justified by the fact that good knowledge of a process along with actual values acquired from statistical analyses should generate a more comprehensive view of potential risks. Consequently, the advanced, hybrid method should provide a more precise risk assessment.

The rest of the paper is organized as follows. Section 2 surveys the related work. The novel hybrid risk assessment method is explained in Section 3. In Section 4, we evaluate the proposed method, and compare it with the reference method [3] on the example of SCADA system in a hydropower plant. Section 5 concludes the paper.

2. RELATED WORK

Literature describes different security risk assessment approaches, methods and tools that can be categorized as qualitative and quantitative. Qualitative risk assessment methods interpret losses as a subjective measure, e.g. the risk level is assessed as low, medium or high. Methods from this category are simple, but they do not provide the possibility of a cost-benefit analysis. In contrast, the quantitative risk assessment is based on mathematical approach (numeric analysis, statistical methods) that interprets the risk in numeric values of appropriate units. Combination of qualitative and quantitative methods is suggested for the information security risk assessment.

One of the methods created for business information systems is CRAMM (CCTA Risk Analysis and Management Method). It is a qualitative method supported with appropriate tools. An integral part of the tools is a rich library of potential vulnerabilities, threats and security measures [4]. Experiences in the application of this tool show that it is not appropriate for use in SCADA systems due to complex mapping of information assets.

Reference [5] describes methods and procedures that provide a framework for a continuous process of security risk assessment within the electrical power remote control system. The authors have pointed out the necessity of perceiving the consequences which the realization of risks would have on the whole electric power system. Based on the risk index, security measures are proposed and the risk assessment procedure is repeated after the security measures have been implemented.

The risk model based on Bayesian network determines the network compromise probability under different levels of attack. Bayesian network model, used in security risk assessment in SCADA systems [6], identifies four risk sources: human factor, environmental factor, equipment failure and management process failure. The proposed model provides a more objective risk assessment comparing to traditional models.

In the absence of the reference method for security risk assessment in SCADA systems there is a need to define the methodology which would integrate the risk management and security risk assessment for both operational and business infrastructures [7]. In the previous research [3], we have proposed a security risk assessment method in the case of Distributed Denial of Service (DDoS) attack on SCADA system infrastructure. In a DDoS attack, each individual attacker can generate traffic similar to the legitimate one, but the attack strength is increasing by using multiple coordinated sources. This property makes intrusion detection and prevention (IDPS) rather difficult. In [8] we have presented an in-depth analysis of performance degradation and service disruption under DDoS attacks, carried out by simulations of typical SCADA system in a hydropower plant.

Based on the proposed security risk assessment, the cost-benefit analysis is performed for the recommended application of IDPS. Method [3] combines the quantitative and qualitative approaches. The security risk assessment is based on the mathematical approach and economic parameters using Annualized Loss Expectancy (*ALE*) and Return on Security Investment (*ROSI*) calculations. The qualitative methodology is characterized with the defining of weighting factors that quantify the conditions under which the attack has occurred. The method defines prerequisites for determination of these factors, namely statistical data analysis and Key Performance Indicator (KPI) definition in accordance with required performances necessary for the realization of business objectives. Establishment of a predefined threshold for *ROSI* should contribute to determining the optimal level of investment in security.

Weighting factors, which quantify indirect costs, are determined according to statistical analysis of the archived relevant values. The motivation for this work comes from the fact that employees' experiences are relevant for the analysis of a process. Hence, we extend the method proposed in [3] by the adjustment of the weighting factors with introduction of the subjective component, aiming at a more precise quantification of indirect costs. The novelty in this paper is the improvement of the method by an algorithm for determination of weighting factors that quantify indirect costs resulting from the conditions under which the successful infrastructural attack occurred.

3. THE PROPOSED HYBRID METHOD

The method starts from an attitude that the costs incurred by the realized attack originate from: (1) direct costs, resulting from the interrupted production process and (2) indirect costs, including the costs of the system recovery and other costs, such as penalties due to non-fulfillment of contractual obligations, unrecoverable losses of resources and environmental damage [3]. The basic formula for *ALE* includes the sum of maximum direct losses (*DL*) and Annualized Rate of Occurrence (*ARO*). The formula is modified with weighting factors that quantify indirect costs (W_k) and a weighting factor W_A whose purpose is to scale the maximum direct costs in the function of the attack intensity (1).

$$ALE = W_A \prod_{k=1}^{N} W_k \left(\sum_{j=1}^{M} DL_j\right) \times ARO \tag{1}$$

Figure 1 shows the schematic overview of the calculation procedure.

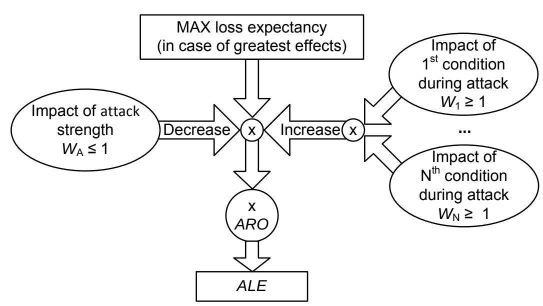

Fig. 1. The factors of *ALE* in SCADA system [3].

Selection of weighting factors is a delicate process depending on a number of techno-economic conditions within the specific SCADA system. After selection the type of weighting factors, it is necessary to determine their values. The algorithm for evaluation of weighting factors is depicted in Figure 2. The algorithm is used for each of the weighting factors in two phases. In the first phase, the experts chosen among the employees who know the process very well, IT specialists and managers are polled. The questionnaire may have one or more (*Q*) Closed-Ended Questions. The question list is created for a specific SCADA system where a weighting factor is defined for each question (W_q) under the condition $\sum W_q$=1. The questionnaire has been designed to offer the final response categories to each of the questions (e.g. very low, low, medium, high, very high), or the response scale (e.g. 1–5, 0–100%). The quantification of obtained responses (Aj) creates one factor per each expert (Wki) (2). The questionnaires answered by all of the experts (E) serve for the creation of the weighting factors {Wki, i = 1, E}.

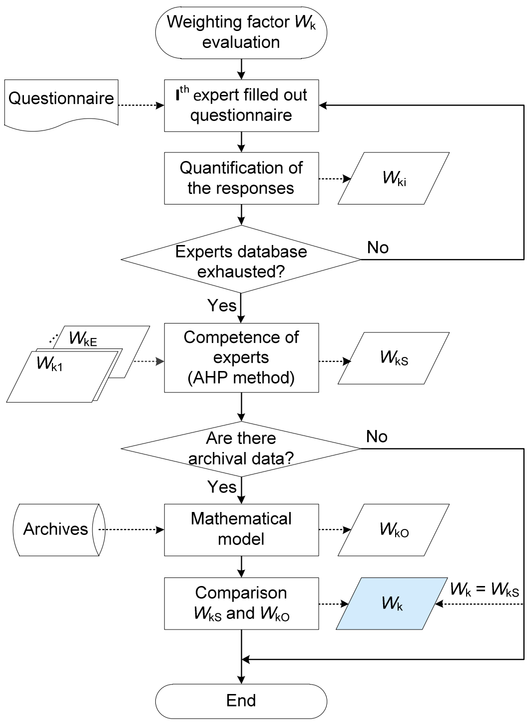

Fig. 2. The weighting factor evaluation algorithm.

The final, subjective value of the weighting factor W_{kS} is determined based on the competence of each expert C_i (3). The competence assessment is performed by Analytical Hierarchical Process (AHP) [9]. It is a multi-criteria decision-making technique that hierarchically presents criteria and performs the ranking of possible alternatives using a series of comparisons of two elements within the relationship intensity scale (up to 9 levels). The method is convenient because the final result is a numeric evaluation of the alternative (the experts, in our case). The obtained weighting factor W_{kS} contains the elements of subjectivity resulting from the choice of questions during the questionnaire design and from the experts' experience.

$$W\text{ki} = \sum_{\text{j}=1}^{Q} W\text{qj} \times A\text{j}, (\sum_{\text{j}=1}^{Q} W\text{qj} = 1) \quad (2)$$

$$W\text{kS} = \sum_{i=1}^{E} C\text{i} \times W\text{ki}, (\sum_{i=1}^{E} C\text{i} = 1) \quad (3)$$

In the second phase, the objective value of the W_{kO} weighting factor is determined based on the data from available archives according to the condition taken for the indirect cost. Based on the archived values, we calculate the occurrence probability of conditions under which the successful infrastructural attack would cause indirect costs. Finally, the comparison and evaluation of the factors, obtained within the two phases, is performed with determination of the final weighting factor W_k = F(W_{kS}, W_{kO}).

4. EVALUATION AND RESULTS

In order to evaluate the proposed hybrid method, we adopt the scenario and reference method from [3] and compare the new method with the reference one. Security risk assessment and cost-benefit analysis of IDPS implementation have been performed on an example of a run-off-river hydro power plant. The network infrastructure consists of the two parts: (1) supervisory network where the key elements are servers and human-machine interfaces and (2) process network containing controllers for supervision and control of equipment and sub-systems of the power plant. Supervisory network is connected to the corporate network with access to Internet. The implementation of four IDPSs has been anticipated: two Network IDPSs (one towards the corporate and the other towards the process network) and one Host IDPS per each key SCADA server. We have analyzed possible consequences of a DDoS attack from the aspect of supervision, control and production of electric power, and consequently, two types of costs. Direct costs are the result of the decreased production, and indirect costs are the result of: non-fulfilled obligations regarding delivery of electric power and overflow of the hydro potential if the attack occurred at the time of high inflow. Indirect costs are quantified with weighting factors W_E and W_H respectively, and they have been determined by a statistical analysis of the archived data about production, inflow and electric power delivery requests.

On the same example, we further analyze the use of the proposed algorithm for determination of the value of weighting factors W_E and W_H that quantify indirect costs resulting from DDoS attack on SCADA infrastructure. In order to determine weighting factors W_E and W_H, we have designed two questionnaires with 3 and 4 questions, respectively. We have polled: (a) the dispatcher from the Planning Department, (b) an operator from Control Centre, (c) the manager of the Exploitation Unit and (d) the top manager. The competence of each participant has been determined by AHP method based on the following criteria: (1) work experience, (2) qualification degree, (3) professional field and (4) work position. Table I shows an example of the decision-making matrix elements and the obtained values of eigenvector after the second iteration. The same principle has been used with polled participants, for each criterion. The competence has been measured by multiplying the obtained eigenvectors. We have applied formulas (2) and (3), and obtained the subjective values for the weighting factors (W_{ES} = 1.96 and W_{HS} = 2.86).

TABLE I. PAIRWISE COMPARISON MATRIX OF THE MAIN CRITERIA.

	(1)	(2)	(3)	(4)	Eigenvector
(1)	1	5	2	4	0,5066
(2)	1/5	1	1	1/7	0,0768
(3)	1/2	1	1	1/3	0,1235
(4)	1/4	7	3	1	0,2931

In the second phase of the algorithm, we have taken the objective values obtained in [3]. The last step is the comparison of the values from the two phases and their averaging.

At the end, we have shown the influence of the improved method on the final *ROSI* value. This indicator of effectiveness of the investment into the security mechanisms represents the relation between the savings due to prevention of a cyber attack and the cost of the implemented measure (C_S) (4) [10].

$$ROSI = (ALE \times \%RiskMitigated - C_S) / C_S \quad (4)$$

Figure 3 shows the *ROSI* value in function of *ARO* obtained with two risk assessment methods, the reference method [3] and the proposed hybrid method. The diagram shows two values of the proposed threshold that determines the profitability of the investment in security.

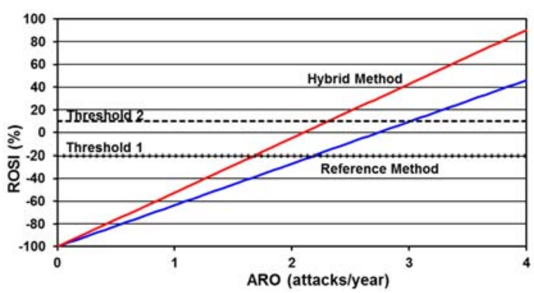

Fig. 3. *ROSI* as a function of *ARO*

Weighting factors obtained by the hybrid risk assessment method increase the *ROSI* value. The influence will be higher in the case of more frequent attacks and a higher level of the predefined threshold. The obtained result shows that the proposed quantification of the subjective risk assessment will change the final assessment of the profitability of the investment into the security mechanism.

5. CONCLUSIONS

In the paper, we have presented the improvement of the security risk assessment method in industrial SCADA systems. We have proposed an algorithm for calculation of weighting factors that quantify conditions in which an attack has been realized. Polling of experts, who know the specific process and SCADA system very well, should enable fine adjustment of weighting factors obtained by statistical analysis of archived data. Responses are then translated into a metric form, and their quantification is performed. We have also presented the results obtained with the improved hybrid method in terms of *ROSI* value that represents the relation between the savings realized by prevention of a cyber attack and the cost of the implemented security mechanism. The proposed method has advantages due to the important experts' experience, which is superimposed on the pure historical data.

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AFFORDABILITY OF EMERGING TECHNOLOGIES – CASE OF BROADBAND ADOPTION IN WESTERN BALKAN COUNTRIES

dr Đorđe Mitrović[1], MSc Sonja Josipović[2]
[1]University of Belgrade, Faculty of Economics
[2]University of Belgrade, Faculty of Mechanical Engineering

Abstract:*Broadband technology fosters economic growth and development and increases the global competitiveness of the country. The affordability of technology is very important for broader use of specific technology. The main problem is not the covering of initial cost of technology installation, but the cost associated with using of given technology. The purpose of the present paper is to analyse the current level and dynamics of broadband adoption in Western Balkan countries using simple Data Envelopment Analysis based composite indexes constructed on data about broadband coverage and service prices. The current level of broadband adoption foreach country is measured in relation to other sample countries. The values of the calculated composite indexes indicate the strong and weak sides of the corresponding aspects of broadband technology implementation and give directions for setting further priorities for political intervention in the domain of information society building.*

Key words: *broadband internet,composite indexes,affordability,economic growth*

1. INTRODUCTION

Today, the existing variations in economic performances between countries and the competitiveness of their economies in larger measure depend on adoption, use and speed of broadband internet technology.Broadband access contributes to improving the overall social welfare, as well. This technology reduces the cost of searching, collecting and processing the necessary information, which makes it easier to compare prices which encourages and enhances competition and improves the quality of products.

The purpose of the paper is to analyse the current level and dynamics of mobile broadband adoption in Western Balkan countries using simple Data Envelopment Analysis based composite indexes constructed on data about mobile broadband coverage and service prices. The current level of mobile broadband adoption for each country is measured in relation to other sample countries. The values of the calculated composite indexes indicate the strong and weak sides of the corresponding aspects of mobile broadband technology implementation and give directions for setting further priorities for political intervention in the domain of information society building.

This paper is structured as follows. After introduction and discussion on the economy context of the achieving broadband level measurement, the index calculation methodology is explained and the adoptionand affordability indexes are calculated for Western Balkan countries. Third Section discusses the main results and explains the calculated values of indexes regarding priorities in country's policies aimed at decreasing the digital divide and increasing the global economic competitiveness. Fourth Section contains main conclusions and recommendations for further research.

2. LITERATURE REVIEW

According to Qiang and Rossotto (2009), it is noticed that in high-income economies during the period 1980-2002 an increasing in total broadband subscribers per 100 people would lead to increase in GDP per capita for 1.21 percentage point (all others factors being equal), while in developing countries increasing of GDP per capita would be 1.38 percentage point. Koutroumpis (2009) emphasized that in OECD countries during the period 2002-2007 average percentage of country's growth attributed to broadband infrastructure is 10.54%. Also, this research shows that average impact of broadband infrastructure on GDP in these countries was equal to 0.24%. Countries with higher broadband penetration had higher impact of broadband infrastructure to economic growth. Czernich et al. (2011) also observed relation between broadband penetration rate and GDP growth in OECD countries in period 1996-2007. Researchers concluded that after introduction of broadband, country's GDP per capita was 2.7–3.9% higher on average than before its introduction. According to this research "an increase in the broadband penetration rate by 10 percentage points raised annual growth in per capita GDP by 0.9–1.5 percentage points."

Gruber et al. (2014) argue that at the level of the EU the broader economic benefits of broadband investment are higher than their cost. The total economic benefits from investment in broadband infrastructure are 32% higher than the cost (for the EU in total). Kolko (2012) found positive link between higher penetration of broadband technologies and local economic growth. But, there is no evidence that broadband availability reduce unemployment rate (Czernich, 2014). The impact of development of local broadband infrastructure on economic activity as measured by local employment rates is positive, but economically rather limited (Fabritz, 2013). Similarly, Whitacre et al. (2014) concluded that there was positive link between level of broadband adoption in US rural areas and income growth between 2001 and 2010 and negative relationship between the level of broadband adoption and unemployment growth.

There are also researches that encompass other broadband characteristics than simple broadband penetration and their impacts on economic growth like speeds of data transmission, type of broadband connection, quality of broadband service and service providers. Kongaut and Bohlin (2014) analysed the relationship between broadband speed and economic growth. They used the sample of high and low income OECD countries and data for broadband speed and GDP from period 2008-2012. The main conclusion from this research study is that broadband speed contributes positively to economic outputs such as GDP and that the effects of broadband speed are also greater in countries with lower income. Despite the presence of several limitations in this analysis, authors concluded that an increase in broadband speed of 10% leading to an increase in GDP per capita of 0.8%. Jung (2014) performed an analysis of the impact of broadband on regional productivity in Brazil and also concluded that faster download speed and critical mass to account for network externalities enhance of the economic impact of broadband.

3. DATA AND METHODOLOGY

The calculation of the BAD and BAF indexes implies the determination of its individual indicators weights. The simplest way is to give equal importance to all indicators and determine the same weight. However, this method of determining the weight would be suitable only in the case when the opportunity costs of moving from one to another technology (for example, from a cable modem to the mobile broadband) would be the same in all countries, which is, of course, far from reality (Badasyan et al. 2011).

The overview of the recommended indicators used in analysis for indexes calculation is given in Table 1.

Table 1. Statistical indicators

Sub-index	Indicator used
Broadband Adoption (BAD)	BD1 – xDSL penetration rate per population
	BD2 – Cable modem penetration rate per population
	BD3 – Dedicated data cards/wireless modems per 100 population
Broadband Affordability (BAF)	BF1 – HHI based on mobile telephony market share by revenues
	BF2 – Fixed-broadband prices as a percentage of GNI p.c.
	BF3 – Mobile-broadband prices as a % of GNI p.c.

We havedecided on the Data Envelopment Analysis (DEA) methodology. In short, based on the data related to each country individually, the DEA methodology, constructs the "efficiency frontier" using mathematical linear programming, which determines the best state of the practice and, in relation to that state, measures the relative position of each of the countries in terms of the value of the set of the observed indicators.

In order to apply the DEA methodology and determine the weight, the values of all the individual indicators must be normalized. This is very important because different indicators aren't expressed in the same direction. The raw values are normalized into an interval between 0 and 1 – higher indicator's value represents better performance of given country in the broadband area analysed. The normalization of the values of the individual indicators was carried out according to OECD (2008).

The normalized values for the 6 broadband indicators are calculated for 35 countries, but because of lack of space we presented here only values for Western Balkan countries + Turkey + Iceland as EU candidate countries: Croatia (HR), FYR Macedonia (MC), Montenegro (ME), Serbia (SR), Turkey (TU), Albania (AL), Bosnia and Herzegovina (BH) and Iceland (IC). The raw data we used for the analysis was taken from the statistics base Eurostat and national statistics offices of the countries analysed (all values are for 2013 year).Calculated normalized numerical values are given in Table 2.

Table 2. Normalized values of the indicators

Country	BD1	BD2	BD3	BF1	BF2	BF3
HR	0.489	0.113	0.093	0.250	0.664	0.756
MC	0.158	0.310	0.000	0.194	0.174	0.628
ME	0.264	0.035	0.154	0.417	0.207	0.307
SR	0.210	0.274	0.044	0.417	0.000	0.606
TU	0.200	0.040	0.024	0.222	0.766	0.744
AL	0.000	0.072	0.016	0.139	0.273	0.000
BH	0.131	0.198	0.029	0.472	0.541	0.023
IC	0.544	0.000	0.201	0.750	0.883	0.972

Source: Calculated by author

We then determined the main indexes using the DEA methodology according to Zhou et al. (2006), Cherchye et al. (2006), Zhou et al. (2007), Cherchye et al. (2008), OECD (2008), Hatefi and Torabi (2010). Indexesare calculated as the weight sum of the corresponding individual indicators, where the weights are endogenously determined by mathematical linear programming so as to obtain the maximum possible value of the indexes for each individual country. In this way, certain combinations of the weight for the individual indicators within the main indexes for a country is the best possible combination – there is no other combination of the weights that would enable a country to achieve a greater index value. In other words, we consider the most favourable situation for each country.

The resulting indexes are ranged between zero (the worst possible performance) and 1 (the best possible performance – benchmark). The optimal calculated set of weights provides the best position for the given country related to all other analysed countries. Any other weighting profile would worsen the relative position of the given country.

The calculated numerical values of the broadband indexes for Western Balkan countries are given in Table 3.

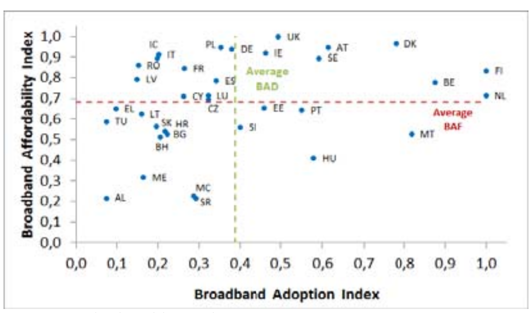
Table 3. Calculated values of the broadband indexes

Country	BAD	BAF
HR	0.216	0.541
MC	0.287	0.226
ME	0.164	0.316
SR	0.292	0.216
TU	0.074	0.588
AL	0.074	0.216
BH	0.206	0.512
IC	0.197	0.892

Source: Calculated by author

4. CALCULATED VALUES – DISCUSSION

The ranking of countries according to the calculated indexes values is presentedon Figure 1.



Source: Calculated by author

Figure 1. The ranking of countries according to broadband indexes

The leading country in the Western Balkans in terms of implementation of mobile broadband internet access is Croatia, followed by Montenegro, Macedonia and Serbia. Serbia is in a better position than Croatia when it comes to the adoption and implementation of broadband Internet access (infrastructure development), but is worse in terms of paying ability or affordability of these services for residents and businesses. Montenegro is in a better position than Serbia when it comes to the service price (affordability), different modalities of use of mobile broadband Internet access services and available internet speed for users, but its position was worsened by the degree of adoption of this technology by users. Albania and Bosnia and Herzegovina occupy the last place according to the value of calculated indexes owing primarily to the unevenly prevalent technology of broadband access among the population, worse infrastructure and the degree of adoption of the given technology by the users in the country.

In the field of broadband affordability Serbian government needs to pay more attention to institutional, regulatory and legal framework which is very inadequate – active state regulations create burden on businesses, individuals and households that discourage broadband adoption and make related services less affordable.For example, according to indicator BF2 (fixed-broadband prices as a percentage of GNI per capita)Serbia takes the last position in total sample analysed.At the same time, predominantly market share regarding fixed broadband technologies remains cover by the telecom company in the state ownership.

5. CONCLUSION

Based on recent researches presented in the literature and using the proposed methodology which takes into account broadband adoption and affordability, this contribution provide a more comprehensive picture of global competitiveness of Western Balkan countries. The values of the calculated indexes indicate the strong and weak sides of the corresponding aspects of broadband technology implementation and, thus, help when setting further priorities for political intervention not only in the domain of information society building, but also in the improvement of the competitive advantage of the country.Such policies require additional investment in new ICT, permanent education of population, research and development processes in enterprises, scientific institutions and universities and better legal and institutional framework related to intellectual property rights.

Although the methodology presented in this paper is only basic, the analysis showed that the BADand BAF indexes can serve as a good tool that will allow the classification of goals and priorities when designing the development policies of the Western Balkans countries and the evaluation of accomplished achievements (by comparing to other countries in the region and the European Union).

As one of interesting and very important relation in further research it should be analysed if there exists positive correlation between BAD and BAF indexes showing broadband adoption and affordability and the indexes that indicate the degree of the digital divide in Western Balkan countries. It can be analysed by using DIDIX and TDI indexes as it is proposed by Hüsing and Selhofer (2004), Vehovar (2006) and Howard et al. (2010). There is an example in literature of the analysis showed that between the level of digital divide and the affordability to broadband technology there is a negative correlation (Badasyan et al. 2011). It would be expected because the increasing competition in the domain of providing broadband services leads to a reduction of their prices and greater availability for end users. However, increased competition is more expressed in urban than in rural areas and, therefore, on one hand, there is an increase in the affordability of these services, but it could be expected a lower value of the sub-index regarding the level of digital divide.

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INTEGRATING PORT EQUIPMENT MAINTENANCE PROCESS INTO PORT MANAGEMENT INFORMATION SYSTEM (PMIS)

Branislav Stevanov[1], Zdravko Tešić[1], Sanja Bojić[1], Milosav Georgijević[1]
[1]Faculty of Technical Sciences, University of Novi Sad, Serbia

Abstract. *The maintenance process in ports encompasses preventive, corrective and combined maintenance of all types of equipment used for performing work processes (reloading, transport, weighing, warehousing). The equipment is exposed to various potentially harmful effects, which results in malfunctions and the need to maintain the system. The paper shows research on the analysis and the reengineering of the maintenance process for the river port information system implementation and the integration with other port processes.*
Key words: *Maintenance process, Port management information system*

1. INTRODUCTION

River ports provide many services which can include unloading of goods from the vessels, storing the goods at the appropriate space such as open or closed warehouses, and loading of goods to the other means of transport such as trucks or railway. River ports can also provide measuring services and mooring services for vessels. In order to fulfill all the planned activities, ports must be provided with adequate equipment. Maintenance of equipment presents very important activity in the process of providing transloading services in river ports. Most of transloading equipment present cranes, forklifts, wheel loaders etc. Also, in order to successfully manage all port operations, it is important to manage all the created information and that can be done with the application of the port management information system (PMIS). Additionally, the port management information system can be connected to other types of information systems such as geographic information systems (GIS) and to various web applications made for supply chain management (SCM). This enables that all the activities are executed in a timely manner. To fully implement port management information system, port processes have to be changed in the terms of changing or adding information which is needed for successful and accurate execution of port operations. This paper presents a model for port equipment maintenance process which is created prior to earlier process analysis. Section 2 presents overview of maintenance management. Section 3 presents case study of river port equipment maintenance and process modeling for the integration into PMIS. Section 4 presents conclusions and future work recommendations.

2. MAINTENANCE MANAGEMENT

Equipment maintenance management presents important support process in industrial and service enterprises. It presents safety feature for many work systems, as it is important to identify critical equipment and maintain it regularly, to make it available and reliable during its operational time [10]. To automate the maintenance management process it is necessary to do three main activities [6]:

- collecting information about equipment,
- processing information and
- making maintenance decisions.

Different technologies can be used to collect information about equipment condition, such as radio-frequency identification (RFID), hand-held computers and smart-phones [7]. This information includes various information like equipment location, inventory number, manufacturer data, production date, equipment type, weight, energy consumption data and equipment current condition data. The collected data is worthless if it is not managed properly through appropriate software support. Acquired information management means data storage and retrieval, data processing and distribution. Most of the software applications for maintenance process integration and management utilize internet and web platforms [2]. Before the implementation through the information system, it is important to define all the activities through process model. Through process definition the maintenance activities and information flows are defined. This provides a basis for resolving different decisions that have to be made. Examples of maintenance process analysis, design and integration can be found in [4], [8] and [1].

The case study presents the port of Novi Sad and the port management information system. It is presented how the existing port services are integrated with other systems and participants in the supply chain. It is also presented how the equipment maintenance process is reengineered to be ready for integration into PMIS.

3. CASE STUDY - RIVER PORT AND PMIS

The port of Novi Sad is located on the left bank of the Danube river, at 1254. kilometer, on a total area of 350000 m^2. Quay length is 800 meters. The port has four anchorages. Port is connected to the railway. The port handles and stores [9] :

- bulk cargo,
- general cargo,
- containers and
- liquid cargo.

The port disposes with the following equipment [9]:

- 5 portal cranes, capacity 5t to 27.5t,
- 7 forklifts with a capacity of 3t, 1 forklift with a capacity of 5t, 2 forklifts with a capacity of 12.5t, 1 forklift with a capacity of 28 t,
- 2 wheel loaders, 3 skid steer loaders,
- 2 weighbridges, of which one is for road and rail with a measuring range of 100t,
- 2 telescopic funnels for bulk cargo handling, capacity up to 500 t/h per funnel,
- 2 packaging machines (packing of bags of 50kg and big bags of 1 000 kg),
- Pump for oil products with a storage capacity of 270000 m^3.

The port management information system PMIS presents integrated system which facilitates planning, execution, control and management of the business processes in the port. The PMIS provides the information and data in real time related to the movement of vessels (entering the port, activities in the port, exiting the port), weighing and warehousing processes and transloading service provision. PMIS also provides data management about business partners, financial transactions, human resources and existing equipment. The model of PMIS was developed using the information and knowledge gained during the work on the EU project DaHar [3], in the segment related to the development of River Information Services (RIS) [11]. The requirements set by the employees of the port have also been taken into account. PMIS present combination of interconnected components, which collect, process, store and distribute the information needed for decision making, coordination and process management at the port. PMIS provides its users with real-time information about vessels' entry and exit from the port, equipment management at the port, logistics information, financial and accounting updates. PMIS can be connected to other systems and participants in the supply chain. The integration model is presented in Figure 1. The aim of creating the river port model and application software is to raise competitiveness by increasing the efficiency of using the work systems in the port, increasing customers' satisfaction and the quality of services provided. The PMIS enables integration of port business processes, as well as external integrations with the RIS and other systems, which should create the following positive effects:

- improved data correctness,
- real-time data provision,
- decreasing the scope of manually processed data and the number of mistakes in data,
- information exchange control,
- improvement in the quality of decision-making and customer service.

Figure 2 shows which port processes integrate through PMIS.

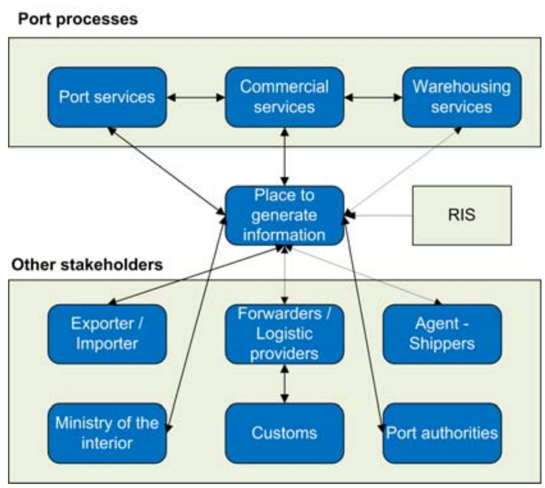

Figure 1. Integration model [5]

Analysis and reengineering equipment maintenance process for PMIS integration

The application of IT solutions in the equipment maintenance management is at the lower level compared to other processes in the port. The process analysis showed that the activities workflow isn't structured or systematically defined. Records and documents are generated manually and are incomplete and not up-to-date. There is a lack of certain activities necessary to implement the maintenance management process. The existing state and solutions applied in advanced business systems serve as the basis for setting up a new model of maintenance process, in order to be ready for the PMIS support. Having in mind the types and specific features of the equipment used for the port services provision, the following basic structure of the maintenance process has been defined:

- creating basic maintenance code lists,
- maintenance of equipment:
    - reporting malfunctions,

- preparation for intervention,
- maintenance procedure implementation,
- reports processing and analysis.

Maintenance code lists creation

This process should facilitate updates of basic internal information about the factors important in the maintenance process. It has been designed to facilitate the application of a unique labeling system (identification and classification) of the tools and machines. The concept of the unique catalogue facilitates unambiguous identification of factors (each factor has an identification number or label). The classification enables the factors to be put into groups and subgroups, according to certain characteristics that facilitate grouping for the purpose of executing other processes. The tools and equipment are classified using the catalogue of tools and equipment. The locations of malfunctions can also be classified, so that the reports and reviews could group and sort the information. The causes of malfunctions are classified according to the code list presented in the detailed project.

Basic-internal catalogue of tools and machines encompasses the information about the equipment used for reloading, such as cranes, two loading hoppers, loaders, mini-loaders, fork-lifters (3-12.5t), tractors, trailers, passenger vehicles. The internal catalogue of tools and equipment contains information about the tools and equipment listed in the *Tool and Equipment Record.*

Reporting malfunctions

The foreman or the operator of the tool/machines which experienced the malfunction is obliged to report it. It is done by filling in a *Malfunction identification notice.* The reported malfunctions are recorded (by the on-duty employee) for the head of the maintenance department in the *Maintenance log.* The decision regarding the need to address the malfunction is made by a manager.

Preparation for intervention

The preparation for intervention is conducted by the head of the maintenance department. The procedure is based on the type of *malfunction,* i.e. *information about the malfunction* and the analysis of the documentation regarding the equipment. The preparation of the additional maintenance interventions encompasses the following activities:

- entering the description of the activity into the *Maintenance order form,*
- completing *Procurement need form*, based on the information entered in the order form, so that material and spare parts could be taken from the warehouse,
- processing *Service order form*, for commissioning other organisations for the works on removing the reported malfunction.

Maintenance procedure implementation

Those in charge of performing the procedure leave for the location and follow the description listed in the *order*. After the malfunction has been removed, the head of maintenance department is informed, and the unused material and spare parts are returned to the warehouse and the *Spare part return form* is created and processed. If the activity has been performed by an external organization, the head of maintenance signs the *Report on the performed service*. The interventions are recorded in:

- *Maintenance log*, entering the time when the activity was finished,
- *Tool and equipment card*, information about the changes to the equipment following the maintenance activities.

The signed and approved orders, with supporting procurement forms and return forms are submitted to the accounting department.

Reports processing and analysis

Based on the conducted analyses and recorded interventions, the head of the maintenance department creates reports on performed activities on removing malfunctions:

- Report on malfunction,
- Report on causes of malfunction,
- Report on used material and spare parts,
- Suggestions for remedial measures,
- Damage report.

The reports are created using the templates provided in the detailed project document.

IDEF0 maintenance process model

For process modeling the IDEF0 method is chosen. IDEF0 model is shown in Figure 3, according to the previously conducted analysis and suggestions for introducing and improving the maintenance process. With all the activities and all information and material flows defined, the integration of port equipment maintenance process into PMIS is enabled.

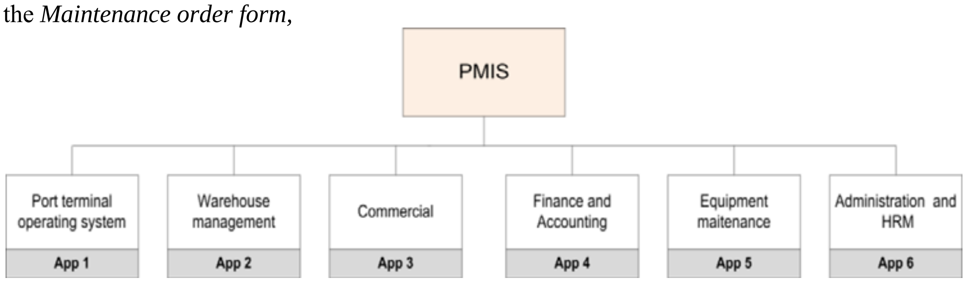

Figure 2. PMIS integration structure for port processes

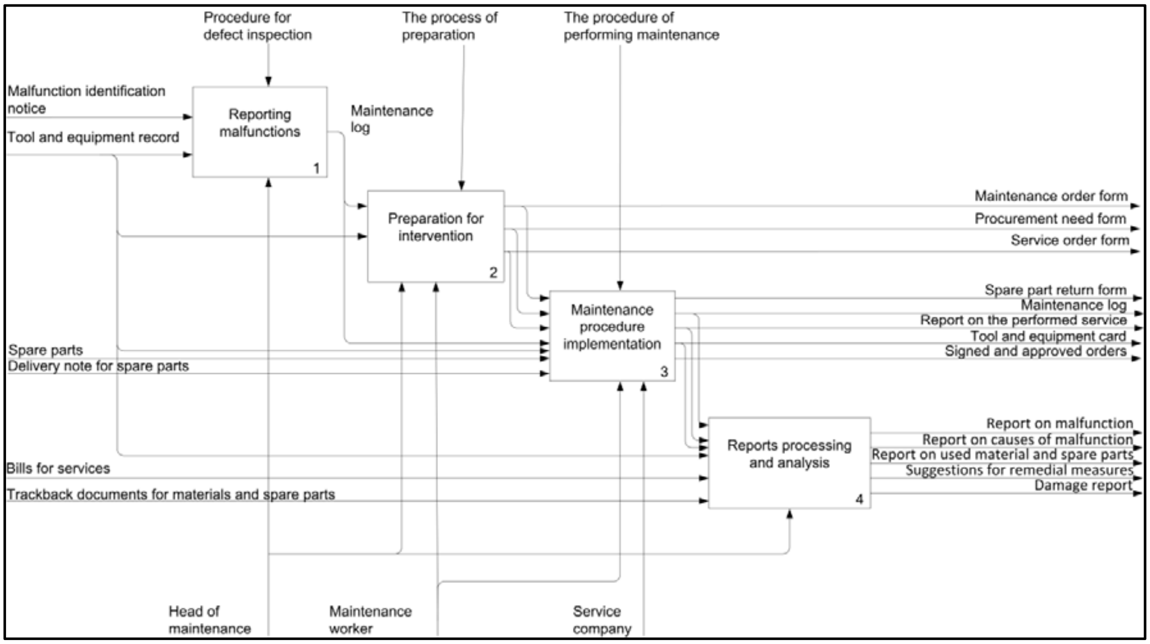

Figure 3. Maintenance process IDEF0 model

4. CONCLUSIONS

The research presented in this paper presented process analysis for maintenance of port equipment. The created process model gave focus on all the necessary activities and flows. Future research work should encompass the implementation of RFID technology to automatic detection of the equipment state.

5. ACKNOWLEDGEMENT

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MODIFIED KINNEY METHOD FOR RISK MANAGEMENT OF IMPARTIALITY AND INDEPENDENCE IN INSPECTION AND CERTIFICATION BODY FOR PRODUCTS, PROCESSES AND SERVICES

Snezana Pavicevic[1], Bozo Vukasinovic[2]
[1]Consult ADQM d.o.o., Belgrade, Serbia
[2]Elkont inzenjering d.o.o., Belgrade, Serbia

Abstract. *This paper presents modified Kinney method which is implemented in few inspection and certification body accredited according to ISO/IEC 17020 and ISO/IEC 17065 in Serbia as way to fulfill the requirement for management of impartiality. Although in Note 2, clause 4.2.3. of ISO/IEC 17065 is specified that "identifying risks does not imply risk assessments as stated in ISO 31000", this standard which provides the basic general principles for risk management, was used as a main tool for managing of risks to impartiality this type of conformity assessment bodies. For identification of risk to impartiality was used also specification ISO PAS 17001.*

Key words: *Impartiality and independence, ISO/IEC 17020, ISO/IEC 17065, modified Kinney method.*

1. INTRODUCTION

One of the main requirements for all conformity assessment body is to provide impartiality and independence of its activities. This requirements are special important if we talk about organization that providing inspection and certification of products, processes and services because of level of confidence that have to providing this type of organization to all interested parties. These types of organizations are one of the key elements not only in infrastructure of quality in one country but also one of the key elements in fulfillment of essential requirements of products, processes and services safety on the market according to New and Global Approach EU Directives.

Requirement that have to fulfill different type of Inspection bodies are covered by International Standard ISO/IEC 17020. For certification bodies, that has to be third-party impartial conformity assessment bodies, relevant International Standard is ISO/IEC 17065. Both types of organizations can be owned and operated by government or industry bodies, or to be separate organizations. Regardless of their ownership and way of operation they have to demonstrate independent of the other parties involved. Inspection bodies, according to level of independence, are classified in three types:

Type A - bodies provide third-party services and are expected to be independent of the other parties involved;

Type B - provide first-party services to their parent body only;

Type C- first-party inspection bodies which may also provide inspection services to other organizations.

Versus Inspection Bodies Certification Bodies has to be third-party impartial conformity assessment body. The main general requirements for impartiality CAB (conformity assessment body) it has to demonstrate through accreditation [1].

In clause 4.1, of International Standard ISO/IEC 17020, as well as in standard ISO/IEC 17065, clause 4.2 required that relevant body shall identify risks to its impartiality on an ongoing basis. International Standard ISO 31000, *Risk management – Principles and guidelines*, can be used as a framework and a process for managing risk of impartiality in inspection body or certification body in spite of that in Standard ISO/IEC 17065, clause 4.2.3, Note 2 is specified that "identifying risks does not imply risk assessments as stated in ISO 31000".

Opinion of the author of this article is that standard ISO 31000 provide general principles of risk management which are the basically same as requirement in ISO/IEC 17065, clause 4.2.4, as well as in ISO/IEC 17020, clause 4.1.4. As a method for identification and adequate risk treatment is used the Kinney method which are widely recognized and in used in the national organization for the risk assessment in the field of Risk Assessment for Health & Safety at the Work. This method, which will be presented, is adapted and modified for the needs of inspection and certification body and requirement for management of impartiality.

2. MANAGEMENT OF IMPARTIALITY AND INDEPENDENCE

First step in a process of management of impartiality and independence was to establishing the context, regarding to objectives of organization and its external and internal parameters which will be taken into account and the Policy of impartiality and independence. Also, at this stage was developed the methodology, selected relevant project team members and its trainings.

In the project team member were included top management of inspection or certification body as well as representatives of top management of the whole organization especially management of those sectors that might have a potential conflict of interest with the part of its organization which is inspection or certification body. Task of the project team was to identified potential risk to impartiality and independence, potential conflict of inters, and to developed way of collecting information through organization. To create a list of potential conflict of interest to impartiality and independence project team was used also Public Specification ISO/IEC 17001, *Conformity assessment – Impartiality - Principles and requirements*, which contains principles and requirements for the element of impartiality as it relates to standards for conformity assessment.

In a stage of risk identification, as a tool for collecting information have been developed two types of questionnaires, one for individuals and another one for the organization. Personal questionnaire was filled by all employees in the inspection or certification body, irrespective of the manner of engagement, as well as individuals from Management Board or other shareholder who can have an impact on decision-making in the inspection or certification body. Issues in the questionnaire were included all identified risk that my having individual.

Another “The Questionnaire about the conflict of interest of The Organization” is filled by the Management Board where were requested information about ownership structure, all potential conflict of interest activities in the organization, financial transactions with existing and potential clients, joint project, marketing or other activities with a clients.

A list of all identified risks to the independence and impartiality had over then 20 identified risk grouped in 6 categories: personal risk (ownership, employment or joint projects with client organization etc.), management risk (engaged in the design, manufacture, supply, installation, purchase, ownership, use or maintenance of the items inspected etc.), sharing of material resources, join marketing activities, risk of different type of agreement with the client (multi agreements with third parties, long-term contracts, subcontracting etc.) and financial risk (borrowings, loans, etc.).

As a basic method for risk assessment it was used the Kinney method. The Kinney method was first developed and used for explosion risk prevention in military industry. Now this method is widely in use for risk assessment in Safety and Health at Work.

This method is based on three criteria: probability (P), risk frequency (F) and the gravity (G) of the induced consequence. For each identified risk is determined by probability (P), risk frequency (F) and the gravity (G) of the induced consequence.

For adapting The Kinney method of risk assessment were modified a following tables:

Table 1. Numerical value for probability (P)

Rank	Qualitative description
0,1	Virtually impossible
0,2	Practically impossible
0,5	Plausible, but unlikely
1	Improbable, but possible at boundary conditions
3	Unusual, but possible
6	Possible
10	Predictable

Table 2. Numerical value for frequency (F)

Rank	Qualitative description
0,5	Never happened
1	Very rare (not in the last 2 years)
2	It happened (ones in the last 2 years)
3	It happened occasional (more than one in the last 2 years)
6	Regular (yealy)
10	Permanent

Table 3. Numerical value for gravity (G)

Rank	Qualitative description
1	Without consequences
3	Significant consequences
7	High
15	Very high
40	The impact that directly affects the loss of impartiality

Frequency of two years was taken as a limited period that is long enough to ensure impartiality and its specified also in standard ISO/IEC 17065, clause 4.2.10, Note 1 and clause 7.13.6.

On the basis of collecting data, from questioners and assessment according to presented tables, the risk is calculated according to the following formula R:

$$R = P \times F \times G$$

The level of risk (R) is ranked from acceptable risk which no required additional measure to extreme, intolerable, which requiring interruption of work activities and immediately corrective measure and could be reflect on the loss of accreditation.

Table 4. Risk ranking scale – risk level (R)

Risk level	Risk class	Required action
< 20	Very low	Acceptable risk: no measure required
20 - 70	Possible	Monitoring and following procedures
70 - 200	Significant	To be taken protective measures and following
200 - 400	High	Immediate improvement
> 400	Very high	Activity cessation. Require immediate action by the top management

On the basis of identified and assessed risks and estimation level of risk project team established safeguards clauses. Typically safeguards clauses could be, as it specified in the standard ISO/IEC 17065 that person who have provided in the past two years of consultancy to the client shall not be used to review or approve the resolution of a complaint or appeal for that client. Another safeguards clause could be not acceptance some client of some product for inspection or certification with explanation to the client.

Task for project teams is also to propose the control measures and points, which is also topic of management review, as well as other risk assessment results. Identified and assessed risk level is also topic of inspection and certification body management review.

Identified risk level is a base for classification of inspection body as a type A, B or C.

Risk identification and assessment have to be presented also to the stakeholders, as well as their opinions, complaints and appeals should be base for review and identifying risks to its impartiality on an ongoing basis.

3. CONCLUSIONS

Even though standard ISO/IEC 17020 for inspection bodies neither standard ISO/IEC 17065 does not require the application of the some methodology for risk assessment presented methodology in this paper were used in few inspection and certification bodies in Serbia. Benefits from the presented methodology were first of all simple, systematic and targeted collecting relevant information for risk analysis. This Kinney modified methodology clearly separated risks which should be following and risks which required safeguard measure, as well as activities that may result with suspension of accreditation.

Also this presented methodology is verify as methodology which is fit for purpose for management of impartiality in several inspection and certification bodies and assessed positively by accreditation body.

All of this confirms that standard ISO 31000 provide widely applicable principles, framework and a process approach for managing risk. Also we would like to open the question why in standard ISO/IEC 31010, *Risk management - Risk assessment techniques* which is following standard ISO 31000 is not recognized the Kinney or other methods widely used in Safety and Health at Work assessment as a risk assessment techniques.

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THE USE OF FUZZY LOGIC IN RISK MODELING OF INSURANCE COMPANIES OPERATIONS

Jelena Rusov[1], Mirjana Misita[2]
[1]Dunav Insurance Company ado Belgrade,
[1]Faculty of Mechanical Engineering, University of Belgrade, Serbia

Abstract. *The significance of fuzzy logic is the possibility of risk management without quantitative models. Data, obtained using fuzzy logic, may allow policyholders the efficient process of making less risky decisions. Furthermore, they provide the apparatus for determining the risk of insurer's business, and based on that policyholders can decide whether to enter into a contract with that company exactly.*

Key words: *Risk, fuzzy logic, insurance.*

1. BASIC CONCEPTS OF FUZZY THEORY

The concept of fuzzy sets was introduced as a generalization of classical sets, forming a characteristic function - the membership function $\mu_A(x)$. References used in the preparation of this part of the work are [1,2,5] . In classical sets, the belonging of an element to some set A is precisely defined, therefore the characteristic function $\mu_A(x)$ can take only two values, 1 or 0

$$\mu_A(x) = \begin{cases} 1, & x \in A \\ 0, & x \notin A \end{cases}.$$

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n fuzzy sets some element can partially belong to a set. If it is defined that the characteristic function takes values in the interval [0, 1], the membership concept is no longer ordinary, but it becomes fuzzy (in terms of partial membership).

Let A be a classical subset of the universal set X, which can be finite or infinite. Fuzzy set A_μ is defined as

$$A_\mu = \left\{ \left(x, \mu_A(x)\right) \middle| \; x \in A, \mu_A(x) \in [0,1] \right\}$$

where $\mu_A(x)$ is a membership function and it represents the degree of belonging of some element from the set A to the fuzzy set A_μ, [2]. Larger value of $\mu_A(x)$ denote a higher degree of membership. Each fuzzy set is completely and in a unique way determined by its membership function.

Linguistic variables, such as very little, little, medium, and so on whose interpretation depend on a context, form the basis of fuzzy logic. Linguistic terms which represent approximate values of a base variable are presented with fuzzy numbers. Each linguistic variable is interpreted as a fuzzy number and it is defined in terms of a base variable, the values of which are real numbers. A linguistic variable takes the value from its set of terms which represents the set of labels to which fuzzy sets are assigned over the same domain, a fuzzy relation with the characteristic fuzzy function $\mu_A(x)$. Each linguistic value can be interpreted as a label of fuzzy subset of overall speech whose main variable is numerical value.

2. MODEL

Risk intensity assesment is a difficult and complicated process. In order to make the data comperable it is necessary to define a unique model of risk assessment. One of possible ways is that risk implies the possibility of occurence of adverse effects on insurance companies' business and financial results. In other words, it is necessary to determine the sufficiency of funds (premiums) for resolving of caused adverse events. The model given in this study is based on fuzzy environment used to determine if an insurance company conducts risky business, on the basis of which future policyholders can make a decision whether they want to enter into a contract (policy) with that insurer exactly.

The main characteristic of fuzzy sets is the fact that a membership function is not strictly defined. Its formulation and input parameters depend on expert knowledge. Fuzzy logic can be managed by risks that don't have a quantitative model. Using them it is possible to assess the degree of risk exposure and explain dependence and relations among factors.

The risk intensity may be defined as numeric variable which takes values in the interval [o, *x*], or as linguistic variable which is defined by terms "low, medium, high etc".

Based on expert knowledge the risk intensity, as numeric variable, takes value in the interval [0, 100], Figure 1.

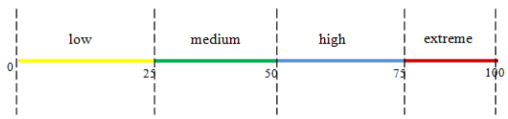


Figure 1 Classic illustration of risk intensity

Fuzzy system consists of two input linguistic variables (the total amount of premium and the amount of resolved claims) and the level of risk tolerance (intensity), as one output variable. One of the main indicators of insurance company's operation is a premium (as one of the main sources of income) and payment of damage claims (one of the main sources of expenditure). Based on these parameters it is possible to determine the risks of the insurance company's operations, that is the risk tolerance assessment, which is very important to a future policyholder (a decision-maker) when deciding whether he will do the business with that company. The references used in the process of forming the model are [3, 4, 6, 7, 8].

The model is applied to the 01-Accident Insurance. For the total amount of premium – TAP as well as for the amount of resolved claims – ARC, the average value of the amount of premium and the amount of claims is taken, for the insurance type 01, over the last 5 years in some insurance company. The input values are given numerically and for the total amount of premium is obtained TAP=73, and for the amount of resolved claims ARC=61 tens of millions RSD.

The next step is the fuzzification of input variables into linguistic variables which take values from the set of terms {S-*low* (*small*), M-*medium*, H-*high* and E-*extreme*}. It is determined that input variables each have three linguistic values while output variables have four of them, therefore their corresponding sets of conditions are as follows:

TAP (*the total amount of premium*) = {S, M ,H},
ARC (*the smount of resolved claims*)={S, M, H},
RI (*risk intensity*) = {S, M, H, E}.

Larger number of linguistic values is not required because the accuracy of the output is acquired. The corresponding confidence intervals of linguistic variables are given as follows:

$$I_1 = \{x_1 \times 10^7 | 0 \le x_1 \le 100\},$$
$$I_2 = \{x_2 \times 10^7 | 0 \le x_2 \le 100\}$$
$$I_3 = \{r | 0 \le r \le 100\}.$$

Real numbers x_1 and x_2 represent consecutively the total amount of a premium and the amount of resolved claims in tens of millions dinars, while *r* is the variable which is in the interval [0, 100] and it represents a scale measuring the risk intensity.

Each linguistic variable, with fuzzy numbers as argumnets, is determined by linguistic values, which are determined by membership functions. Evaluations of input linguistic variables are given by triangular and trapezoidal membership functions. Their shapes are shown in Figure 2 and analytically described in the following way:

$$\mu_m(x) = \begin{cases} 1, & 0 \le x \le 25 \\ \dfrac{50-x}{25}, & 25 \le x \le 50 \\ 0, & x \ge 50 \end{cases}$$

$$\mu_s(x) = \begin{cases} 0, & 0 \le x \le 25 \\ \dfrac{x-25}{25}, & 25 \le x \le 50 \\ \dfrac{75-x}{25}, & 50 \le x \le 75 \\ 0, & x \ge 75 \end{cases}$$

$$\mu_v(x) = \begin{cases} \dfrac{x-50}{25}, & 50 \le x \le 75 \\ 1, & 75 \le x \le 100 \end{cases}.$$

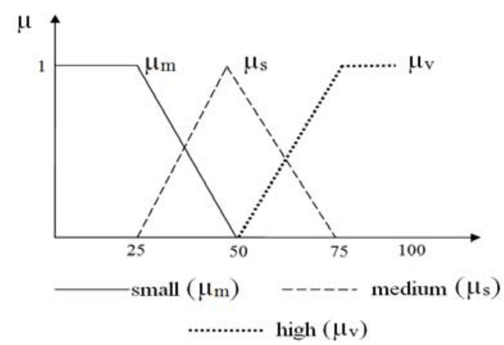


Figure 2 Graphic illustration of membership function of input variables

The corresponding fuzzy input values are:

$$\mu_s(73) = \frac{2}{25},\ \mu_v(73) = \frac{23}{25}$$
$$\mu_s(61) = \frac{14}{25},\ \mu_v(61) = \frac{11}{25}.$$

They are obtained by coding of input values, or by replacing initial values with the corresponding membership function. The transformation of initial values of input variables TAP=73 and ARC=61 (real numbers) into corresponding values of linguistic variables (fuzzy input values) is shown graphically in Figures 3 and 4. The straight line x=73 (x=61) intersects only fuzzy numbers S and H, therefore the cross-section of the straight line x=73 (x=61) and fuzzy number S is empty and the value of the corresponding membership function μ_m, 0. Non-empty cross-sections of the straight line x=73 (x=61) and two remaining fuzzy numbers represent the fuzzy shape of input value $\mu_s(73)$, $\mu_v(73)$, $\mu_s(61)$ i $\mu_v(61)$, (see [2]).

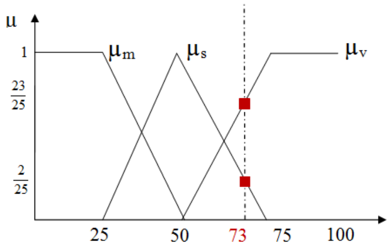


Figure 3 Fuzzy input value for the amount of the collected premium TAP=73

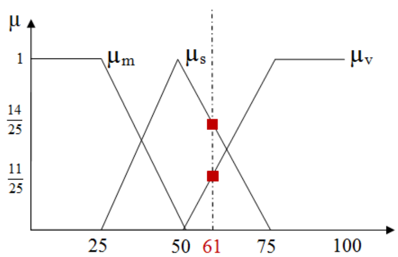


Figure 4 Fuzzy input value for the amount of resolved claims ARC=61

Models based on fuzzy logic consists of if-then rules [2, 8]. The number of rules is obtained as the multiplication of the number of input linguistic variables values and this model has 9 of them. After defining input fuzzy numbers and the application of 9 if-then rules, a decision table is obtained [2].

Table 1 The decision table

	S	**M**	**H**
S	S	S	M
M	S	M	H
H	M	H	E

In order that obtained measured fuzzy input values are applicable, the table 1 needs to be reduced. In this model the reducing is carried out using Mamdani's if-then rules, that are based on a minimum operator [1]. Their application results in the cause-effect table.

Table 2 The cause-effect table

	$\mu_s(61)$	$\mu_v(61)$	0
$\mu_s(73)$	$\mu_s(r)$	$\mu_m(r)$	0
$\mu_v(73)$	$\mu_m(r)$	$\mu_e(r)$	0
0	0	0	0

In fuzzy logic, the logical operator ∧ is being replaced by taking the minimum value under certain conditions, that are “min“ operations [4], and the resluts obtained by its application are shown in the following table.

Table 3. Results

	$\mu_s(61)=\frac{14}{25}$	$\mu_v(61)=\frac{11}{25}$	0
$\mu_s(73)=\frac{2}{25}$	$\min\left(\frac{2}{25},\frac{14}{25}\right)=\frac{2}{25}$	$\min\left(\frac{2}{25},\frac{11}{25}\right)=\frac{2}{25}$	0
$\mu_v(73)=\frac{23}{25}$	$\min\left(\frac{14}{25},\frac{23}{25}\right)=\frac{14}{25}$	$\min\left(\frac{11}{25},\frac{23}{25}\right)=\frac{11}{25}$	0
0	0	0	0

This clearly shows that four active cells are available for the decision table for the risk intensity assessment model to the decision maker.
By taking the minimum value of corresponding fields from tables 2 and 3, and by applying the operator ∧, the output control variables are obtained, which are shown in table 4. It should be noted that in this model the minimum operator is applied to the number and the membership function of the fuzzy number.

Table 4 The table of output control variables

$\frac{2}{25}\wedge\mu_S(r)=\min\left(\frac{2}{25},\mu_s(r)\right)$	$\frac{2}{25}\wedge\mu_V(r)=\min\left(\frac{2}{25},\mu_m(r)\right)$
$\frac{14}{25}\wedge\mu_v(r)=\min\left(\frac{14}{25},\mu_m(r)\right)$	$\frac{11}{25}\wedge\mu_e(r)=\min\left(\frac{11}{25},\mu_e(r)\right)$

As a result four output fuzzy numbers are obtained, and it is necessary to get one fuzzy output variable with the membership function (aggregation process). In other words, it is necessary to make a definite conclusion based on a series of separate conclusions. The aggregation process itself is shown graphically and it follows [2].

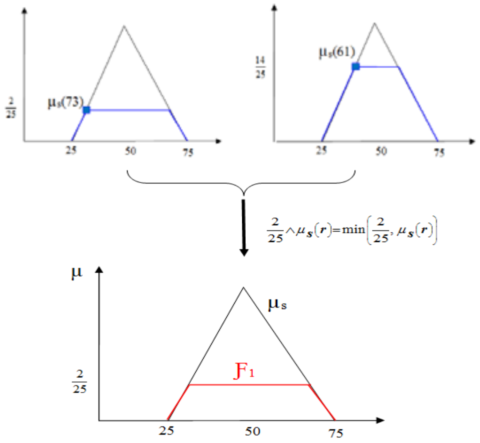
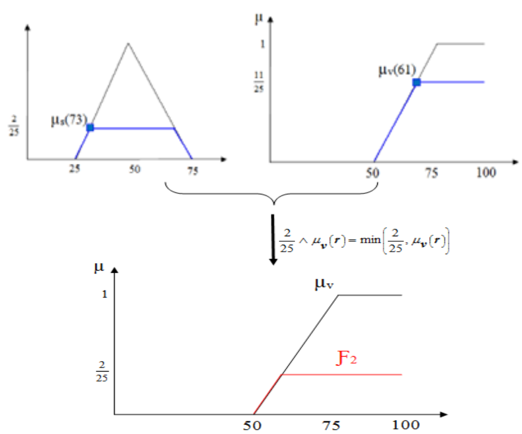
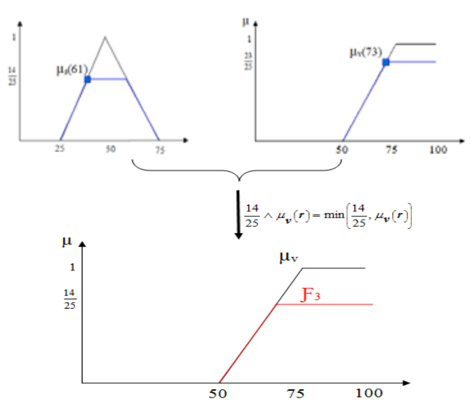


Figure 5a. The graphic illustration of the aggregation process





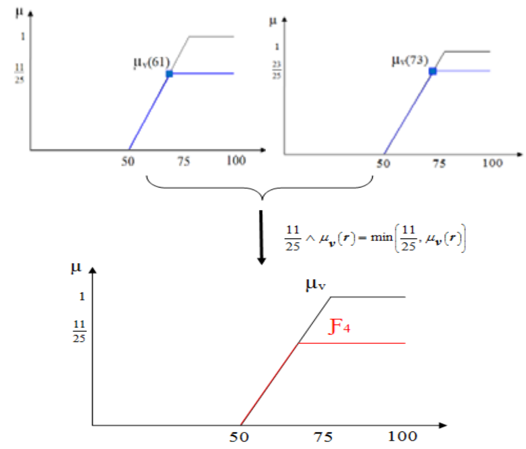


Figure 5b. The graphic illustration of the aggregation process

Output trapezoidal fuzzy numbers Ƒ1, Ƒ2, Ƒ3 and Ƒ4 are obtained and they need to be shown as one output fuzzy number. In geometric sense, it is necessary to find suprema of trapezoids obtained. In Figure 5 it is noticed that output values obtained by rules 2 and 4 are contained in the output value from the rule number 3. Regarding that, it is sufficient to sublimate output values obtained by rules 1 and 3 using a maximum operator and get the aggregate function $\mu_{agg}(\boldsymbol{r})$. Or

$$\mu_{agg}(r)=\max\left(\min\left(\frac{2}{25},\mu_s(r)\right),\min\left(\frac{14}{25},\mu_v(r)\right)\right)$$

whose graph is given in Figure 6.

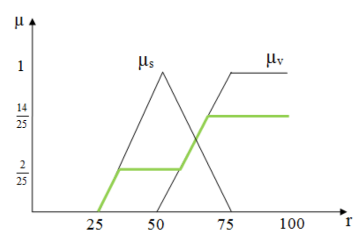


Figure 6 Fuzzy output value after the application of the aggregation

The aggregate functional form is:

$$\mu_{agg}(r)=\begin{cases}\frac{r-20}{25}, & 25\le r\le 27\\ \frac{2}{25}, & 27\le r\le 52\\ \frac{r-50}{25}, & 52\le r\le 64\\ \frac{14}{25}, & 64\le r\le 100\end{cases}.$$

As the result of aggregation, a fuzzy set as a cross-section of fuzzy sets is obtained and it is hardly applicable in that form, so it is necessary to carry out a defuzzification of the result.
The resulting fuzzy output variable needs to be converted into real value, that is the defuzzification process should be applied by using Center of area method-CAM method (see [2]). The method is based on a weighted average and it is the most applicable in practice. A domain aggregate function [25, 100] is divided into 5 subintervals of equal length-15. Replacing $r_i =$40, 55, 70 and 85 with membership function of output fuzzy number results in the values in the following order $\frac{2}{25}, \frac{1}{5}, \frac{14}{25}, \frac{14}{25}$.
The required value is:

$$r = \frac{40 \cdot \frac{2}{25} + 55 \cdot \frac{1}{5} + 70 \cdot \frac{14}{25} + 85 \cdot \frac{14}{25}}{\frac{2}{25} + \frac{1}{5} + \frac{14}{25} + \frac{14}{25}} = 34 .$$

Based on these results follows that on the scale of 0-100, the level of risk is 34.

3. CONCLUSION

Based on the experience of financial experts the risk intensity scale is formed, Figure 1, in view of that can be concluded that the future investment is a medium risk investment. That means that insurers' business is not considered to be risky and the future policyholder can enter into a contract or a policy of Accident Insurance with the company relying on given level of risk, which refers to a sufficiency of collected premiums that enables the insurer to have funds for claims payment.

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THE PROBLEM OF CHOOSING BEST ALTERNATIVE PROJECT IN TERMS OF RISK

Dragan Lj. Milanovic, Dragan D. Milanovic, Mirjana Misita
Industrial Engineering Department, University of Belgrade, Belgrade, Serbia

Abstract. *The paper deals with the problem of risky alternative projects and their choice. The problem is that under conditions of uncertainty and risk the application of several methods does not have to give an exact answer to the question of who is the best alternative project. That tells us that the correct selection of the project depends not only on the selection of method for the evaluation, but also from the decision-maker, types of problems and his views on these issues.*
Key words: *uncertainty and risk, alternative project, methods of evaluation*

1. INTRODUCTION

Thirty years of experience in the application of dynamic methods for project evaluation has pointed to certain system weaknesses. The key weakness is that these methods are all based on fixed cash-flow projections, meaning that their implementation assumes or claims that future is certain.

To eliminate these weaknesses, "the third generation" of methods for financial evaluation of projects appeared in the late 1990s headed by the method of real options, Monte Carlo simulation, decision tree, and optimization methods.

The above methods emerged as a response to inadequacy of traditional methods for evaluating the projects in terms of uncertainty. The foundation for their implementation should be the creation of diverse scenarios and simulations of future effects and recognition of the fact that managerial flexibility has a value and such value must be included in the value of the project as a whole. The main advantage of new methods for evaluating the projects is a significant reduction of space for making mistakes in the projection of essential inputs and making a final investment decision [1].

If the analysis and evaluation of engineering investment projects does not take into account the risk and uncertainty, and if we assume that certain inputs are entered, then all of these methods in the end must show the same result. That means that if a project is acceptable, it will show each method applied. What makes them eventually different is the way how is shown this result. However, under conditions of uncertainty, it is not necessarily so.

The aim of this paper is to show that under condition of risk and uncertainty over the application of several methods does not have to give an exact answer to the question of who is the best alternative project.

2. USED METHODS

The terms risk and uncertainty in decision-making is usually defined as follows: Decision making under uncertainty occurs when the probability of those states of nature is not known or when the decision maker does not want to make use of the estimated probability distribution. If the likelihood of particular scenarios is known and significant for the decision maker, then we deal with decision making under risk [2].

In this paper, for the case to be examined, will be used first the method of expected net present value (with the assumed probability distribution), and then some of the methods that are used when the probability distribution is not known.

Expected NPV is the sum of the product of NPVs under different scenarios and their relevant probabilities (p). The following formula is used to calculate expected NPV:

$$E(NPV) = \sum \left(p_j\right)\left(NPV_j\right) - \textit{discrete case}\ .$$

The standard deviation is a probability-weighted deviation from the expected value. In practice, the calculation of the variance is easier when we use the following formula [3]:

$$V(NPV) = E(NPV^2) - [E(NPV)]^2$$

Standard deviation (σ) is the square root of the variance:

$$\sigma = \sqrt{V}$$

In decision theory, there are certain rules (methods) to make decisions when there are more alternative projects, but there is not an opportunity to assess the probability (or probability distribution) to enactment certain events. When we have more mutually exclusive alternatives, and, given the uncertain future, we are unable to predict the unambiguous value of a method of decision-making (for example, NPV) for each alternative, suitably is this problem to present in the form of matrix decision [4].

Suppose that in a decision-making process is available m alternative projects $(A_1, A_2, A_3, ..., A_m)$, which can produce n states in the future $(S_1, S_2, S_3, ..., S_n)$. Now we can form the following matrix:

Table 1. Matrix decision

	S_1 S_2 S_3 .... S_n
A_1	s_{11} s_{12} s_{13} $\cdots\cdots$ s_{1n}
A_2	s_{21} s_{22} s_{23} $\cdots\cdots$ s_{2n}
A_3	s_{31} s_{32} s_{33} $\cdots\cdots$ s_{3n}
..	....
..	....
..	....
A_m	s_{m1} s_{m2} s_{m3} .. s_{mn}

In this matrix $s_{11}, s_{12}, s_{13}, \cdots\cdots, s_{mn}$ are elements of the decision matrix, which represent the values of the adopted method of decision-making (for example, NPV).

The most well-known methods (rules or criteria) for the decision making under uncertainty are the next five:

- Wald's Maximin rule
- Maximax rule
- Hurwicz's rule
- Savage-Niehans rule
- Laplace's rule.

Maximin rule or Wald's rule (according to its founder A. Wald) is a rule that is based on the pessimistic prediction of results. Wald assumes that, if the future states are unknown, we should take the most cautious attitude and thus developed a theory of evaluation based on Maximin criteria. Maximin rule selects the alternative that has the most favorable result from the most unfavorable possible future state of alternative.

The Maximax criterion is an optimistic approach. It suggests that the decision maker examine the maximum payoffs of alternatives and choose the alternative whose outcome is the best. This criterion appeals to the adventurous decision maker who is attracted by high payoffs. This approach may also appeal to a decision maker who likes to gamble and who is in the position to withstand any losses without substantial inconvenience. [5]

Hurwitz's rule combines two previous extreme rules. The selected alternative has a higher score than alternative selected maximin rule and smaller than alternative selected maximax rule. The compromise is achieved by the introduction of so-called "optimistic parameter" $\lambda (0 \le \lambda \le 1)$, which reflects the awareness of the risk of decision-maker. The problem with this rule is to adopt the optimistic parameter λ (usually based on subjective opinions, or is determined by experiment). In the literature λ also referred to as the coefficient of pessimism [6].

Once we determine the parameter λ, then, according to Hurwitz's rule, for each alternative we calculate value from the following equation:

$$H_j = \lambda \cdot s_{ji_{\max}} + (1 - \lambda) \cdot s_{ji_{\min}}$$

where $s_{ji_{max}}$ is the maximum value and $s_{ji_{min}}$ is the minimum value of alternative A_j For the best alternative is chosen it with maximum H_j.

It is obvious that with increasing values of λ, this rule becomes more optimistic. So for λ = 1 we have practically optimistic maximax rule and, conversely, for λ = 0 we have a pessimistic maximin rule.

Savage-Niehans rule minimizes maximum possible losses caused by erroneous or inadequate assessment. For this purpose we form a new matrix - risk matrix. The elements of this matrix we obtain by subtracting the individual values of certain columns of matrix decision from the maximum values in this column.

In the newly created risk matrix is allocated the largest value for each alternative - the maximum risk, and then we choose one alternative that has the lowest value among the maximum values. This rule has, in addition to certain benefits, the lack of which looks only at the extreme values of the columns.

Laplace rule assumes that, if it is not known the probability distribution of future events (states), it can be considered that these conditions are equally probable. Thus, each state of alternatives has a probability of 1/n (for n states), and then we choose the alternative whose average score has a maximum value.

The good side of this rule is that it takes into account all the conditions of one alternative, and not just extreme. On the other hand, the poor quality of this rule is that it assumes that all states in the future are equally probable and thus excludes the potential risk that the decision-maker accepted, expecting different probabilities of certain states appearance in the future [4].

3. RESEARCH RESULTS

Suppose a company has prepared 4 alternatives of engineering investment projects. Data are given in the following table. Which alternative to choose?

Table 2. Data for four alternative projects

Altern.	NPV($)	p	NPV($)	p	NPV($)	p	NPV($)	p	NPV($)	p
A1	-40.000	0,2	10.000	0,2	60.000	0,2	110.000	0,2	160.000	0,2
A2	-60.000	0,1	0	0,2	80.000	0,4	100.000	0,2	180.000	0,1
A3	0	0,1	20.000	0,4	60.000	0,3	120.000	0,1	150.000	0.1
A4	-10.000	0,1	20.000	0,2	60.000	0,3	90.000	0,3	110.000	0,1

First, we apply the method of the expected NPV. We calculate the expected NPV and standard deviation for each of the four alternatives.

$$A_1: \ E(NPV)_1 = 60.000\,USD$$
$$V(NPV)_1 = 5.000 \cdot 10^6$$
$$\sigma_1 = 70.711\,USD$$
$$A_2: \ E(NPV)_2 = 64.000\,USD$$
$$V(NPV)_2 = 4.064 \cdot 10^6$$
$$\sigma_2 = 63.750\,USD$$
$$A_3: \ E(NPV)_3 = 53.000\,USD$$
$$V(NPV)_3 = 2.121 \cdot 10^6$$
$$\sigma_3 = 46.054\,USD$$
$$A_4: \ E(NPV)_4 = 59.000\,USD$$
$$V(NPV)_4 = 1.329 \cdot 10^6$$
$$\sigma_4 = 36.455\,USD$$

From these results we can conclude the following: From the perspective of the expected present value we should choose alternative A2, as its expected present value is the largest. However, looking at the standard deviation as a criterion, we choose alternative A4, because it has the least deviation from the expected value (less deviation - lower uncertainty of the random variable).

Now we will apply the above-mentioned five rules in the same example, but assuming that the probability distributions are not known.

First we form a matrix decision and risk matrix:

Table 3. Matrix decision for four alternative projects

Alt.	S_1	S_2	S_3	S_4	S_5	Min. value	Max value
A_1	-40.000	10.000	60.000	110.000	160.000	-40.000	160.000
A_2	-60.000	0	80.000	100.000	180.000	-60.000	180.000
A_3	0	20.000	60.000	120.000	150.000	0	150.000
A_4	-10.000	20.000	60.000	90.000	110.000	-10.000	110.000
The maximum value in the column	0	20.000	80.000	120.000	180.000		

Table 4. Risk matrix

Alt.	S_1	S_2	S_3	S_4	S_5	Max risk
A_1	40.000	10.000	20.000	10.000	20.000	40.000
A_2	60.000	20.000	0	20.000	0	60.000
A_3	0	0	20.000	0	30.000	30.000
A_4	10.000	0	20.000	30.000	70.000	70.000

According Maximin rule, we seek the minimum value for each alternative. In our case, we see that the minimum values are: A_1 = -40.000, A_2 = -60.000, A_3 = 0 and A_4 = -10.000, so we should choose A_3 alternative, allowing the decision maker at the same time prevented a utility value is negative.

Using Maximax rule, the choice of alternatives is among the four maximum values, which are: $A_1 = 160.000$, $A_2 = 180.000$, $A_3 = 150.000$ and $A_4 = 110.000$, so we should choose alternative A2.

According to Hurwicz's rule, selection of the best alternative depends on the parameter λ. In the investigated case, graphical representation of the expected value if we change λ from 0 to 1, is:

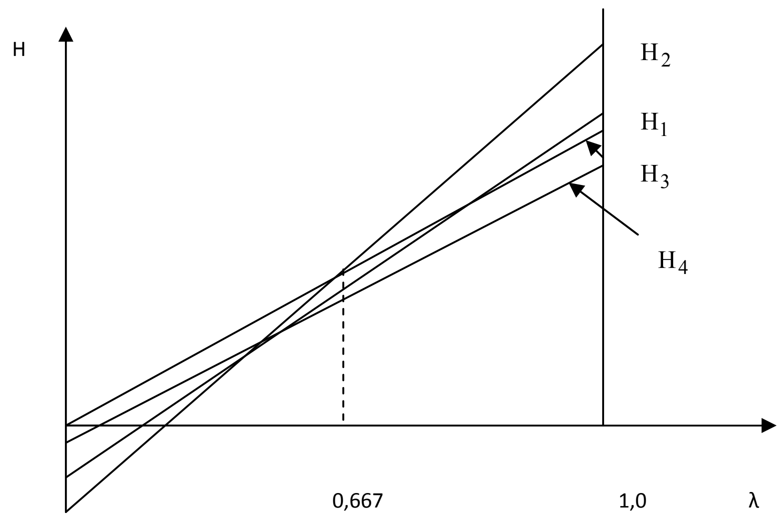

Figure 1. Graphical representation of the expected value

The Figure shows that the most favorable alternative is A_3, if $0 \le \lambda \le 0{,}667$, and if $0{,}667 \le \lambda \le 1$, we need to choose alternative A_2.

Using Savage-Niehans rule, based on the risk matrix (Table 4), we should choose alternative A3, because it has the least amount of risk.

According to Laplace rule, for this case we obtain the following results for the five assumed conditions (as n = 5, the probability of occur any event is 0.2):

$$A_1 : (-40.000)\cdot 0{,}2 + 10.000\cdot 0{,}2 + 60.000\cdot 0{,}2 + \\ + 110.000\cdot 0{,}2 + 160.000\cdot 0{,}2 = 60.000$$

$$A_2 : (-60.000)\cdot 0{,}2 + 0\cdot 0{,}2 + 80.000\cdot 0{,}2 + \\ + 100.000\cdot 0{,}2 + 180.000\cdot 0{,}2 = 60.000$$

$$A_3 : 0\cdot 0{,}2 + 20.000\cdot 0{,}2 + 60.000\cdot 0{,}2 + 1 \\ + 20.000\cdot 0{,}2 + 150.000\cdot 0{,}2 \quad = 70.000$$

$$A_4 : (-10.000)\cdot 0{,}2 + 20.000\cdot 0{,}2 + 60.000\cdot 0{,}2 + \\ + 90.000\cdot 0{,}2 + 110.000\cdot 0{,}2 = 54.000$$

Based on these results, we should choose alternative A_3 as the best, because its expected present value is the largest.

Summary of the results of this research gives the following table:

Table 5. Summary of the results

APPLIED METHOD	SELECTED ALTERNATIVE
1. a. Expected NPV 1 .b. Standard deviation	A2 A4
2. Maximin rule	A3
3. Maximax rule	A2
4. Hurwitz rule $0 \le \lambda \le 0{,}667$ $0{,}667 \le \lambda \le 1$	 A3 A2
5. Savage-Niehans rule	A3
6. Laplace rule	A3

4. CONCLUSION

As this paper has shown, for projects with a higher or lower degree of risk and uncertainty, different methods may give different results, which tells us that the correct selection of the project depends not only on the selection of method for the evaluation, but also from the decision-maker, types of problems and his views on these issues.

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OCCUPATIONAL HAZARDS IN DENTISTRY - APPLICATION OF THE NEAR INFRARED SPECTROSCOPY IN DIAGNOSTICS OF FATIGUE AND MUSCULOSKELETAL DISORDERS

Aleksandar Zunjic[1], Lidija Matija[2], Jelena Muncan[2], Ivana Mileusnic[2], Ljubisa Petrov[2]
[1]Industrial Engineering, Faculty of Mechanical Engineering, University of Belgrade, Serbia
[2]Biomedical Engineering, Faculty of Mechanical Engineering, University of Belgrade, Serbia

Abstract. *Practice in dentistry requires high degree of attention and precision during work related tasks. Awkward standing postures and sitting positions, repetitious hand and wrist movements, as well as mechanical vibrations originating from high-speed instruments can lead to development of musculoskeletal disorders. The objective of this paper is to assess suitability of application of near infrared spectroscopy as a method for evaluation of musculoskeletal disorders in dentists.*

Keywords: dentistry, ergonomics, musculoskeletal disorders, near infrared spectroscopy, aquaphotomics

INTRODUCTION

Many dentists work frequently in static, uncomfortable positions during the therapy of patients. It is necessary to indicate that these continuous positions during the time can lead to the pain, injury, or, in severe cases, to the musculoskeletal disorders, disability or premature pensioning. The adequate ergonomic design of equipment is important, in order of prevention of repetitive strain injuries and other musculoskeletal disorders.

Musculoskeletal disorders (MSD) are generally recognized as one of the most prevalent workplace injuries while health organizations around the world spend billions of dollars every year on this occupational health problem [1]. Work-related MSD frequently occur as a consequence of cumulative trauma and can influence the bones, muscles with their attachments, as well as the blood supply and nerves [2]. A significant number of research has identified that dental workers are at an increased risk of appearance of MSD, with reported prevalence rates between 64% and 93%, which negatively affects efficiency and lead to reduction in overall job satisfaction [3-5]. MSD are not an inevitable part of a dentistry profession. Paying the attention to the symptoms, identifying the occupational risk factors related to the MSD, as well as implementing of adequate health and safety measures can guarantee a long and healthy working career. In connection with the aforementioned, it is necessary to identify all relevant physiological responses in a human body, in order to provide proper ergonomic solutions for the special needs related to the dentistry practice.

Figure 1 shows a modified model of the relationship between mechanical exposure and health effects, based on the model proposed by Westgaard and Winkel [6]. According to the modified model, internal musculoskeletal load results in physiological and psychological responses covering a wide variety of effects at the system, on the level of muscles, organs, as well as on the cellular level. Such responses may include short-term development of fatigue, discomfort or pain and, on a longer time scale the health effects. The relationships between external mechanical exposure and internal biomechanical load, and between mechanical exposure and body responses were examined in laboratory studies.

Dentists during their tasks could be exposed to significant loads in the regions of the hand, forearm, upper arm, shoulder region, neck and back and lower extremities. From the posture and the way the dentists perform their tasks depend in which part of the body the fatigue will be primarily manifested, as well as the locations where MSDs could be developed over time. Although the aetiology of fatigue is not yet well understood, the general understanding is that muscular work produces inordinate increases in intramuscular pressure, therefore impairing local tissue perfusion causing fatigue and ischemia.

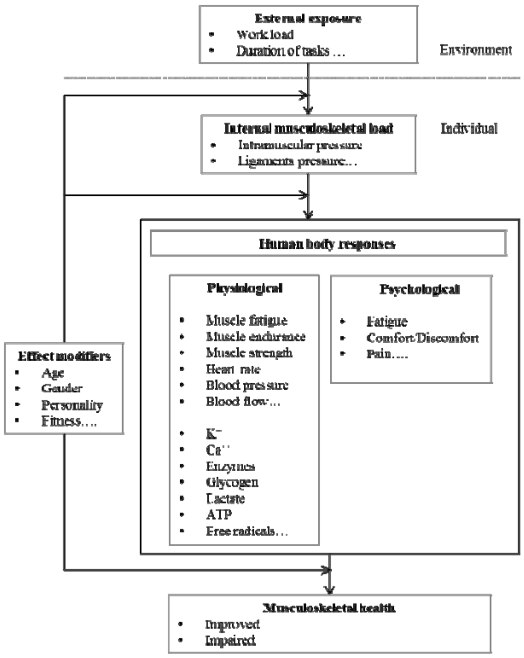

Figure 1. Model of relationship between external mechanical exposure and musculoskeletal health effects (adaptation based on [6])

Low force muscle contractions lead to the impaired oxidative metabolism, thus generating the muscle fatigue, which may be a predecessor for the appearance of muscle disorders [7]. Muscle oxygenation changes throughout of upper extremity work could provide comprehension of pathophysiological mechanisms that are connected with work-related muscle fatigue and disorders.

This paper puts an accent on applications of near infrared spectroscopy as a method of assessing parameters of exposure on the internal level, and proposes a new approach, not reported in the literature, with the potential for detection and monitoring of extensive number of parameters related to muscles functioning which could provide better insight into evaluation of the musculoskeletal disorders.

APPLICATION OF NIRS FOR ASSESSMENT OF MUSCOSKELETAL DISORDERS

Changes in musculoskeletal system can be detected using various methods. Measurement of forces, study of movements, subjective responses and electromyography measurements are frequently used to investigate musculoskeletal work-related risk factors. However, in vivo evaluations of local metabolism and hemodynamic are difficult, especially in the workplace. One of the methods that could potentially be used for this purpose is near infrared spectroscopy (NIRS). With the development of portable non-invasive optical instrumentation for measurement of the blood volume and local muscle oxygenation, studying muscle physiology as a function of ergonomic risk factors is becoming more evident.

Light manual jobs with elevated arms, which are characteristic for a work of a dentist, influence the blood flow and local tissue oxygenation of working muscle. Further, work with a monotonous or repetitive muscle activity pattern is associated with a higher risk of low back and upper extremity disorder development. There is certain evidence that signals obtained on the basis of the near-infrared spectroscopy can be used to evaluate oxidative metabolism in muscles during the work. Since this method is used in ergonomics for only short period of time, it is necessary to examine in what extent it can be used in the studies of work in dentistry practice from ergonomic aspect. Considering that different parts of the body during dentistry tasks may be exposed to different types of stresses (static, repetitive, long term), it is necessary to examine whether the NIRS method can be successfully applied to said body regions.

Near infrared spectroscopy is a non-invasive method, which uses the near-infrared part of the electromagnetic spectrum (680-2500 nm). In the near-infrared part of the electromagnetic spectrum, oxygenated blood is absorbed at 800 nm, whilst at 760 nm it is mostly absorbed by deoxygenated haemoglobin (Figure2). During a muscle action, the intramuscular pressure reduces the blood flow making a decrease in blood volume and oxygenation of tissues. NIRS can be succesfully used as a measure of changes in oxygenation in muscles during contraction, revealing variations in the level of oxygenation by giving information about the levels of deoxygenated and oxygenated haemoglobin, local blood circulation, as well as in the blood volume in muscles during work [8].

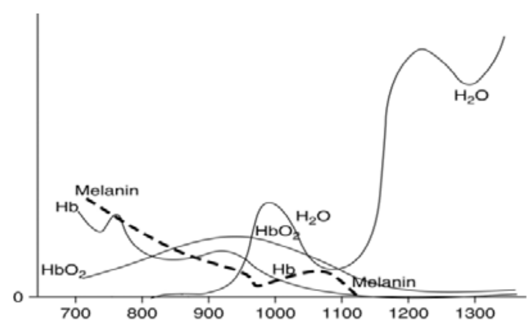

Figure 2. Absorption spectra for major human tissue chromophores: oxygenated haemoglobin (HbO_2), deoxygenated haemoglobin (Hb), melanin, and water (H_2O) over wavelengths in NIR range.

By using this technique, tissue oxygenation can be measured in the area of tissues in a working physiological setting, which improves specificity and has clear advantages as compared to other methods [9]. Near infrared spectroscopy has been increasingly used for discovering the relationship between fatigue development and the lack of oxygen

[10]. Additionally, NIRS is a sensitive tool which can be used to discriminate pathological and normal states [11]. Thus, NIRS has a diagnostic role in assessing the presence and scope of both metabolic and circulatory irregularities as well.

Earliest reports on NIRS as diagnostic applications date from 1977 [12]. Ozaki et al. later examined venal blood to determine the level of deoxyhemoglobin on the back of a hand [13]. Sowa and co-workers used NIRS imaging as a non-invasive technique to discover the effects of restricted blood flow and ischemia [14]. Mancini et al. used NIRS for estimation of skeletal muscle oxygenation by using differential absorption properties of haemoglobin [15]. Ischemia in the forearm was studied by Mansfield et al. in 1997 [16]. Reduced blood flow [17] or decreased muscle oxygen availability [18] have been associated with fatigue. It has been suggested that impaired blood flow and reduced muscle tissue oxygenation during continuous repetitive work contribute to the development of work-related MSD [19, 20].

It has been shown that low-force static muscle contractions [21] such as computer mouse work [22] can produce a decrease in local tissue oxygenation. Subjects that experienced great tension and fatigue showed a significant drop in forearm oxygenation when time pressure and accuracy were imposed on the work to be performed [22]. NIRS was successfully used in the assessment of haemoglobin kinetics and tissue oxygenation in the shoulder muscles [30]. Lin and co-workers have successfully used the NIRS to assess the effect of various work/rest ratios on oxygenation and blood volume in forearm flexor and extensor muscles during repetitive handheld power tool operations [31]. Crenshaw and associates demonstrate NIRS sensitivity in the assessment muscle contractile characteristics, oxygenation and hemodynamics of the finger flexors during a VDT mouse point and click task [32]. However, the NIRS results over the right lumbar erector spinae were not remarkably altered over time, and exhibited poor relationships with the perceived low back discomfort records for standing and seated exposures [33].

Possibilities of applications of aquaphotomics in the frame of NIRS

Beyond the state of art in NIRS of muscle fatigue, there is one novel framework which utilizes a part of near infrared spectra not previously known to be useful - the region of the 1st overtone of water. Variations in spectra caused by water are often regarded as a nuisance in vibrational spectroscopy. However, this new approach, called Aquaphotomics [23] utilizes exactly this region. Variations in water spectral pattern have been discovered systematically as a result of various changes (concentrations of solutes, concentrations of molecules which don't even absorb light in the NIR range such as metals etc., temperature, light illumination etc.). These findings lead to conclusion that water spectral pattern can be used to extract information on the sources of changes [23]. Aquaphotomics has been successfully used in various diagnostic applications [24-29].

We can conclude that Aquaphotomics has the potential for simultaneous measurements and monitoring of many physiological parameters related to muscle fatigue. It is thus worthwhile to focus research efforts in this direction.

CONCLUSION

This study has shown that NIRS method can be used for the assessment of work load in dentists. The method has disadvantage in the assessment of static work load for sedentary and standing positions in the connection of the region of lower back. However, in all other mentioned cases this method shows high potential for application for the purposes of assessment of MSDs in dentists.

Besides, this study has shown that Aquaphotomics approach also has the potential of application in the framework of NIRS method. However, this approach requires extensive laboratory research for the purposes of obtaining novel information in connection with the possibility of detection of muscle fatigue and MSDs.

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DENTISTS' WORKSPACE AND MUSCULOSKELETAL DISORDERS PREVENTION: PRELIMINARY STUDY

Ahmed Ali Essdai[1], Nuri Mohamed Saad[1]
[1]Faculty of Mechanical Engineering, University of Belgrade, Serbia

Abstract. *The importance of studying and analyzing the ergonomics concepts in dentistry is to reduce dentists' health problems that may be faced through time, such as musculoskeletal disorders, which result the most often in neck and shoulders pain. This paper is a preliminary study for dentists' workplace modeling through anthropometric measurements analysis and ergonomic principles application, using sample of 25 dentists in Belgrade region and smaller control sample to confirm study results, all that in aim to minimize musculoskeletal disorders and injury risk reduction over time due neck flexion issues. Special attention is paid to the proper position of patients' dental chair that may give more comfort for dentists that work in standing position, through minimizing the dentists' neck flexion.*

Key words: *musculoskeletal disorders, anthropometric measurements, dental chair, neck flexion*

1.INTRODUCTION

Dental work is a vision-demanding very precise task that needs high concentration with repetitive movements of arms and hands sometimes in combination with exertion of force and in combination with postural loads of upper back and head and improper fixed postures during work. The musculoskeletal disorders (MSDs) have high influence on dentist occupation and appear as neck, shoulder, back and headache pain [10]. It is evident that biomechanical factors, such as awkward posture, force, repetition, and equipment design, are affecting the development of dentists` musculoskeletal problems, namely neck, shoulder, upper and lower back pain, CTS (carpal tunnel syndrome), tendonitis, ulnar and radial nerve entrapment syndromes and repetitive strain injuries [11]. Pain, swelling, burning sensation, cramping, blanching, decreased range of motion, stiffness, muscle weakness, and sensory nerve disturbances like tingling and numbness are some of the symptoms seen during the dentists career [5]. Table 1 shows some available previous studies results of musculoskeletal disorders prevalence among dental professionals. It can be seen that dentists have high prevalence of musculoskeletal disorders especially in neck, shoulders, and wrist/hands and they have been ascribed to the nature of the dental work [1]. The studies in Table 1 also find out that MSDs are not related to gender, years of practice, or operating style**.** It is also evident that those studies did not mention specifically the working posture of dentist (standing or sitting) and it's relation with MDS and the optimum position of dental chair. Work related MSDs may developed gradually as result of repeated stresses to soft tissues, such as muscles, tendons, nerves, ligaments, joints, cartilage, and blood vessels **[**13**].** The most commonly reported MSDs in dental hygienists include tension neck syndrome and shoulder impingement **[**13**].** The prevalence of general musculoskeletal pain among dentists are much higher, and is ranging from 63% to 95% for combined low back, neck, shoulder, arm, and hand pain **[**13**].**

Study	Population	Sample size	Back pain (%)	Neck pain(%)	Shoulder pain (%)
Basset(1983)	General dentist	465	62	-----	-----
Shugars et al.(1984)	Ortho-dentists General dentist	32 347	41 57	----- -----	----- -----
Kuroinka et al.(1987)	General dentist	359	----	72	----
Marshall et al. (1997)	General dentist	355	82% (MDSs in general)		
Kerosuo et al.(2000)	Ortho-dentists General dentist	81 147	70%(MDSs in general) 28 56		 53
Lalumandier et al.(2001)	Ortho-dentists General dentist	59 647	43 35	19 28	15 21

Table 1.Previous studies of musculoskeletal disorder prevalence among dental professionals [10,9]

It is also known that increasing neck inclination for 30degrees more causes a decrease in duration from 5 to 2 h to reach fatigue in the neck muscles **[**11**].**Previous research show that the need to survey dentist workplace design still exists and according to that fact the aim of this paper is to analyze the proper position of patients dental chair the may give more comfort for dentist in standing position, that still is prevalent, with minimal MSDs. Eccles**[3]** also confirms that still exist the need for application of ergonomic principles to the study of the man/machine system leading to improvement in the design of dental equipment and better comfort of the dentist**.**

2. METHODOLOGY

The static anthropometric measurements for 25 dentists in Belgrade(Serbia) that agreed to participate in experiment were collected, followed by an interview on even smaller sample, since only one dental clinic agreed to participate in an interview. In Serbia there are about 6000 licensed dentists in both private and public sector. Data for Belgrade region are not given on site http//www.stomkoms.org.rs[2].butsite http://zubari.cu.rs/beograd/[3].gives information for 188 private dentists in Belgrade and we used that data as starting point in this survey. The work place design is considered for the standing position since all the dentists in our sample are working in standing position. Sitting, as the preferred position for the dentist to adopt, was introduced in the 1960s in an attempt to reduce the fatigue and musculoskeletal problems associated with dental practice assuming that back problems would decrease [1]. However, a questionnaire survey that appears in 1977 [16] showed problems still exist while dentists in our sample confirm that in way that they feel better when working in standing position. Ergonomic designs must accommodate a range of user dimensions, typically from a 5th to a 95th percentile and this range will accommodate 9.5 out of 10 users. Most work chairs are designed on a “middle-out” model of anthropometrics intended to accommodate the middle 95 percent of the user population from the 5th-percentile to the 95th-percentile [14]. Accordingly, percentiles analysis is performed for P95 (95th-percentile) and P5 (5th-percentile) for both male and female, since they are working on same dental chair in order to establish the appropriate dental chair height that should allow comfort working position with minimum musculoskeletal disorders and better dental task control [8 ,12]. Since dental operators often cannot avoid prolonged static postures, more than one-half of the body’s muscles are contracted statically with neck flexion [16]. According to that neck flexion angle is measured for lower jaw tasks. The inclined angle (β) of neck flexion (as can be seen in Figure 1) is measured for a dentist during performing a task, since this angle is the most usually applied in performing different dental tasks with patients, as concluded from the interview. This angle could be controlled or reduced through adequate dental chair height that gives minimum neck flexion through suitable patient posture which we aimed for. The recorded measurements for neck flexion angle and dental chair height during performing inspection task for lower jaw are given in Table 2.

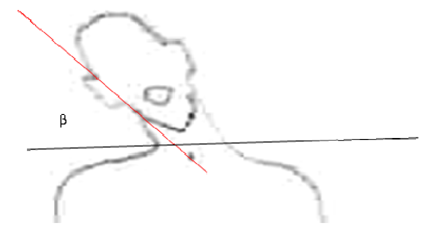

Figure 1. Geometry of neck flexion angle measurement

Average dental chair height (B) (measured)	670 mm
Average neck flexion angle to the right side β (measured)	55 degrees
Working field height (standing position) (A) (measured)	1150 mm
Mouth seat level (C) (measured)	410mm
Inclined chair angle (α) (fixed)	30 deg.

Table 2. Recorded measures of current dentist inspection task (lower jaw task)

3. DATA AND STATISTICAL ANALYSIS

The sample data for 25 dentists are summarized in Table 3. There were18 male and 9 female dentists in the sample. Their average age is around 45 years with standard deviation 9.41 while average weight is 77.56 kgwith standard deviation 14.87. From Table 3 the result shows P95=1268mm and P5=1018mm for the working field height of dentists in standing position.

Table 3. Data statistics including percentiles

	Mean value	Standard deviation	P95	P5
Shoe number	41,52	2,815955	45,8	37,4
Standing Height in mm	1744,2	100,8462	1868	1618
Sitting Height in mm	881,2	51,52427	974	810
Lower Leg Length in mm	573	40,07805	635	512,5
Upper Leg Length in mm	584,12	60,25109	668	483,6
Shoulder Width in mm	435,2	48,87228	522	381
Hip Breadth in mm	374,8	46,08597	420	310
Arm length in mm	656,8	74,74791	728	582
Arm working field height	1144,2	96,99914	1268	1018

That means that 1268-1018=250mm is the range needed to cover dentists in our sample. The figures 2&3 are illustrating percentiles P95 and P5 for working field height in order to find out the suitable dental chair height. Figure (4) is illustrating the domain of dimensions on dental chair and adjustable height. The dimensions are as follows:

A (A5-A95): the dentist working field height needed between 1268mm and 1018mm

B: average dental chair height needed amounts 610mm
C: patient mouth seat level needed amounts 500mm.

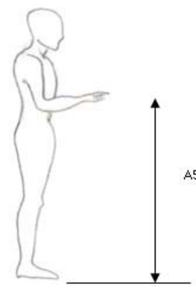

Figure 2. P5 working field height

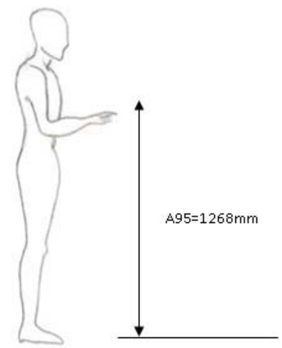

Figure 3. P95 working field height

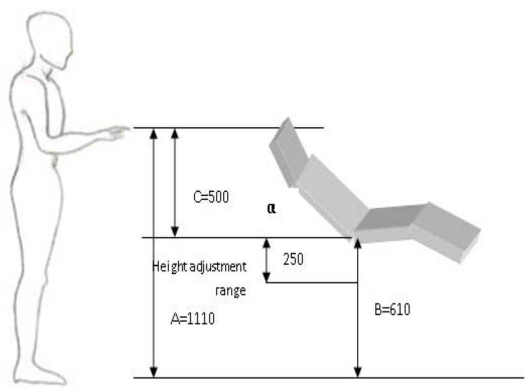

Figure 4.Illustration of Max.and Min. dental chair height in mm

4. RESULTS AND DISCUSSION

Using percentile analysis for P95&P5 it was found that the height adjustment range of patient chair needed amounts 250mm as shown in Figure 4 while inclined chair angle (α) was fixed without change 30 degree as indicated in ergonomic requirements for dental equipment according to **[5]**.By applying this survey results on female dentists that accepted to participate in interview and in performing inspection task (lower jaw task), the gained results in control experiment are given in Table 4.

The mouth seat level is increased from 410mm to 500mm which indicates a slight difference equal to 9cm, while the neck flexion angle was increased from 55 degrees to 63 degrees using recommendations of this study that this gives reduction in neck flexion.

Table 4. Recorded measures for calculated P95 and P5 of dentist - inspection task

Average dental chair height (B)	610 mm
Average neck flexion angle to the right side direction (lower jaw task)	63 degrees
Working field height (standing position)	1110mm (within the limits)
Mouth seat level	500mm
Inclined chair angle (α)	30 degrees

4. CONCLUSION

The use of ergonomic principles and workplace design using anthropometric measurements not for the whole population but for the specific occupation professionals results in more comfort and safety over time for any career. This study has confirmed that neck flexion for dentist career is the one of the largest problems that causes musculoskeletal disorders. The dental chair high has strong relation with neck flexion angle of dentist and the suitable adjustment of this high is result in minimum flexion of the neck , this flexion is reduced by 8 degrees (before applying anthropometry measures was 53degrees and after adjusting the chair according to anthropometry measures is found 63degrees). This conclusion gives possibility for lowering musculoskeletal disorders over time for the dentist career. Further studies will be performed as continuation of this preliminary study in aim to study the problem on larger sample size. Updated records will highly contribute in safer and more comfortable dental career in Belgrade region and Serbia. Organizational factors, such as work space, length of the shift, and breaks schedule are also contributing factors to the MS issues and they could be also analyzed in the future research.

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ERGONOMIC DESIGN PROPERTIES OF DENTISTRY EQUIPMENT

Ljubiša Petrov[1], Jelena Munćan[2], Ivana Mileusnić[2], Lidija Matija[2]
[1]Innovation Center, Faculty of Mechanical Engineering, Universityof Belgrade
[2]Faculty of Mechanical Engineering, Universityof Belgrade

Abstract: *Dental workers are at high risk in relation to specific musculoskeletal disorders,which can lead to the appearance of occupational diseasesthat refer to the dysfunction of the neck, back, arms, handsand fingers. According to the data from the literature, it is estimated that as a result of the working conditions the musculoskeletal injuries occur in 54% to 93% of dental professionals. This paper discusses the functional systems for dentists in terms of ergonomic designing, selection and adjustment of the equipment that is used in dentistry. Special attention is devoted to the analysis of chairs for patients and dentists, including the possibilities for their ergonomic improvements.*
Keywords: *ergonomics, dental equipment, muscosceletal disorders*

INTRODUCTION

Dentists and dental technicians are at high risk in relation tospecific musculoskeletal disorders. These disorders can lead to the pain and dysfunction of the neck, back, arms, hands and fingers.

The main risk factors among dentists could be classified as biomechanical and psychological. Important risk factors are longlasting static postures and forced positions (especially important for the region of neck, arms and shoulders), the repetition of movements and the need for the application of sustained physical strength (usually related to the arms and hands), inadequate lighting (intensity and positioning), inadequate design of instruments, biological and chemical exposures, and stress.

The goal of this research is to give the brief outline of the man-machine system for dentists, from the aspect of identification and analysis of functions of dental equipment, that should meet the ergonomic criteria for optimal work.

THE ERGONOMIC CRITERIA FOR ASSESSMENT OF DENTIST'S WORKING ENVIRONMENT

One of the approach for the assessment of design of products is based on the application of ergonomic standards and reccommendations [1]. They should provide an important requirement relating to the man-machine system, which refers to the fact that product with its design does not induce an error[2] during the work.

In connection with the design of dental equipment,it is important to consider the following standards and directives[3-7]:

- ISO/TC 106/SC 6 N 411, Ergonomic requirements for dental equipment
- ISO Standard 11226 “Ergonomics – Evaluation of static working postures”.
- ISO Standard 6385 “Ergonomic principles in the design of work systems”.
- Directive concerning Medical Devices. European Medical Device Directive (MDD), 12 July 1993, 93/42/EEC.
- Directive concerning health and safety at work, 89/391/EEC.

In the connection with the goal of the research, it wasnecessary to explore the modern constructive achievements and technical solutions concerning the dental equipment, their influence on dental workers, and their compliance with the specified ISO standards and directives.However, in this paper, particular attention has been directed to the elements that probably have the greatest ergonomic impact on the dentists - the working chairs and the chairs for patients.

WORKING CHAIRS FOR DENTISTS

When it comes to the working chair, it must provide the minimum angle between the thigh and lower leg of at least 110°[3]. This angle is necessary for the correct position of the pelvis and spinal column and stimulates active anatomical upright body position. The result is a least burdensome position. This approach allows the movement of the chair in the sitting position as well as more space above the thigh, for the positioning of the patient.Figure 1 illustrates the new generation of functional, ergonomic chair for dentists.

Figure 1. Dentist chair with adjustable armrests(http://www.posiflexdesign.com).

The seat should be height-adjustable, and the front edge should be shot down and away from the legs so as not to impede circulation and innervation to the legs of practitioners.

Support for hands is essential for health and comfort. Contemporary chairs provide support for the hands and allow a wide range of movements. The armrests should be placed below level of the elbow so that shoulders are not raised when restraints are used. They must not impede access to the patient. But some studies have revealed that the use of armrest reduces work of the upper muscles, as well as the frequency and volume of the arm during the performance of regular dental procedures.

DENTAL CHAIRS FOR PATIENTS

The basic principle is that the patient must lie comfortably without feeling pressure on the back. The chair should have a flat surface in order to achieve relaxed position of the patient.

The chair should enable the three movements of the head of the patient:

- Frontal in the occlusal plane of the mandible from 0° (horizontal), when the dentist sits next to the patient, to about 45°, when the dentist is sitting behind the patient's head, and back in the occlusal plane of the maxilla of 20°-25° behind the vertical plane for treatment the maxilla [3];
- Lateroflexio (turning heads obliquely to the side), about 30° [3], right and left. This movement always follows the movement of the upper body of the patient in the same direction to head and body were in a straight line. Consequently, the patient is uncomfortable to turn his head obliquely to the side, especially at a greater angle and for longer periods. Therefore, it is essential that the patient's body follow the position of the head positioning the head restraint so that the body is in a straight line;
- Around the longitudinal axis, a maximum of about 45 °, right and left [3].

For decades, the focus of many manufacturers of dental chairs was the comfort of the patient. However, when compared to the average time that a patient spends in the chair with the time the dentist spends in the work, it becomes obvious who is at greater risk of developing discomfort, disorder and disease development.

As a result of consideration of the problem of the pain in relation to the work and injuries among dentists, manufacturers are increasingly focusing on ergonomics of chairs for a patient from a position of dentists. Desirable characteristics should facilitate the neutral position of the spine, shoulders, elbows and joints of the hand. On the one hand, the chair should allow close positioning of the dentist over the mouth of the patient. On the other hand, it is necessary to ensure the correct position of the spinal column, leg and arm of dentists in order to minimize the stress and fatigue.

For designing purposes, the following elements of the chair should be taken into account:

Small and thin headrests

This allows for more legroom and easier access to the patient. At the same time, allows greater flexibility for positioning the patient. Double mobility allows rotation of the inclination of the patient's head.

Narrow backrest

This feature provides additional space for approaching the dentist and maneuvering.

Flexibility

The individual parts should be adjustable in terms of placement of patients of different sizes and ages.

Armrests

These parts should be positioned so as not to interfere with access to the patient, and not to touch the knees of a dentist and thus put a pressure in a static position, which can be long standing.

Height adjustment

The chair should be adjustable in height enough for the dentist to work. Otherwise, the dentist is forced to hold hands raised, which affects primarily on the fatigue of the shoulder area and other parts of the muscles involved in the process.

Handpiece holders

There are several technical solutions forpositioning of this system. Each of them has its advantages and disadvantages and can greatly affect musculoskeletal health and productivity of the operator. Of great importance is their primary purpose in terms of activities to be performed: if it comes to interventions in the field of conservative, protective or oral surgery.

AN EXAMPLE OF CONTEMPORARY DESIGN OF A DENTAL UNIT

Figure 2. Contemporary dental unit (www.kavo.com).

Functional parts of the system shown in Figure 2. are:

1. Completely operating concept for quick and direct access to all important functions for time-saving and smooth treatment processes
2. Intraoral camera to enhance dentist excetuion of working tasks
3. High resolution screen with enhanced visibility
4. System software, which supports useful functions and other access to thr relevant patient data
5. Automatic cleaning and a disinfectionhygiene centre of improved usability
6. High performance operating module
7. Modern futuristic design with adequate soothing colors
8. Patient armrest
9. Ergonomically designed patient chair.

DISCUSSION

It is estimated that as a result of the working conditions,the musculoskeletal injuries occur in 54% to 93% of dental professionals, and most injuries occur in the spine (neck and back), shoulders, knees and hands [8].

While special procedures increase the risk of injuriesto the fingers and hands, bad posture is a risk factor in all procedures. This is connected with the requirement that a dentist remains in one position during lengthy procedures. These problems are compounded by the stress and time demands.Musculoskeletal disorders (29.5%) and cardiovascular disease (21.2%) are the most common reasons that lead to damage or even permanent disability among dentists [9].

Good ergonomics is essential, so the ability to work, efficiency, and high performance can be maintained at a high level during working life. The importance of application of ergonomics in dentistry is at the high level and includes characteristics and condition of the equipment, such aslighting, noise, etc. Dental chair for patients and doctors, operating units, light sources, handheld instruments and peripheral equipment must be flexible, so as to guarantee good working positions.

One major challenge is the development of ergonomic equipment starting from the functional principles, and keeping the idea of aesthetic design and custom color.On the basis of the aboveconsiderations, taking into the account the surveys that were conducted with dentists, it is possible to define a five coherent priorities in order to improve the ergonomic working conditions of the dentist:

1. improving of chairs for doctors and patients;
2. optimal illumination of the oral cavity of the patient;
3. adequate support for the head, neck and shoulders of the patient and the dentist;
4. using of intraoral cameras in order to increase the field of vision;
5. mechatronic support for shoulders, arms and hands of a dentist.

CONCLUSION

Number of employees in the manufacturing industry and the supply of dental equipment is estimated between 40.000 and 60.000, and the estimation of the number of dentists is between 700.000 and 800.000 worldwide [10]. In particular, problems that are here considered have the implications for a large number of people. In order to get an even better picture of the magnitude of the problem, to this issue should be added also the number of patients - literally every one of us.

MSDshave significant social and economic consequences, including the abandonment of the profession or a significant reduction in working hours. The literature on this subject includes a number of studies, but it is still necessary to analyze the evidence linking risk factors and to work on finding and establishing of the effective prevention. In this sense, the basic recommendations are:

-Formulate the strategy for prevention through the promotion of training in all aspects of ergonomic practices (for example biomechanics) and to reduce the stress.

- Promote educational programs in the field of dental ergonomics for dentists including periodical checking of appearance and status of professional disease.
- Formulation of global guidelines for the design and development of ergonomic dental equipment.
- Promoting the development of standards in all areas of dentistry products.

Of great importance is the cooperation of engineers with healthcare professionals and equipmentusers, as well as with the experts in the field ofergonomics,biomechanics, mechatronics, manufacturing industries, etc., to produce dentistry products that will prevent or minimize the occurrence of MSD.
A significant factor is also the promotion of technological innovations and their integration in the dental practice, as a measure of the highest importance for the improvement of working conditions of dentists.

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IDENTIFICATION OF ANTHROPOMETRIC MEASUREMENTS' FACTORS OF SERBIAN ADMINISTRATIVE WORKERS: PRELIMINARY STUDY

Nuri Mohamed Saad Algheriani[1],Ahmed Ali Essdai[1]
[1]Faculty of Mechanical Engineering, University of Belgrade, Serbia

Abstract. *Many statistical techniques have been used in different sectors in order to minimize the production cost and increase the safety of the products. The aim of this paper is to find out the most important dimensions of the work places in the administration by applying a method based on multivariate statistical technique which would maximize the accommodation range of the population with greater safety. Accordingly, factor analysis is applied on anthropometric measurements of 50 administrative workers, since this is preliminary study. The results show that three dimensions space is obtained. Results of this research could be useful in administrative workers workplace designs and might lead to better productivity and safety.*

Key words: *anthropometric measurements, administrative workers, factor analysis*

1. INTRODUCTION

Products acceptance depends on the degree of comfort that users feel while using that product. In many cases the variability in human users will affect the acceptability of the products' design more than do the hardware from which the product is manufactured [7]. In many cases of product design problems safety and performance measures are based on body dimensions, therefore anthropometric measurements are required for ergonomic adaptations of workstations [7].According to that, for the effective design for human variability it is necessary to estimate the characteristics of the users and using of ergonomics principles is vital for increasing workers efficiency and productivity throughout reducing musculoskeletal symptoms, injuries, workers compensation claims, and reduction in lost and absent days [6]. There are many factors believed to influence the working posture including workstation layout, location and orientation of work, individual work methods, and the workers anthropometric characteristics. Therefore these factors must be taken into account in order to design high quality product in this case workplace in such a way that will increase the accommodation for human users and safety with reduction of design cost. Since variations on anthropometric characteristics are explained with a lot more than just two variables, multivariate analysis technique could be used in order to obtain precise and adequate results [8].

2. PREVIOUS RESEARCH

Ergonomic and hazard problems in the manufacturing process are important issues for many researchers and investigators. Some of them included manufacturing workers in companies in the United States and Taiwan [7]. These surveys showed that the workers are exposed to different ergonomic problems in the production process such as musculoskeletal problems of over exertion and repetitive motion without any fatal injuries as a result of improper anthropometric data used for design. Design according to general population or old data used for truck design also needs correction with new, more accurate anthropometric information from certain profession that should be used in truck cab designs [2]. Crane operators' anthropometric measurements survey has been done in different plants in Serbia in which multivariate statistical technique was applied to find out the critical dimension of the crane cabin affecting the adjustability and ergonomics of the product. Factor analysis technique was used on a sample of 83 crane cabin operators and results showed that critical anthropometric measures take three dimensions in design of working space [8].The forward head posture is commonly adopted by administrative workers and it involves a combination of lower cervical flexion, upper cervical extension as well as ''rounded shoulders'' [9]. Also, office work frequently involves prolonged viewing of a visual display unit that additionally increases upper cervical extension [9]. Subjectively spoken, administrative workers complain about pain in head/neck, shoulders, elbows, wrists/hands, upper back, low back, hips, knees and ankles/feet [10] and there is the need to give further attention to developing specific measures to reduce or prevent musculoskeletal symptoms among employees in the office environment [5]. Some authors even argue that excessive sitting time is a risk factor for cardiovascular disease, diabetes and premature mortality [4].For several of the European countries, including both Serbia and Norway, anthropometric data relevant for new European standards and directives till now still are lacking or they are very old. One of rare surveys that included anthropometric measurements is done on the sample of 86 female and 13 male Norwegian administrative workers old between 20 and 39 years [1]. Previous research force the need to collect data on Serbian administrative works, while method used could be multivariate technique.

3. RESEARCH METHODOLOGY

This survey was conducted in Serbia and our sample consisted of 50 administrative workers (descriptive statistics is shown in Table 1). The participants were male and female with an average age 45 and standard deviation 10.42 years. Measurements were collected from several companies located in Serbia with appropriate number of administrative workers. The static anthropometry method was used to conduct the sample of research. A total of 9 basic static anthropometric dimensions including weight were recorded for each individual, namely foot length (mm), standing height (mm), sitting height (mm), lower leg length (mm), upper leg length (mm), shoulder width (mm), hip breadth (mm), and arm length (mm). Tools and equipment used in the anthropometric measurements of administrative workers were an anthrop meter, beam caliper, sliding calipers, steel tape, and other instruments including weight scale and stool for seated measurement. The participants remained in their clothes and shoes during the measurement.

Table1: Descriptive Statistics

Dimension	N	Minimum	Maximum	Mean	Std. Deviation
Foot length in mm	50	43	279	257.80	33.718
Year of Birth	50	1950	1989	1970.12	10.421
Weight in kg	50	54	100	79.18	12.157
Standing Height in mm	50	1600	1910	1761.90	75.023
Sitting Height in mm	50	800	970	886.50	42.176
Lower Leg Length in mm	50	500	680	579.30	37.621
Upper Leg Length in mm	50	490	960	630.90	63.211
Shoulder Width in mm	50	358	595	438.16	49.704
Hip Breadth in mm	50	300	485	382.00	38.039
Arm length in mm	50	580	780	675.20	42.269

The factor analysis method applied in this research was used to determine the groups of factors that characterize the body constitution of administrative workers. Factor analysis is a statistical approach used to analyze multivariate data correlated among each other with various degree, and starts by calculating correlation between variables which leads to correlation matrix. This matrix is analyzed in order to obtain the least possible number of factors enabling us to express as much variation as possible between the variables. Several assumptions are required for the data set in order to conduct factor analysis such as: (1) Sample size: as general rule the number of the observation should be at least 5 times the number of variables. (2) Measure of sampling adequacy: this value must be greater than or equal 0.5 to be appropriate for factor analysis. (3) No outliers in the data set: it means that no extreme data are present in the data set. (4) Identifying the significant loading: as the factor loading is the correlation of the variable and the factor, therefore the value of loading should be at least equal to 0.3 or more [3].

4. RESULTS

As indicated before factor analysis can be used to identify the structure of asset of variables as well as to provide a process for data reduction. The size of research sample meets the criteria of factor analysis with a ratio of 6.25 to 1, and measure sampling of sampling adequacy (Table 2) was 0.654 indicates appropriateness of applying factor analysis. Descriptive statistics of the input data is shown in Table 1. A correlation matrix was established as a first step in performing the factor analysis as illustrated in Table 3, and it appears clear that there are enough correlation coefficients greater than 0.3 to fulfill the criteria of factor analysis. The second step was the calculation of the eigenvalues as the sum of squared factor loading from a column representing the amount of variance explained with a factor. It can be seen from the eigenvalues presented in Table 4 the amount of possible factors to be retained was extracted and they were 3 factors by applying the latent root criterion. For the same purpose a diagram was constructed by plotting the eigenvalues against the number of components as can be seen in Figure 1 and greater than 1 are again three factors.

Table2: KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.654
Bartlett's Test of Sphericity	Approx. Chi-Square	140.345
	Df	28
	Sig.	.000

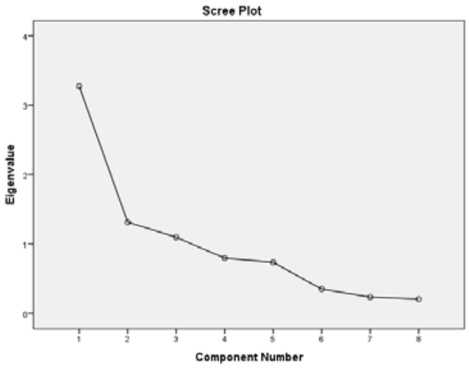

Figure1: Diagram representing eigenvalues

4. DISCUSSION AND CONCLUSION

The results that have been derived from factor analysis of administrative workers anthropometric measurements that appeared in component matrix were rotated by Varimax method. By examination of the total variance and the rotated component matrix in Table 4, it's obvious that there are three principle factors explained 71.062% of variance between variables that can be named as the length, width and height of administrative workers workplace.

Table 5. Rotated Component Matrix[a]			
	Component		
	1	2	3
Foot length in mm	-.030	-.057	.750
Standing Height in mm	.457	.275	.735
Sitting Height in mm	.187	.195	.774
Lower Leg Length in mm	.850	.166	.143
Upper Leg Length in mm	.723	-.050	.178
Shoulder Width in mm	.222	.860	.110
Hip Breadth in mm	.046	.922	.117
Arm length in mm	.679	.411	-.003
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.[a]			
a. Rotation converged in 5 iterations.			

As can be seen from table 5 and Figure 2 the first factor is length of administrative workers in x direction that is formed by variables: Lower leg length in mm with factor loading 0.850, Upper leg length in mm with factor loading 0.723 and Arm length in mm with factor loading 0.679. The second factor in y direction called width of administrative workers work place consist of the following variables: Shoulder width in mm with factor loading 0.860 and Hip breadth in mm with factor loading 0.922. The third factor is in z direction interpreted as height of administrative workers workplace and composed from these variables: Standing height in mm with factor loading 0.735, Sitting height in mm with factor loading 0.774 and Foot length in mm with factor loading 0.750.

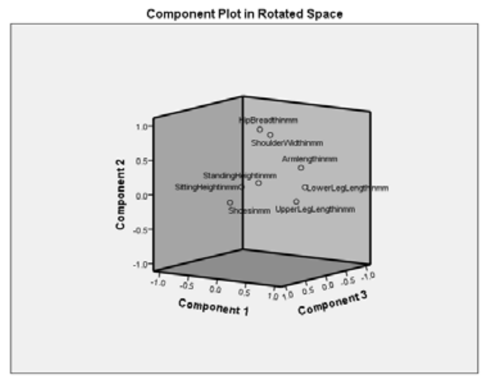

Figure 2: Diagram representing component plot in rotated space

Finally it can be concluded that in administrative workers workplace design, the three factors extracted by factor analysis can describe the most important anthropometric measurements in three dimension space as seen in component plot in rotated space diagram. This finding of work can be used in further research to determine the right design of administrative workplace. Further studies will be performed as continuation of this preliminary study in aim to study the problem on larger sample size.

Table 3. Correlation matrix									
		Foot length in mm	Standing Height in mm	Sitting Height in mm	Lower Leg Length in mm	Upper Leg Length in mm	Shoulder Width in mm	Hip Breadth in mm	Arm length in mm
Correlation	Foot length in mm	1.000	.382	.261	.063	.146	.014	.103	.127
	Standing Height in mm	.382	1.000	.695	.544	.385	.404	.335	.366
	Sitting Height in mm	.261	.695	1.000	.316	.200	.286	.214	.167
	Lower Leg Length in mm	.063	.544	.316	1.000	.421	.271	.243	.595
	Upper Leg Length in mm	.146	.385	.200	.421	1.000	.289	.051	.269
	Shoulder Width in mm	.014	.404	.286	.271	.289	1.000	.707	.390
	Hip Breadth in mm	.103	.335	.214	.243	.051	.707	1.000	.384
	Arm length in mm	.127	.366	.167	.595	.269	.390	.384	1.000

Table4: Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.275	40.932	40.932	3.275	40.932	40.932	2.002	25.019	25.019
2	1.315	16.432	57.364	1.315	16.432	57.364	1.904	23.805	48.824
3	1.096	13.698	71.062	1.096	13.698	71.062	1.779	22.238	71.062
4	.795	9.934	80.996						
5	.734	9.177	90.172						
6	.348	4.356	94.528						
7	.233	2.912	97.440						
8	.205	2.560	100.000						
Extraction Method: Principal Component Analysis.									

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GENERAL ERGONOMIC CONSIDERATIONS OF DESIGN OF A TELEROBOTIC SYSTEM

Aleksandar Zunjic, Jelena Muncan, Lidija Matija, Ljubisa Petrov, Ivana Mileusnic
Faculty of Mechanical Engineering, University of Belgrade, Serbia

Abstract. *Designing the man - telerobot system requires a multidisciplinary approach. Ergonomics has an important role in almost all stages of the designing of this complex system. One of its main role consists in optimization of sensory, mental and physical workload of operators.One of the first steps in designing of a system that contains a teleoperator consists in determining the optimal distribution of functions between operator and telerobot. This distribution of functions is dependent on the types of interactions between mentioned entities, which are considered in this paper. Interface components also need to be designed in accordance with the ergonomic principles. Conclusion of the paper is that depending on the specific task that needs to be done depends the design solution of the telerobotic system.*

Keywords: ergonomics, teleoperators, human - telerobot interaction, interface, teleoperation

INTRODUCTION

Teleoperation has a long tradition in mobile robotics (Steinfeld). Teleoperation is a term that refers to the remote control of technical devices. The origin of teleoperation is connected with the invention of the radio technology and the patent (1898) of Nikola Tesla, who developed the first teleoperated device, a radio-controlled boat(Viinikainen). However, this term is usualy used for mobile and robotic applications where the operator is at certain distance from the remote manipulator. In teleoperation, anoperator interacts with the world via a telerobot (Stanton et al.).The first robotic teleoperation tasks, such as manipulating nuclear material, can be classified as remote or remote operation.

BILATERAL TELEOPERATION SYSTEM

When a teleoperation system possesses force feedback option in relation to the operator, it is called a bilateral teleoperation system. The bilateral teleoperation has rapidly developed for the purpose of the remote handling of radioactive materials. The first bilateral teleoperation system was based on the mechanical manipulation. One of the first contemporary bilateral teleoperation systemwas built in 1940s in the United States (Viinikainen).Byusing this bilateral teleoperation system, with the radioactive materials wasmanipulated safely. Thissystem consisted of the mechanical manipulator, wichwas controlled by an operator behind a lead glass. The master control device that was used by the operator was identical to the manipulator (slave) on the other side of the glass. Movements of the master control device were transferred to the slave manipulator by a mechanical linkage. Through the mechanical linkage, the operator also could feel the forces that acted on the slave manipulator.

The term "remote manipulation" emphasizes that the controlled system is at some distance from the operator. Today, in most cases, there is no direct visual contact with the controlled system. The visual feedback is usually made by combination of a camera and a display. When the connection between an operator and a manipulator is mechanical, the term "remote manipulation" means mechanical manipulation. In the mechanical manipulation, the commands are transmitted mechanically or hydraulically (pneumatically) to the execution part of a teleoperator. In that case,visual feedback is usually direct, but can be also via a monitor. Commands also can be sent electrically by wire or radio (wireless). Electrical actuation and software based control systems make possible that the teleoperation distances be significantly greater than the distances that are allowed by mechanical linkages.

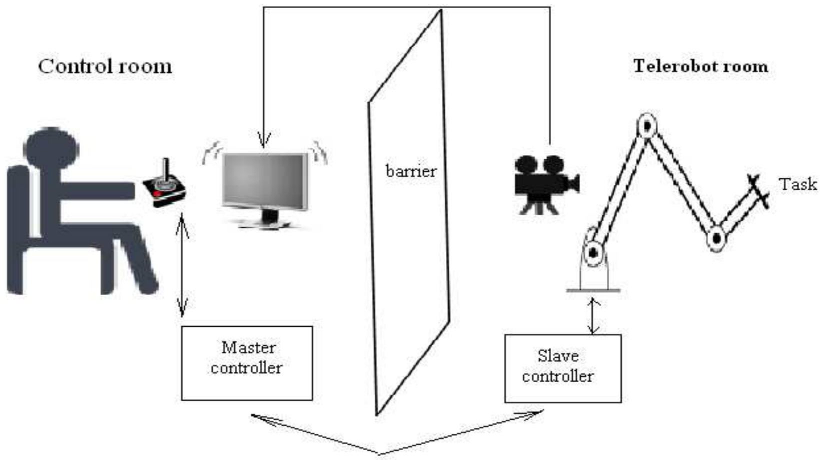

Figure 1. Example of a modern control system with a teleoperator.

The main drawbacks of the electrically based teleoperation systems are the cost caused by the overall complexity of the systems, as well as the technical challenges caused by time delays in the communication links. Basic components of the modern teleoperation system are presented in Figure 1.

Stability and transparency are the two major challenges of the modern bilateral teleoperation systems. The term "transparency" refers to the degree of telepresence in a teleoperation system (telepresence means that the information about the remote environment is represented to the operator in a natural manner). In a system with the perfect transparency, the operator of the system should feel as he performs the task directly, without telerobots between him and the task. Perfect transparency is of course almost impossible to achieve, but a good degree of telepresence guarantees the feasibility of the manipulation task. The stability and transparency requirements of the bilateral teleoperation systems often become troublesome with the fact that stability and transparency demands tend to have contradicting effects to the systems. Often, an improvement of transparency makes the system more unstable.Also,increasing the stability impairs the level of transparency (Viinikainen).

TYPES OF HUMAN - TELEROBOT INTERACTION

Interaction of one man and a single telerobot is very common. However, this is not an unique example of the interaction, which can be found in the theory and practice (Yanco and Drury). Practically, there are many types of interactions between a human and a telerobot. In the Figure 2, various possibilities of interaction between mentioned entities are represented. Arrows indicate commands flow between the humans and teleoperators. A maximum of two humans and two teleoperators are shown in each figure (A-H), but the same concepts is valid for "many" as for "two".

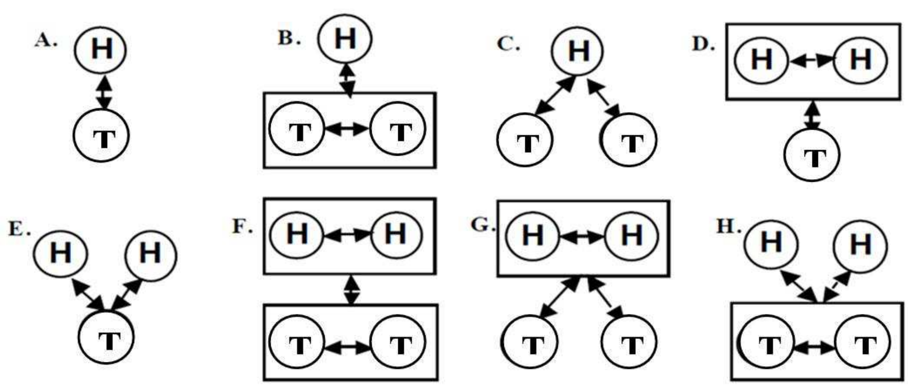

Figure 2. Types of interaction in the human - telerobot system (based on Yanco and Drury)

Several questions appear during a consideration of the interactions, which are represented in Figure 2. For example, if there are multiple human operators (represented with H in the figure), are these humans agreeing on commands before providing the teleoperator - telerobot(s) direction, or are they independently issuing commands that teleoperator(s) (represented with T in the figure) need to analyze and give the priority? Also, if there are multiple teleoperators, are they each receiving and acting on commands independently, or are all teleoperators receiving all commands and coordinating among themselves to determine which teleoperator(s) should respond to which commands?

In the most simple case of bilateral teleoperation that is shown in Figure 2A, one human gives commands to one teleoperator, which sends back the sensor information to the human. An example of this case is one person who directs a bomb-disposal teleoperator. In this case, and all others that will be mentioned below, the humans need the appropriate level of awareness about the interaction, in order of understanding the locations of the entities, distances between objects, activities, as well as surroundings of the teleoperators. Similarly, in some cases, the teleoperators need certain kind of awareness, so to have the knowledge (on the machine level) about the humans' commands and to have the possibility to act in order of modifyingthe initiated action, to eliminate possible human error. The humans and teleoperatorsalso may need othertypes of interaction awareness, depending upon the type ofinterconnection that may apply.

Figures 2B and 2C show the case where one human controls two teleoperators. In Figure 2B, the human is giving a command to a group of teleoperators, which coordinate among themselves to determine which teleoperator should performswhich part of the command. An example of this case is when anoperator gives a command to a group of teleoperators, to find human victims in a partially destroyed building.Figure 2C shows one person directing two teleoperators, which work independently. This case could happen in emergency services in the future, where one operator might want to direct multiple teleoperators to different parts of a hazardous waste spill, to receive as much information about the environment as quickly as possible.

In Figures 2D and 2E multiple people are controlling one teleoperator. In Figure 2D, the people coordinate among themselves to issue one command to the teleoperator. An example of this situation is when a pilot and anoperator for controlling of the sensors data coordinate to direct an unmanned aerial vehicle to a convenient position for viewing enemy targets. Besides the human - machine awareness, these people need the human-human awareness, so to be in possibility to complete the task efficiently. In Figure 2E, the humans act independently, and send different commands to the same teleoperator. The teleoperator should make decisions aboutpriority of the commands before carrying them out. A possible example of this type of teleoperator is a waiter telerobot, which is directed by one person to bring a drink to one table, while another person requests that the drink bedelivered to another table. The teleoperator must make a decision which order should be delivered first.

Figures 2F-2H represent the cases where multiple humans manage with the multiple teleoperators. Figure 2F illustrates a team of operators directing a group of teleoperators. The humans make an agreement about one command.The teleoperators then process that command,and they make a decision what teleoperator will carry out what part of the command, or the whole command. For example, the teleoperators can decide that the teleoperator that is nearest to the target will be executor of the command.

In Figure 2G, a team of operators issues different commands to different individual telerobots. The operators agree which instruction should go to which telerobot, and each telerobot acts independently to fulfill the command (thus, no coordination is needed betweentelerobots). This situation may happen in the urban search and rescue action if multiple operators work together to direct individual telerobots to different parts of the destroyed area.

Finally, Figure 2H shows the case where operators do not coordinate before issuing different commands to a group of telerobots. Telerobots make the priority among different commands, and they divide the commands among themselves before their realization.Such a situation may occurs when telerobots receive their orders from multiple, non-coordinating humans from different locations. Similar situation may happen when the communication between operators is hindered.

OPERATOR'S INTERFACE

Control of teleoperators require a master human interface device that can provide haptic input as well as the output, which reflects the responses of a slave robotic system. For that purpose, the force-reflecting hand controllers can be used.Unlike conventional input devices, forces on a controlled device (the efector part) are sensed and "reflected" back to the operator, which handles with the device. For example, the back-driven motors are used to make the control to resistin relation to further forward motion of the execution part of a teleoperator, which is in a contact with an obstacle.In addition to the forces, displacements at the end effector of the manipulator are also transferred to the control, which will cause the tactile, kinesthetic and proprioceptive sensations of an operator.

However, most force-feedback devices are not hand held, or mounted on a panel. Rather, most of them are large master robot arms. However, activation of control devices of a telerobotic system also can be performed using the sense of sight (Klarin and Zunjic). At the present time, the production of master human interface devices with small dimensions presents a design challenge.

An operator receives the information from the teleoperator by the senses. Besides the tactile and visual senses, one of the possible ways of receiving the information in the execution of certain teleoperation tasks is by the sense of hearing. Input devices that are used in the execution of teleoperation tasks should have the properties of the kinesthetic displays. These displays should produce sensations of the mechanical energy flow. Particularly, electric motors can provide force feedback against the limbs of the body,so as to mimic the forces that originate from the physical interaction between the teleoperator and real world objects. Ergonomic data regarding the capabilities and limitations of the senses can be used to provide guidelines for the design of display technology, which will be used by operators.For example, haptic displays need not to be designed with theproperties that exceeds the capabilities of the sense for detection of the information. The haptic input device should adequately represent any movement of the operator during the interaction, but also, to adequately reflect the teleoperator's actions.

Visual displays for monitoring of teleoperation tasks should also meet certain ergonomics characteristics. Some of these recommendations for designing and arrangement of visual displays in the human - teleoperator system are(Park and Woldstad):

·Select dimension of the display based on the task being performed. Consider a multiple 2D display format, if the task demands frequent use of focused attention.

For 3D perspective displays, ensure visual enhancement cues to aid depth perception.

As a visual enhancement cue, a single line is not sufficient to aid depth perception. Design a visual enhancement cue which has a volume in 3D space.

Take into the consideration the task difficulty when selecting the level of visual enhancement.

For 3D perspective displays, ensure that the movement of the control and the resulting change in the display are in the same relative location. Keep lateral displacements to <15°.

Provide the hand of the human operator with the proportional force of the manipulator (force feedback). As an alternative, consider a display of force feedback.

CONCLUSION

It is not advisable to address the role of the human in the teleoperation system only from the aspect of technological automatization.It is necessary to perform careful consideration of human capabilities and constraints in parallel with the level of a teleoperator autonomy. This is especially important when an operator is located at the long distance from the teleoperator (for example, when controlling is performed through the web connection). Such consideration should be performed in the phase of early development of the system.In that sense, a comprehensive analysis of the operator's task can be performed. Experts in the field of the ergonomics should be involved in this process, in order of avoiding the mistakes in the functioning of the system and to achieve the optimal interaction.

After considering the task that needs to be done and redistribution of functions between men and telerobot, it is necessary to perform the basic design of the system. At this stage the ergonomic experts should provide a variety of information, which are necessary for telerobot design (e.g. in connection with the problem of scaling of forces etc.). After that, follows the stage of designing of the interface, which should be fully compliant with the characteristics of operators. At the stage of testing and evaluation of the system, ergonomic experts can give suggestions for improvement, if certain shortcomings are identified. Therefore, multidisciplinary cooperation between experts from different scientific disciplines is required, starting from the stage of establishing goals and performance specifications, in order to obtain the efficient man - telerobot system.

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ERGONOMIC ANALYSIS OF THE EFFECTS OF THE INTRODUCTION OF ELECTRONIC DISPLAYS IN THE COCKPITS OF LIGHT SINGLE-ENGINE PISTON AIRCRAFTS

Aleksandar Žunjić[1], Dragana Žakić Nedeljković[2]
[1]Faculty of Mechanical Engineering,University of Belgrade, Serbia
[2]Technical Test Center, Serbian Armed Forces, Belgrade

Abstract. *This paper sublimates previous experience and results of certain studies related to the introduction of glass cockpit(GC) in the light piston aircraft.It considers the influence of the replacement of analog, conventional displays with the glass cockpits, on the safetyof thelight piston aircrafts, primarily from the aspect of reducing human (pilots) errors. Certain design solutions that were proposed with the introduction of the new technology in the light aviation are evaluated, including also into the consideration the results of studies that have not confirmed the expected increase of safety, in comparison with airplanes equipped with the conventional instruments.*

Key words*: aircraft, glass cockpit, analog instruments, digital displays, ergonomics*

INTRODUCTION

This paper in brief summarizes specific experiences gained by the research related to the introduction of glass cockpit in light piston aircraft. In connection with that, it will be evaluated the influence of the replacement of analog, conventional displays with the glass cockpits, on the safety of light piston aircrafts.

This paper specifically focuses on the analysis of the design solution of a display (as a part of glass cockpit equipment) that shows the speed and altitude of the aircraft.For this purpose, the guiding line will be reduction of pilot´s overload and improvement of the performance and safety.

THE HUMAN FACTORS AND DESIGN OF COCKPIT INSTRUMENTS AS A CONSEQUENCE OF THE ACCIDENTS IN AVIATION

Although some of the research (mentioned in subheading) in the domain of human factors are related to the late 19th and early20th centuries, the human factors, as an area of scientific research and practice, was fully recognized during World War II. During the first two years of World War II, over2000 multi-engine US aircraftsexperienced accidents. They were caused by controls for the landing gear and flap leversthat were identical in shape, size, and the method of operation, and located too close together to allowidentification through kinesthetic feedback. Because of that, during the landing of the aircraft, a pilot relying on the touch and kinesthetic feedback information rather than on the visual inspection often caused the mistake, changing one control for the other[1].Another possible cause of errors were inadequate design solutions of displays and their arrangement in the cockpit.

The engineering psychologists were called upon to investigate militaryaircraft accidents in the United States. They triedto explore why so many of these accidents were being attributed to "pilot error" and what "pilot error" really mean from acausation standpoint.They discovered that the "pilot error" was in fact error created as a result of inadequate design[1].Namely,controls and displays werebeing designed in ways that were not compatible with human capabilities and limitations. Accordingly, these designs were initiators for making errors by the pilots. For example, thetransition from one aircraft to another, with a different arrangement of the instrumentswould lead tomisperceptions and pilot´s error - especially in conditions of flight under stress.

Thes discoveries initiate investigations which were initially focused on the human perception and reactions, and later the central focus moves to the design aspect. The studyof US Air Force tried to determine the best combination of control shapes to use in cockpit for the various flight functions. The results were the control shapes associated with the function where possible.This led to the standardization of aircraft controls that are used worldwide today. Similar research in the late 40s and 50s led to the identification and standardized arrangement of the instruments most critical to flight, that remains in use for a long time. These efforts have resulted in reduction of pilot´s errors and improvements in aviation safety[1]. Similar researches have led to the development of standards in the domain of displays, such as the British standard BS3693 [3].

ARRANGEMENT OF COCKPIT INSTRUMENTS IN THE FUNCTION OF REDUCING HUMAN ERRORS

The cockpit of an aircraft must be designed in the way that enables the pilot to control the aircraft without errors and excessive effort. This meansthat the pilot needs the comfortable work space, easy access to controls,intuitive handling and high level of readability, legibility and visibility of the displays. According to the current standards of the FAA, all kinds of visual displays (navigation, motor, etc.) which are intended for use by pilot must be clearly visible from the pilot's seat, in his field of view when he looks ahead during the flying, with minimal body movements in the pilot's seat and with the minimal need for the eye movements. In aviation,especially in a military aviation, when it comes to security, decisions must be maked in a very short period of time. So, quick scan of displays must give the pilot unequivocal generic impression of the situation during the fly. If the display and its position in the cockpit are not compatible with the human sensibility and perception(s) ability, so it is difficult to scan, or scanning lasts longer, there is a high probability that the pilot will make an error inreading or interpretation of data, and consequently he will react in an unacceptable way.

INTRODUCTION OF GLASS COCKPIT INTO LIGHT AIRCRAFTS

During only a few years, the cockpits of light piston aircrafts were in most cases have undergone a transition from conventional analog flight instruments to the panel integrated electronic displays that are usually called "glass cockpits" (GC). Glass cockpit first started to appear in light aircrafts.Data from the General Aviation Manufacturers Association (GAMA) point out that by 2006, more than 90 percent of new piston-powered, light airplanes were equipped with full glass cockpit displays[4].

Separate displays that were designed to show individual states more frequently are merged in order to improve the management of the fly. The accuracy and reliability of the instruments are improved by the introduction of electronics, the quantity of information and data which are available to the pilot during flight significantly increases, and a pilot's panelthat was designed to accommodate the analog displays now is more economically used. With the introduction of these advanced aircraft systems, there was a hope that they would eliminate pilots' errors. However, experience has shown that, at the same time, while these advanced systems help to reduce many types of errors, they at the same time increase the risk of new, unexpected errors[6].

THE PROBLEMS AND THE POTENTIAL RISKS CAUSED BY USING GC DISPLAYS

It is undisputed that GC displays (Figure 1) can present more information in the planned area compared to the conventional instruments, but many information require at the same time focusing pilot´s attention on the position of data while he controls the flight. That creates a risk of mental overload. There is a difficulty with understanding data from the displays and danger of dropping the attention that is necessary to work with the control devices. A preliminary NTSB study [4] found that between 2002 and 2008 light single-engine aircrafts equipped with glass cockpit displays experienced higher fatal, but lower total accidents, than the same aircrafts fitted with traditional cockpit displays. This suggests that the complexityof GC integrated information can practically reduce the functionality of thesystem, which proved to be fatal in certain situations.

Figure 1. Example of GC displays in the Lasta light single-engine piston aircraft.

Pilots in practice are facing one problem, which refers tothe vertical linear tape on the flight display used to show airspeed and altitude [2], whereas traditional cockpits represent airspeed and altitude on circular analog displays.Analysis of this problem was given by the study (Hiremath et al. 2009) which researched pilot´s unusual attitude recovery ability using either traditional or glass cockpits. The results showed that pilots using the glass cockpit spand much more time to recover from unusual attitudes than pilots using the cockpitwith traditional (analog) instruments. The authors indicated that in the traditional cockpit the position of the airspeed and altitude indicator needles can be recognized at the first sight. As opposed, glass cockpit tape displaydoes not represent the whole scale. To get an idea of the airspeed or altitude, the pilot has to focus longer on the numerical values[5], which contributes to the reduction of awareness of thesituation.

Another problem related to the electronic displays was observed on the basis of interviewing the pilots who fly on the glass cockpit aircrafts.The practice of the test pilots indicates a problem with the moving of the vertical marks on the scale of the display during the execution of the specific tasks.For example, when the pilot increases the angle of attack at a constant engine power when the reduction of speed is required, thealtitudedecreases i.e. becomes unstable. The marks on the altitude display are changing in both directions (up and down) and the pilot needs more attention and time to monitor the altitude change tendency and a rate of this changes. The reason is because the glass cockpit altimeters use a fixed pointer and the moving scale. Furthermore, higher altitudes are shown at the top of the display and the scale with marks moves downwards to indicate increasing altitude. Presenting higher altitudes at the top of the linear tapeis consistent with the pictorial realism. But, a downward tape movement to represent increasing altitude violates the logical principle and confuses the pilots[5].

Thus, it can be seen a double problem concerning the GC displays. The first refers to the increased mental workload that arises due to the increased number of information that are presented on the GC. The second appears as a consequence of the transition from circular analog display to the linear tape display (regarding the altimeter).

One of the possible design solutions for this problem is an electronic display with analog appearance that would be placed on the same panel with linear altitude display. This solution is in agreement with previous experience of pilots and it would significantly improve and facilitate reading of the data.

The wide variability in cockpit instruments design has influence on pilot´s ability to identify system malfunctions. For example, visually scan the analog displays for many experienced pilots is a routine, due to standardization of the instrument apperiance, operating range, marking and position on the pilot˙s desk. Unfortunately, traditional instrument scanning procedures are not in compliance and do not apply to glass cockpit aircraft.

CONCLUSION

The research of the properties and improvement of analog displays last more than half a century[3]. A certain number of accidents that were caused by inadequate design of this type of displays initiated an increased number of experimental studies.This researches have focused on examining the characteristics of this type of displays and their individual components, and has led to the determination of certain recommendations [7-8], as well as standards that are related to the analog displays.

The analog displeys are still in useinvarious branches of industries, so their research and testing are not finished yet. Nevertheless, it can be concluded that more time was invested in development of analog displays compared to the development of the electronic displays (such are the primary flight displays in aircrafts).

The experimental studies of the GC displays are very rare, and it is extremely difficult to find some in the literature. This applies particularly to researchesin controlled laboratory conditions. However, there are some recommendations that can be found in the literature relating to the use of electronic displays in aviation.These recommendations should be taken as a starting point for the design of future GC displays. The conclusion is that the scope for improving the safety of the aircraft should be sought in the redesigning of displays, as well as in the training of pilots and insisting on their full understanding of the GC system (before they get the permission to fly independently).

Regular training and simulators, as well as a periodic testing of pilots who have completed training related to the use of GC displays in different situations, may improve and strengthen their flying skills. In addition, the NTSB concluded that due to the complexity of GC and the differences in the operation and design, pilots are not always provided with all the information they need[4]. According to that, it is necessary to make a thorough analysis of the information that will be presented on the GC displays.

Improvements of the properties of GC displays,above all,we should look in the implementation of experimental researches. Considering that some of the conducted researches have shown that in practice there is no advantage of GC displays over analog displays, one of possible design solutions could be found in the combination of analog and electronic displays, where it is justified in terms of usability and safety. Also, good communication with the manufacturers of the devicescan contribute to the supply with information about the potential disadvantages of the system. Exchange of experiences with other users of the same devices, making of internal studies, global studies, the establishment of guides and publications on this topic, can also contribute to the improvement of the flight safety in terms of GC displays, and lead to decreasing of pilots' errors.

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REVIEW OF THE ON-SCREEN READABILITY RESEARCHES

Ljiljana D. Ristić
Ph.D. candidate, Faculty of Mechanical Engineering, Belgrade, Serbia

Abstract: *Since that the computer has become a common platform for the dissemination of information, it is very important, how are those information presented on VDT screens. In this regard, improvement of the readability can significantly enhance the quality of represented information. This review considers certain crucial characteristics that define the successful application of the readability concept.*
Key words: *readability, tipeface, computer display.*

INTRODUCTION

There are three main concepts that define the quality of presentation of symbols on VDT screens. These are the visibility, legibility and readability (Klarin and Zunjic, 2007; Zunjic, 2013). Mentioned concepts posses certain similarities and differences. Visibility is an important characteristic that influences on the possibility of detection of objects displayed on a VDT screen (Zunjic et al, 2012a). In the broadest terms, legibility can be described as the convenience of reading, with regard to the differentiation between alphanumeric characters (Zunjic, 2004). Readability is what makes some texts easier to read from others. It is often confused with legibility. Kember and Varley maintain that readability is reflected in the reading process, while legibility relates to the capability to differ the individual characters. Zunjic (2013) gives the precise rules for making distinctions between the mentioned concepts. The importance of these concepts is widely recognized. They have been found the appropriate applications in certain global VDT checklists (for example Zunjic et al, 2012b), as well as in standards (for example ISO). Application of such standards can provide efficient user experience (Zunjic, 2012c). However, the accent of this paper is on certain characteristics that determine the readability.

"George Klare (1963) defines readability as the ease of understanding or comprehension due to the style of writing. This definition focuses on writing style as separate from issues such as content, coherence, and organization. In a similar manner, Gretchen Hargis and her colleagues at IBM (1998) state that readability, the ease of reading words and sentences, is an attribute of clarity. The creator of the SMOG readability formula G. Harry McLaughlin (1969) defines readability as: the degree to which a given class of people find certain reading matter compelling and comprehensible. This definition stresses the interaction between the text and a class of readers of known characteristics such as reading skill, prior knowledge, and motivation. Edgar Dale and Jeanne Chall's (1949) definition may be the most comprehensive: The sum total (including all the interactions) of all those elements within a given piece of printed material that affect the success a group of readers have with it. The success is the extent to which they understand it, read it at an optimal speed, and find it interesting."

THE READABILITY FACTORS

There are several important factors which influence the on-screen text readability:

a) Font type („serif" – Times New Roman and „sans serif"- Arial).
b) Type size
c) Screen resolution
d) Format (dot-matrix, anti-alians).

Font type

There are thousands of fonts and font variations that could potentially be used on a web site, but the vast majority of these fonts will not work for most users on the web because computers can display only the fonts installed on the computer, and not all computers have the same fonts installed.

Two categories are often „serif" – Times New Roman and „sans serif"- Arial. Serif fonts are characterized by the flared extensions, or strokes, on the tips of such letters as f, l, and i, as can be seen in the Figure 1. An example of the serif fons are presented in Figure 2.

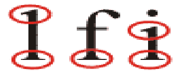

Figure 1. Serif fonts

Serif fonts also usually have a combination of thick and thin strokes, as seen in the curve of the letter "f" above. Examples of serif fonts include Times New Roman, Georgia, and Book Antiqua.

Times New Roman (AaBbCc...MmNn...WwXxYyZz)
Georgia (AaBbCc...MmNn...WwXxYyZz)
Book Antiqua (AaBbCc...MmNn...WwXxYyZz)

Figure 2. Examples of serif fonts.

Sans-serif fonts have plain endings, and appear blockier than serif fonts. They do not have the flared extensions, strokes, or other kinds of ornamentation (Figure 3).

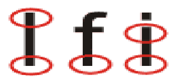

Figure 3. Sans serif fonts.

"Sans" means *without*, and "serif" refers to the extra *strokes*, or *lines*. Sans-serif fonts include Arial, Tahoma, Trebuchet MS, and Verdana (Figure 4).

Arial (AaBbCc...MmNn...WwXxYyZz)
Tahoma (AaBbCc...MmNn...WwXxYyZz)
Trebuchet MS (AaBbCc...MmNn...WwXxYyZz)
Verdana (AaBbCc...MmNn...WwXxYyZz)

Figure 4. Examples of the sans-serif fonts.

By far two of the most common typefaces currently being used within electronic mediums such as the World Wide Web (Web), are Times New Roman (Times) and Arial (Ramsden, 2000). The popularity of these two typefaces is ostensibly caused by the fact that most computer operating systems today are pre-configured to have Times as the default serif typeface, whereas Arial has generally served as a popular sans serif alternative to Times.

Tipe size

Typically, the presentation of Times and Arial has been displayed in either 10- or 12-point sizes on the Web. The size that is used is often determined at least in part by the x-height (the height of the torso for lower-case letters, or simply the height of a lowercase 'x') of that particular typeface. For example, Arial, which has a proportionally larger x-height than Times, is often displayed in a smaller text size—such as a 10-point size—whereas Times is often displayed in a 12-point size, giving them approximately the same x-height and general appearance in height. To a certain degree, larger text sizes are considered more readable than smaller sizes (Bouma, 1971; Rudnicky and Kolers, 1984) for print-based research and Mills and Weldon, 1987 for screen-based research). Yet the differences between text sizes are often not significantly apparent until the size differences become quite large (Tinker,1963).

Screen resolution

The few studies that have examined online reading have generally found that commonly used typefaces of around 11-point sizes or more, are generally readable on screen resolutions as small as 1024_768 pixels. For example, in examining the readability of different type sizes on computer screens with this size resolution, Tullis et al. (1995) found no significant differences between 9-point Arial, 9.75-point MS Serif and MS Sans Serif, and 9-point Arial typefaces. However participants reading the smaller, 6-point Small Fonts and 7.5-point Arial were found to be less accurate in detecting typographical errors than when reading the larger, 9 and 9.75-point Arial and 9.75-point MS Sans Serif typefaces.Moreover, using a lower screen resolution of 640x480, Boyarski et al. (1998) found that 10-point serif (Times and Georgia) and sans serif (Verdana) typefaces were equally readable (a 10-point typeface has a character height close to 4 mm at this resolution, which is similar to a 12-point size at1024x768 pixels).

Format

One such display characteristic is the aliasing or 'stair-casing' phenomenon that is associated with the dot-matrix characters on computer screens which, in effect, can make letters look jagged on medium to low-resolution screens. Efforts to lessen the aliasing effects associated with dot-matrix characters have been accomplished through the use of anti-aliasing techniques, which produce 'smoothed' text within a graphical image (such as JPEG or GIF files) or use formats such as AdobeTM Portable Document Format (PDF) files (Figure 5). Anti-aliased formats are designed to make text more readable by adding several shades of darker contrast—such as gray—to the aliased area as a means to reduce the contrast differences between the background and the characters. However, this type of smoothing can blur the letterforms somewhat, possibly making anti-aliased text less readable for particular typefaces and sizes of text than the equivalent in a dot-matrix format. To date, little research has been conducted that examines the impact of antialiased versus dot-matrix formats on text readability; the few studies that compared text in these formats were met with mostly inconclusive results. For example, Gould et al. (1987) found no evidence of any effect on reading for anti-aliased text compared to dot-matrix text, but participants generally preferred the anti-aliased text (consisting of a 10-point serif typeface with a character height of 3.5mm at a resolution of 1024x768 pixels). A more recent study by Boyarski et al. (1998) compared anti-aliased text to dot-matrix text and also found no significant differences in readability. Their results concerning the perceived readability of the two formats were inconclusive as well. The results indicated that a Microsoft antialiased text, but not Adobe anti-aliased text, was considered more readable than the compared dot-matrix text. The Boyarski, et al. study used a 16-point, anti-aliased serif typeface at a screen resolution of 640x480 pixels. These studies did not, however, examine typeface and size differences within dot-matrix and anti-aliased formats. Today it is quite common for computer displayed documents—particularly within web-sites—to have medium-sized (10 and 12-point) dot-matrix and antialiased text.

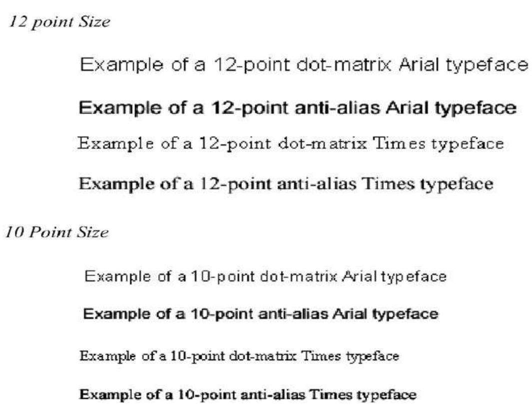

Figure 5. Examples of dot-matrix and anti-aliased text.

It is apparent there is a need for a better understanding of the relationship between typeface, size, and format.

RESEARCHES OF READABILITY

Bernand (2003) was one of his empirical research studies comparing these factors in terms of subjective and actual readability. The question addressed was: what typeface (serif, Times or sans serif, Arial), size (10 or 12-point), and format (dot-matrix or anti-aliased) are most readable (objectively and subjectively), and are most preferred for reading on a computer display?

The study included thirty-five undergraduate and graduate students. Most participants (86%) reported reading from computer screens a few times or more per week. For the experiment, was used a Pentium II based PC computer, using a 60 Hz, 96dpi 17-in high-resolution RGB monitor with a resolution of 1024x768 pixels was used. This resolution was chosen in order to reflect the current trend towards higher resolution settings (Georgia Tech Research Corp., 1998). The light sources were located overhead and to the participants' side in order to reduce glare on the screen. The format of the presented text was presented as an HTML web page. The browser used was Microsoft's Internet Explorer 5.0, which was configured to display only the URL address bar.

The text variations used were the 10- and 12-point Times and Arial proportional typefaces that are typically included within Microsoft's Office software suites. At the resolution used in that study, the 10 and 12-point typefaces had a point height of 3.5 and 4.2 mm, respectively. Times had an approximate x-height of 1.8 and 2.0mm for the respective 10 and 12-point sizes. Arial had an approximate x-height of 2.0 and 2.5mm for the respective 10 and 12-point sizes. To create anti-aliased text, Adobe Acrobat's PDF was used because it is currently the most widely used anti-aliased text document format file.

Their task was assigned to read eight passages as accurately and as quickly with the replacement of words that were presented in random passages. Reading time was measured by the recording in seconds the time taken to read each passage. A stopwatch registered the time taken to read each passage.

Objective text: analyzing the percentage of detected substituted words for each typeface/size/format combination revealed no significant differences ($p > 0:05$) in accuracy for typeface, size, or format. A possible explanation for this outcome is that participants did, in fact, slow their rate of reading for a less readable text combination to achieve roughly the same level of accuracy. To test this, the participants' adjusted accuracy scores were examined.

Subjective text: a significant main effect of type size [$F(1, 34) = 20.34$; $p<0:001$] was found for perceived sharpness. Pairwise comparisons revealed that text at the 12-point size ($M = 4:6$) were perceived as being sharper than at the 10-point size ($M = 3:9$). This is probably due to the greater perception of text readability at the larger, 12-point size.

Participants were asked to rank each text combination from the most to the least preferred. The most preferred type was 12-point dot-matrix Arial ($M = 5:7$), followed by both 12-point dot-matrix Times and 12-point anti-aliased Arial text ($M = 5:4$ for both). Together these text conditions were significantly preferred over the other conditions [$w2(7;N = 35) = 137$; $p< 0:001$]. In addition, 10-point antialiased Times ($M = 0:6$) was significantly less preferred than all of the text conditions except 12-point anti-aliased Times and 10-point dot-matrix Times. Examining only the participants' first and second preference choices reveal the overall tendency for 12-point dot-matrix and anti-aliased Arial, as well as 12-point dot-matrix Times to be most preferred. Overall, 87% of the participants chose one of them as their first or second choice. Neither the 10-point dot-matrix nor anti-aliased Times was ranked first or second by any participant.

Times New Roman and Arial typefaces in 10 and 12-point, dot-matrix and anti-aliased format conditions were compared for readability (accuracy, reading speed, and accuracy/ reading speed), as well as perceptions of typeface legibility, sharpness, ease of reading, and general preference.

In this staudy proved that Bernand (2003) the 10-point anti-aliased Arial typeface was read slower than the other type conditions. Examining perceptions of typeface legibility, sharpness, and ease of reading detected significant effects for typeface, size, and format. Overall, the 12 point dot-matrix Arial typeface was preferred to the other typefaces. Recommendations for appropriate typeface combinations for computer-displayed text are discussed.

CONCLUSIONS

The rapid development of information technology leads to a massive use of various media with display screen (computers, phones, ect) and therefore a growing need to test.

The effect of size, type and format on the perceptions of reading performance, did however, produce significant differences. Text at the 12-point size produced significantly greater subjective readability (perceptions of text legibility and sharpness) and had lower levels of perceived difficulty in reading than text at the 10-point size. Text at the 12-point size was also significantly preferred to text at the 10-point size. Participants also perceived Times at both 10- and 12-point sizes as significantly more difficult to read than Arial, even though 10-point Arial and 12-point Times have approximately the same x-height. It is possible the serifs and the narrow character spacing of Times affected its perceived readability.

Future studies could extend this research by examining a greater number of typefaces or sizes in both aliased and anti-aliased formats. In addition, as with all studies that examine reading performance with different typefaces, caution should be made in generalizing these outcomes to other typeface combinations. Many factors should be taken into account, such as style and size of text, the line and character spacing, the computer settings and the user characteristics, such as age and reading ability.

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CONTINUING PROFESSIONAL DEVELOPMENT FOR ENGINEERS - VOCATIONAL TEACHERS IN MECHATRONICS

Milica Gerasimovic[1], Tanja Sijakovic[2], Ugljesa Bugaric[3]
[1]PhD, Advisor/Coordinator, Institute for Improvement of Education, Belgrade
[2]PhD, Advisor/Coordinator, Institute for Improvement of Education, Belgrade
[3]PhD,Professor, Faculty for Mechanical Engineering, Belgrade University

Abstract. *This paper concerns the continuing professional development (CPD) of engineers - vocational teachers in mechatronics.Vocational teachers' work is based on teaching competence and competence related to a specific work-life vocational practice.Mechatronics is broadly based on three regions:mechanical, electrical and computer engineering,and represents a scientific field, which has been recently developing and growing in an unusually rapid way. Needs of mechanical and electrical engineers - VET teachers in mechatronics among the others areusing of new pedagogies andmaking extensive use of new technologies.In this paper, we analysevocational teachers' participationin Serbian Vocational Education and Training (VET) CPD program, in the field of Mechatronics in the sample of 43 VET teachers.The obtained results show thattraining topic of the greatest positive influenceand the greatest needs for CPD trainings are divided between new technologies in the workplace and various pedagogical and didactic knowledge and skills.*
Keywords: *continuing professional development, mechatronics, vocational teachers, engineers*

Vocational education

As the subject of studies and research, vocational educationis a significant phenomenon. The reason for continuing innovation and modernization of vocational education, among other things, is that the vocational education, based on labor market needs, keeps track of all changes of economic and technological development of society. The main objective of the reform of vocational education is to improve the quality of education, which involves the establishment: social partnership, decentralization, accessibility, openness, program and organizational diversity, and focus on outcomes.

The goals and circumstances of vocational education vary across countries. The specifics may vary from place to place, but in most countries academic education prepares students for college or university while vocational education prepares them for immediate entry into the labor market. The authors assume that vocational education equips students with skills which can enhance their productivity on the job, therefore, vocationally trained workers are in demand, and their chances of gaining employment are enhanced [1, 2, 8].

In the process of continual improvement and modernization of vocational education very important partare the teachers.

Vocational teachers' work is based on two main competences: teaching competence and competence related to a specific work-life vocational practice. Teachers in vocational education need to complete a pedagogical education in their first years of teaching in addition to teaching.

Vocational teachers are expected to be well qualified, knowledgeable and up-to-date in the vocation they teach. Changes in working life and the modernizationof vocational education place new demands on vocational teachers' competence [7].One way for vocational teachers to maintain a high-quality professional identity is to continue to have contact with their vocational field.

The aim of this article is to explore vocational teachers' participation in Serbian Vocational Education and Training (VET) Continuing Professional Development (CPD) program, specifically in the field of Mechatronics.

Mechatronics

There are many different ways of defining the meaning of mechatronics.Some authors defineme chatronics as a synergistic combination of mechanicalengineering, electronics, computer science and control engineering [11, 3],and the most common definition of mechatronics is “synergistic combination of mechanical engineering, electronic engineering and software engineering” [5]. Mechatronics relates to the design of systems, devices and products aimed at achieving an optimal balance between basic mechanical structure and its overall control.

Mechatronic curriculum in Serbia

In Serbian VET system mechatronics as aneducational profile Technician of Mechatronics is available in 20 VET schools. The curriculum developed on the basis ofqualification standards. The purpose of Technician of Mechatronics qualification is[4]:

- repairing and maintening equipment and mechatronic devices and system,
- installing of machatronic components,
- diagnosing faults.

Curriculum consists of general and vocational subjects. The main vocational subjects and moduls are:

- Digital electronics and microcontrollers;
- Hydraulic and Pneumatic;
- Electric drive and equipment;
- Modeling withanalysisof the elements and mechanisms;
- Programmable logic controllers;
- Testingand diagnosticsofmechatronic systems.

An important part of the curriculum are the subjects which supporting learning process and development of professional competencies. Some of them are:

- Mathematics;
- Technical drawing;
- Physics;
- Technicalmechanicswith mechanisms;
- Machine elements;
- Electrical engineering (basic level).

Mechatronics curriculum comprises a range of subjects that arefundamentally different in nature and which require very different learning andapplication practices.The essence ofa well-developedMechatronics curriculumreflected on the physics-based relationship between mechanical and electrical systems.

VET teachers in Mechatronics

Mechatronics is broadly based on three regions:mechanical, electrical and computer engineering.In this moment there are about 80 teachers in Mechatronics in Serbia and they are mechanical and electrical engineers. The complexity of their work is reflected in the developmentboth practical and theoretical student’s understanding of mechatronics as well as interpersonal and communication skills needed to work in a multi-disciplinary field. Tasks and problem solving in mechatronics requires cognitive and operational knowledge and practical experience about building systems, diagnosis and maintenance-techniques.

On the other handmechatronics represents a scientific field, which has been recently developing and growing in an unusually rapid way.

Therefore, needs of mechanical and electrical engineers - VET teachers in mechatronics are: using of new pedagogies, teaching new competences, working more closely with their colleagues and employers and making extensive use of new technologies.

Continuing professional development

It is well known that continuing professional development of teachers is important part of improving the quality of education. In other words, without the continuing professional development one cannot expect quality teaching and learning in schools. Overall context in which education takes place are significantly changed in the last few decades. Consequently, competences expected of teachers have become an integral part of the global, but also national governing educational policy. These competences are supposed to be developing during the initial teachers education as well as during the in service teacher training.In Serbia, the concept of professional development of teachers is given in Law on the Basis of Education System and Rulebook on permanent professional development. According to the above document each teacher is required to have 120 hours of Professional training for a period of five years. These 120 hours include attending seminars (at least 100 hours of training) and, up to 20 hours of other forms of training such as conferences, round tables, etc. In order to be evaluated in the context of professional development, seminars must be officially approved. Approval of the seminar is carried out in the Institute for Improvement of education. Accredited Commission approved courses in every two years, according to nationally set priorities and defined competencies of teachers.The number of points that seminar brings to participant is directly related to the total number of hours of training. Also, the round tables, conferences etc., must be approved at the Institute for Improvement of education, in order to bring points to the participants.Once approved, these types of professional training bring one point to participants, for every completed day.

One of the frequently asked questions of experts is the efficiency and significance of training based teacher professional development. In other words, in orderto be effective professional development should rely on the fulfillment of the basic principles of meaningful development.In that sense, Littlestates six principles for meaningful professional development [6]:

1. Professional development offers meaningful intellectual, social, and emotional engagement with ideas, with materials, and with colleagues both in and out of teaching
2. Professional development takes explicit account of the contexts of teaching and the experience of teachers
3. Professional development offers support for informed dissent
4. Professional development places classroom practice in the larger contexts of school practice and the educational careers of children
5. Professional development prepares teachers (as well as students and their parents) to employ the techniques and perspectives of inquiry
6. The governance of professional development ensures bureaucratic restraint and a balance between the interests of individuals and the interests of institutions [6].

Inspired by some of these principles, we have done research with VET teachers in Mehatronics, that will be presented below.

Research

In order to evaluate functionality of previous trainings and needs for further improvement of teacher competencies survey was conducted on a sample of 43 VET teachers in mechatronics from 14 Serbian's VET schools.A questionnaire has been created on the basis ofTALIS(The OECD Teaching and Learning International Surveyquestionnaire), adapted for VET teacher's needs. There were 12 questionsrelated to general information, practical application of in-service training, the need for further training and restrictions. Survey was conductedonlinein the spring 2015.

The statistical analysis is performed using the SPSS 18.0 software [8].

Results and Discussion

The findings particularly focus on the variablesofage, impact of CPD in teaching process, needs for CPD and obstacles to professional training.

In 58,1% of the cases of participation, the participant was male, and in 41,9% of the cases, the participant was female. The variable of years in teaching process was categorised into the sixgroups, and the distribution of participants is shown in Table 1.

Table1 Years in teaching process

1-2 years	3–5 years	6–10 years	11–15 years	16–20 years	≥20 years
4,7%	7,0%	18,6%	32,6%	14,0%	23,3%

The next aspect that was examined in the analysis was the functionality of previous CPD trainings. Training topics of great positive influence in teaching process in mechatronics were: implementation of the curriculum based on outcomes and competences (30,2%); monitoring and evaluation of student achievement(25,6%); IT (25,6%); new technologies in the workplace (34,9%);application of different methods, forms and techniques in teaching process (34,9%); encouraging critical thinking (32,6%); teamwork and school cooperation (41,9%) and explore own teaching practice (34,9%).

The findings showed that the great need for CPD trainings in mechatronics were in the following areas:

newtechnologies in the workplace (25,6%); motivationstudentsto learn(18,6%);teaching students with special needs (11,6%)and explore own teaching practice (11,6%).

It is interesting to see what participantsmentioned as a restrictions for their professional development in mechatronics (Table 2).

Table2 Restrictions for CPD

Restrictions	Frequency (%)
CPD training is too expensive / unavailable	74,4
Lack of school management support	18,6
Lack of time	16,3
Lack of appropriate CPD training	74,4
Lack of motivation	11,6
The decision of CPD training is made at the school level (inability of choosing)	37,2

In summary the findings showed thatthere were slightly more male participants than female and the participation mostly rate among the 11-15 years of teaching experiences (32,6%).Training topic of the greatest positive influence in teaching process were team work and school cooperation, application of different methods, forms and techniques in teaching process and new technologies in the workplace. The greatest need for CPD trainings are divided between new technologies in the workplace and various pedagogical and didactic knowledge and skills.

Conclusons

Professional development is a complex process that involves continuous development of teachers' competences in order to improve their performance and consequently student's achievement.This means that it has to rely on the knowledge and skills that teachers already have, that it has to take into account their previous experience and to respond to theircurrent needs. Following this line, a significant number of surveyed teachers claimed that they need additional knowledge in new technologies in the workplace, but also in the field of pedagogical and didactic knowledge and skills. According to the fact that in Serbia there is still no education for the teaching profession in secondary vocational education, the need for additional knowledge in pedagogy and didactics is not surprising. This could be one of the key obstacles to the quality of our educational system. It becomes more than obvious that we cannot educate engineers to be teachers during the in-service trainings, but we need to shape them for teachers during the initial education.

As we saw from the results VET mehatronics teachers mostly claim that there is a lack of appropriate CPD training for them, that those trainings which exist are too expensive and that teacher do not have many opportunities to choose trainings but it is done on school level.

All this leads to the conclusion that the current system of CPD mechatronics teachers, insufficiently respect their needs and opportunities. There is no balance between the interests of individuals and the interests of institutions which supposed to be one of the main principles for a meaningful professional improvement.Those who create trainingsfor teachers can't do this with neglecting the teacher's needs, previous knowledge, experience and motivation for the training[10].This is part of CPD that needs to be improved in furtherer period.

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DIDACTIC EQUIPMENT FOR EDUCATION OF STUDENTS IN AUTOMATED HYDRAULIC SYSTEMS

M.Jocanovic[1], V.Karanovic[1], M.Velickovic[2]
[1]Faculty of Technical Sciences, University of Novi Sad, Serbia
[2]Festo GmbH, Belgrade, Serbia

Abstract. *In the field of technical knowledge transfer it is of the highest significance to include practical training and education in the education system as well. There are only few world famous companies producers of both industrial components and didactic equipment as well. Didactic components for hydraulics ensure large spectrum of possibilities and introducing to the students the basic principles of hydraulic components functions, as well as their implementation and functioning and simulations within specific hydraulic systems. This article presents product scope of didactic components of one of the largest world companies, producers of both industry automation and didactic components and solutions – Festo company.*

Key words: didactic equipment, hydraulic systems, automation, practical knowledge.

1.INTRODUCTION

Modern educational equipment and didactic tools are of the key significance for education of students nowadays, as well as to accomplish and sustain continual achieving both theoretical and especially practical knowledge. In hydraulic components and hydraulic systems areas, it is very important for a student to learn both necessary theoretical basics about the component work, and to place the components in an imaginary hydraulic system, and by using an appropriate didactic tool to determine, simulate, and prove both the functionality of the component in the suggested system, and the functionality of the system as a hole. From the equipment available in the world market, there are only few producers of hydraulic equipment (and those who do not directly deal with production of hydraulic industrial components) who make possible through their didactic equipment and simulation softwares - performing of modern, advanced education, simulations and experimental testings.

From available didactic tools used as education resources for hydraulics there are following companies present with their didactic equipment: Festo [1], Bosch Rexroth [2], Exago Group [3], ElveTechnic[4], and only couple of other companies in the world market.

2.DIDACTIC EQUIPMENT DESIGNED FOR BASIC AND ADVANCED LEVELS OF TRAININGOF COMPANY FESTO DIDACTIC

FESTO Didactic GmbH & Co. KG is one of the companies most actively participating in cooperation and training of students in our country. Through active cooperation with technical colleges in our country, didactic products placed in the market of our country and surrounding markets belong to the top high technology solutions by their functionality and variety. The aim of this work is to, through short didactic products portfolio of company Festo, to present some of possibilities of didactic components used for trainings and simulations, partly also for laboratory experiments. Equipment of company Festo consists of several product areas which are designed from the basic sets and then followed by more complex ones, so the students can learn gradually with the appropriate didactic tools.

2.1 Basic level trainings

For the basic level trainings equipment is designed for introducing of students with elementary functions of hydraulic components and concerns classical and proportional constructions. Equipment is designed (Figure 1) to allow trainings of two student groups at one working place: they can simultaneously follow trainers lectures and compare directly hydraulic schemes, learning about the functionality of components and systems.

Figure 1. *Example of didactic equipment for students basic training level in hydraulics [5].*

Equipment concept is such to allow the students the following:

- Introducing of students to variety of components used in mobile and stationary hydraulics;
- Introducing of students with various types of hydraulic systems used in mobile or stationary systems (open, semi-closed or closed hydraulic systems);
- Training of students allowing the students to learn on practical problems bound for hydraulic system and check theoretical knowledge in calculation of force, flow rate, speed, pressure and power of hydraulic system,
- Independent and safe installation of hydraulic components of students to didactic system work place;
- Students training, as it is in practice, to select and plug in hydraulic components into a system, perform control in a correct manner and safely set the system to work.

Besides the named possibilities given for students training, basic level of didactic equipment includes an amount of written work material concepted in a way to enable students to get introduced to every component within hydraulic system (pumps, motors, valves, hydraulic cylinders...), its functionality and part in hydraulic system. Also, functionality and part of each hydraulic component is worked on and shown through practical exercise –every hydraulic system from the exercise is mounted with accompanied component on a didactic table.

Advanced students training level

Through advanced students trainings, trainees are educated to use equipment from basic sets for trainings in electro-control of components with components in basic and advanced sets.

Besides the equipment from basic sets, Festo enables an option for certain components packages, to upgrade the basic level and allow students education with controlling and functions of proportional hydraulics. This way wide possibility is given to both students and professors to learn and simulate with add on equipment and study different applications of both classical and proportional hydraulics. This equipment level enables wide potential for students to get better knowledge of complex hydraulic systems functions, their control, as well to work on various examples of hydraulic systems use in stationary and mobile applications.

Besides named options, Festo didactic equipment allows didactic equipment (hardware) add-on devices with wide portfolio of electro-control components which enable students trainings in area of controlling by use of relay and PLC (*Programmable Logic Controller*) components – Figure 2. Besides these, Festo enables add-on`s with sensor components as well.

Figure 2. *Festo PLC didactic module [6].*

Besides named equipment modules that further can be built on, and expand learning of trainees this way, Festo offers modular equipment with combinations of pneumatic and hydraulic control or combinations of electronic and mechanical equipment or some other type of control. These modules are used to show in practical way-work of some mechanism, technical solution or technology process – figure 3.

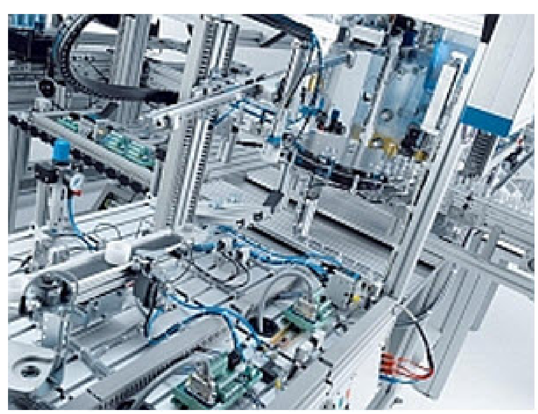

Figure 3. *Automated system in production [7].*

3. MODULES DESIGNED TO MEASURE WORK PARAMETERS OF HYDRAULIC SYSTEMS

Along with the earlier mentioned equipment, Festo Didactic expands with modules consisted also of some components enabling follow up and fine tuning of work parameters during work of hydraulic system. This equipment simplifies in many details to a student to comprehend formation and control of certain physical values appearing during work of each hydraulic system work. Within this package there are certain flow meters types, devices for measurement of actuator rode speed or rotating speed of motor output shaft, digital and analog pressure regulators, and so on.

4. SOFTWARE PACKAGES

Software packages used for students' trainings for hydraulics are widely spread and each producer of didactic equipment has developed his original software for education using their own didactic table.

Basic software packages that Festo developed, known by the name FluidSim® and FluidLab® allow the trainees – to simulate everything they learned in theory and calculate working parameters in order to show later the same in the real hydraulic system (didactic table). In this way it is enabled complete student education, exactly option that student with appropriate simulating and hardware equipment gets to learn about the hydraulic component and the system as a whole.

Besides the hydraulic components work simulation, and of the system itself, in FluidSim software and FluidLab there is possibility of creating electronic schemes through which one can control specific electrical components in hydraulic system. This enables that through work simulation of the whole hydraulic system along with its control in real system avoid the most frequent errors made, and construction or project errors are also reduced to a minimum.

Besides these, there are also software packages for control in process industry like SCADA systems (Supervisory Control And Data Acquisition). This software type gives information about important work parameters during work of hydraulic or process system – figures 4 and 5.

In the process of follow up and working with certain system work parameters, to software package user is given a possibility to use a wide portfolio of different components (electro-mechanical, hydraulic and pneumatic) and to, with systems for follow up, control and system regulation (sensors, relays, PLCs) perform necessary corrections in the work of certain component or work parameter, in order to get technological process to correct state and keep it in needed and defined tolerances.

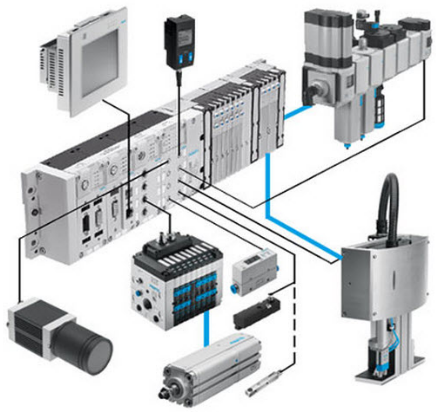

***Figure 4**. Components connections and control units in one SACDA system [8].*

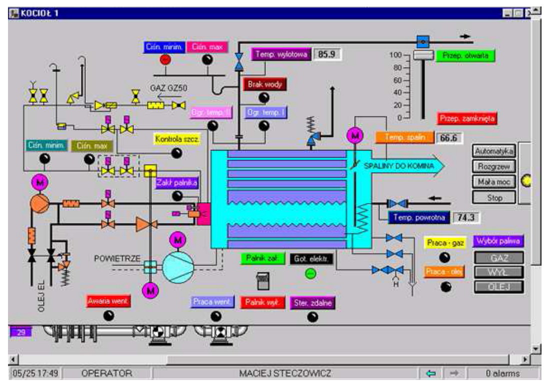

***Figure 5**. SCADA software for following specific work parameters in the system process [9].*

5. CONCLUSION

Within area of automated control of hydraulic system, it is necessary to follow certain trends in didactic means development and students training, to allow achieving better understanding and acquisition of knowledge from use and regulation in hydraulic systems. Besides reaching academic knowledge, students are given possibilities of gaining practical knowledge which is very important for easier employment, because employer expects also from the engineer practical use of the academic knowledge.

In this way, system of education and training of students is lifted up for a level, without obligation for students to have additional practice learning in industrial companies, where the training comes more to training for a single process industry type.

Apply of certain didactic resources, makes possible broad knowledge transfer and practical training in wide spectrum of process and mobile applications. It is important to emphasize that practical trainings need to be performed, especially when the technical solutions develop in a very fast pace as they do nowadays. The time has come when no more the experts of specific narrow specialties are enough: we need experts of wider knowledge who apply combination out of different areas of electronics, mechatronics, machine engineering etc.

In the future, concept of didactic resources for gaining specific technical knowledge will be practically an obligatory part of education, and with development of new software solutions and simulations, even the technical – hardware part is possible to evolve in advantage simulation softwares or distance learning in order to allow the cheapest and simplest way of education.

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ONE SOLUTION OF TRAINING COURSE FOR IMPROVING EMPLOYEES SKILLS IN IT DEVELOPMENT COMPANY

Marko Arsenovic, Srdjan Sladojevic, Darko Stefanovic,
University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia

Abstract. *Training courses present an adequate way to broaden the knowledge base of all employees, which enhances the company's capability to embrace and use advances in technology, building a more effective, highly motivated and efficient working team. This paper describes the two approaches of designing the trainig course. The approaches were implemented and evaluated at the two groups of IT developers from the same company. The analytical results showed that the courses where participants are more engaged in, with assesments tasks and small projects, give significantly better results than traditional courses where participants act solely as listeners.*

Keywords*: IT employees, training, knowledge transfer*

I INTRODUCTION

Training and career development play a significant role in any company or organization that aims at progressing[1]. Training refers to the process of acquiring the fundamental skills necessary for a certain work position. It targets specific goals, for instance understanding a process and operating a certain machine or system. Career development through training and courses improves employees performance in a way that they could make better decisions, manage people and think creatively.

Constantly changing business environment is pushing the organizations and companies to train and develop their employees to stay ahead of the competition.

Being an employee in an IT industry is a challenging task, often being overwhelmed by large projects, lack of time due to constant deadlines [2]. As a result of that, many employees have some shortcomings in their working skills. A training course allows them to improve skills so that every day working tasks could be accomplished successfully. A development program through courses and trainings brings all employees to a higher level so they all have similar abilities, expertise and knowledge. Such a program can benefit a company by increasing productivity in a way that each individual does not have to rely heavily on others to complete basic work tasks. Providing the required development program to their employees, companies are getting overall well-informed and effective staff who are able substitue one another should the need arise. They are prepared to work on teams or work independently without constant help and supervision from others in their workplace.

The employees who receive the necessary training are able to perform the job better and become more aware of proper procedures for basic work assignments. The training may also build the employee's self-reliance because of the fact that they comprehending the industry and the responsibilities of the job. This confidence may push them to perform even better and think of new ideas that help them excel. Continuous training also keeps the employees on the cutting edge of industry developments, which is of great importance in the IT sector, where technology grows exponentially. Employees who are efficient and capable to keep up with new industry standards help their company hold a position as a leader and strong competitor within that industry.

This paper describes approaches and educational methodologies of training courses held in one IT company. The rest of this paper is organized as follows: related work in the field is presented in Section III. Methodology is described in section IV while Section V contains the results and comparison of the training courses.

I RELATED WORK

In relation to IT training, there are various methodologies and approaches that can be used to deliver a training course. The closest related work is a research paper by Thomas Acton & Willie Golden [3]. Job-related training increases an employee's competence to perform job-related tasks. This research was conducted on IT sector employees, because of their level of proficiency with technology they are able to adopt to new training methods that incorporate computer and communications technology. The research found that technology driven methods such as CBT (computer-based training) and web-based training were not that common. The preferred training method is the one where the instructor leads formal training and where organizations derive direct and indirect benefits from that training. Organizations and companies that are devoted to training and professional development have employees who display better performance, have reduced level of work related stress and have overall working enviroment satisfaction. Due to this research result, instructor led training was chosen to be the basic course design, with two aproches which are described further in this paper. Many companies' training programs use a combination of methods to capitalize on each method's strengths for learning and transfer [4]. The traditional training methods discussed in this book are organized into three broad categories: presentation methods, hands-on methods, and group building methods. Presentation methods are methods in which trainees are passive recipients of information. This information may include facts, processes, and problem-solving methods. Lectures and audiovisual techniques are presentation methods. The lecture method has several disadvantages. Lectures tend to lack participant involvement, feedback, and meaningful connection to the work environment—all of which inhibit learning and transfer of knowledge. Based on this research we made a comparison of basic lecture training without involvment and training where participants are more engaged during the course.

III METHODOLOGY

This section describes the general ideas, concepts of courses templates approach methodology, and a description software engineering courses design.

Two courses were held at the same period of time in one IT company. Each course had 15 participants, all of them were the IT developers from the same company. The both groups had the equal number of senior and junior developers, because of the course evaluation, the rest of developers from that company did not participate in the courses.

Setting goals helps to evaluate the training program and also to motivate employees. Both courses were held every working day, in the period of four weeks. The daily topics were designed to cover the technologies used in this company. First course was designed as a review of new technologies, displayed through verbal presentations and examples. The main purpose was to introduce the developers with the material so that they can be able to consume the cutting edge technology in their future projects. Each of that presentations was held during the work time and lasted 90 minutes. Figure 1 shows the task order in workflow for both aproaches of the training courses [5].

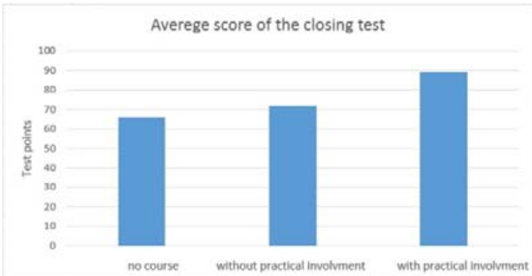
Figure 1 : Workflow of training course approaches

The second course was devided into various themes examined in daily lectures (90 minutes). The lecture contained basics of daily objectives and also up-to-date information as well as methods related to the topic. After every lecture the course material was provided. Assessment tasks were given to the participants of the second course after every lecture. The assessment tasks were used for evaluating the performance of the intended learning outcomes. The main focus of evaluation was to demonstrate how employees solved their problems using new introduced technologies. The result of daily tasks, graded in points from 0-10 were displayed on a monitor in the company's hallways. Every task was designed in a way to cover the important things from daily topic. All the participants had the chance to retake any assessment at any moment, in order to create a supportive workplace, reduce stress and motivate them to give their best to successfully complete all the tasks given. When the course had finished, there was a summary comprising of all main course objectives and discussions of tasks solutions.

IV RESULTS

This section discusses the results of the closing tests given to all the develeopers from the company were the courses were held. The closing test was consisted of multiple choice questions, small programming tasks and standard questions. Possible scores on the test range from 0 to 100 points, combining test results from this three sections.

Employees that were involved in the training and development programs had the advantage and better overall results over employees who didn't participate in any of these two courses. The average score of developers who didn't participate in any of these two courses was 66. Comparing the results of only the developers who attended the courses, the average score value from participants from the second course was grater than from participants from the first course, particularly in the task part of the test, which was valued the most, which is an indicator of good practical knowledge gained. The average score of developers who attended the courses are 72 and 89 points respectively as shown on graph 1.



Graph 1: Average score of closing test

Putting the employees through regular training course where they had exposure to the information but not a practical involvment proved to be less effective.

V CONCLUSION

A well prepared training and development program provides the employees with needed knowledge and experience. Courses where participants are more engaged give better results. A properly trained employee is more informed about procedures and tasks related to his/her work. The confidence which is built up by training courses and development programs comes from the fact that the employee is completely aware of his/her roles and obligations. It helps the employee to carry out the tasks in better ways and even find new methods and approaches to complete the daily duties. Training and proffessional development through courses makes the employees pleased with the thought of being the part of the company or organization. The employees are able to execute their working duties on their own using knowledge and skills gained through the development program. They feel they are an important component of the company or the organization that they work for and that they are motivated to perform better.

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SUCCESSFUL CHANGE MANAGEMENT

Sanja Stanisavljev[1], Milivoj Klarin[1], Dragan Ćoćkalo [1], Dejan Đorđević [1], Zvonko Sajfert [1],
Technical faculty "Mihajlo Pupin", Zrenjanin

Apstract: *The authors analyze the significance of the change, identifying and managing change in order to survive in today's market. The changes are more frequent, faster, and it is necessary to monitor them and to timely react to them. There are a number of proven techniques, strategies that, if properly implemented can guarantee success.*
Key words: *management; change, organization, successful.*

1. INTRODUCTION

Kotter defines change management as the utilization of basic structures and tools to control any organizational change effort.

Authors who have studied this area and research it agree that it is of great importance to understand the importance of S implementations of changes in the organization [1,2,3,4,5,6,10].Understand the great role and importance of time required to implement changes, have realistic expectations, to look at the real picture to avoid undesired resistance is very important.

Today's modern business characterized by numerous changes that are more dynamic, more frequent and faster. They are numerous, can be within the organization itself and the environment. If the company changes ahead of the time, respond to them and accept the challenges of the environment can transform threats into opportunities and thus ensure the survival of themselves and the desired competitive advantage.

For the organization to decide whether to let the changes, manage, adapt their business strategies change, keep up with changes, even in front of them and so remain competitive, or will ignore the threats and disappear from the market. If the organization decides to adapt by changing then it is successful.

If organizations are changing their strategy, parts of the organization or entity, fully implement new techniques and business strategies they pass through organizational changes. Such changes should point to the mistakes that should be avoided, the benefits and opportunities that are acquired by changing and increasing business.

The success of modern organizations is reflected in the ability to recognize changes early diagnosis and assessment of results. It is also important to inform employees about the successful implementation of the change, the benefits of which have been acquired, thus putting to know how the changes are significant and strengthens their significance. According Muema [7], after each change, it is necessary to check which administer the final phase of implementation.

2. SUCCESSFUL MANAGEMENT CHANGE

When the changes are introduced in any segment is understood to come insecurity, fear, worry, anxiety and stress. First is the manager must detail familiar with the situation, the details and plan to introduce the changes, and then to inform and inform employees. It must prepare the employees and changes in the environment, and to learn about problems and strategies, and techniques on how to avoid problems and stress. Often people do not want to change something you are used to, because they need to be convinced by the argument that it is for their better future. Often the problem and structure of employees. Investment in education and training of employees, training and acquiring new knowledge is constant and inevitable need it.

Change Management services of varying degrees of complexity and industries has helped us to solidify the following four guiding principles for Change Management and Integration, Figure 1. [12].

To make the change was successful important that all who are involved and contribute in any way to the implementation of changes. Important people, each employee, customers, technology, multidisciplinary approach, a combination of knowledge, skills. An important approach is that although change is complex, try to simplify and

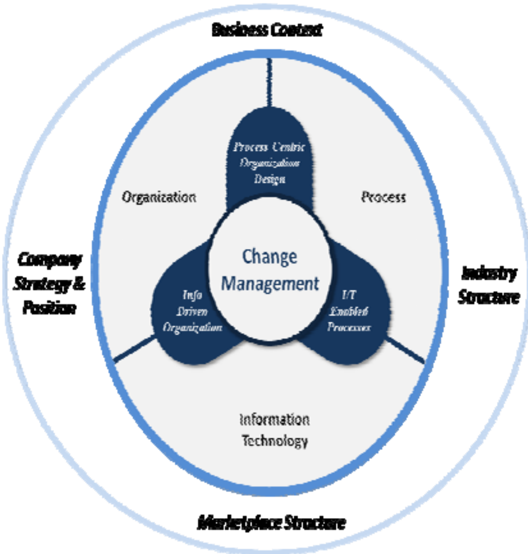

Figure 1.Change Management and Integration [12]

facilitate access and manage the new situation. The company must be ready to manage the constant changes that are happening in his environment, because only in this way can provide further existence and development. In order to adapt the company to survive in a very complex and changing environment and continued effective operation, it is necessary change management.Planning, implementing and managing change in a fast-changing environment is increasingly the situation in which most organizations now work. Dynamic environments such as these require dynamic processes, people, systems and culture, especially for managing change successfully, notably effectively optimizing organizational response to market opportunities and threats.

Key elements for success:

- Plan long-term broadly - a sound strategic vision, not a specific detailed plan (the latter is impossible to predict reliably). Detailed five years plans are out of date two weeks after they are written. Focus on detail for establishing and measuring delivery of immediate actions, not medium-to-long-term plans.

-Establish forums and communicating methods to enable immediate review and decision-making.

-Participation of interested people is essential. This enables their input to be gained, their approval and commitment to be secured, and automatically takes care of communicating the actions and expectations.

-Empower people to make decisions at a local operating level - delegate responsibility and power as much as possible (or at least encourage people to make recommendations which can be quickly approved).

-Remove (as far as is possible) from strategic change and approval processes and teams (or circumvent) any ultra-cautious, ultra-autocratic or compulsively-interfering executives. Autocracy and interference are the biggest obstacles to establishing a successful and sustainable dynamic culture and capability.

-Encourage, enable and develop capable people to be active in other areas of the organization via 'virtual teams' and 'matrix management'.

Scrutinize and optimize ICT (information and communications technology) systems to enable effective information management and key activity team-working.

-Use workshops as a vehicle to review priorities, agree broad medium-to-long-term vision and aims, and to agree short term action plans and implementation method and accountabilities.

-Adjust recruitment, training and development to accelerate the development of people who contribute positively to a culture of empowered dynamism.

-Use Nudge theory - to understand potential hidden influential factors on people are thinking [11].

Profitable application of the Change Management approach includes:

-Implementation Climate

-Organizational Readiness

-Change Management Plan [12].

Continual training acquired, the acquisition of new t echniques and knowledge, motivation of employees, informing the employees about existing problems, a dvantages, disadvantages of existing processes, abou t upcoming changes or conditions that change brings , are some of the ways to reduced stress and cope wit h and manage change and excluding the possibility r esistance.

3. CONCLUSION

The point of change management is that the company training that in the new circumstances maintain and improve his position. It's kind of a process of renewal and capitalization learning company or its management. The changes will secure the future and create growth and enterprise development.

As with any change, as well as in organizational change required is a period of adjustment, introduction to the paper, not easy to discard the old and so quick and easy to accept a new system of business, a new environment, a new strategy. Major role then has a manager who after preparing himself must prepare, inform and familiarize employees with the coming changes.

Organizational change is to identify the goals that executives, employees and as individuals and as a team, the organization as a whole wants to achieve for the sake of better conditions and results of operations. Access and the way to achieve these set goals, move on to a different, new levels of business, governance new situation is change management. It is an organizational process aimed at helping employees to accept and embrace changes in their current business environment. It is necessary to manage changes in order to control the implementation of changes, new strategies, ideas, techniques, changing working environment, minimize stress and resistance to change. The person who is responsible for the management of changes that can and does not have to be a manager, employees or new employees, the so-called change agent must inform employees, introduce the upcoming changes and preparation of results, motivate them, eliminate stress ... It is clear that it will survive and be in the race for competitiveness only organizations prepared for the challenges, ready to accept and manage change, organizations that are innovative. The changes are faster and more numerous, dynamic and, consequently, dynamic and flexible and must be a modern organization.

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EMPOWERMENT AND ENTREPRENEURSHIP IN JOB ENVIRONMENT

Reza Shafiezadehgarousi[1], Mohammad Omid[2], Mohammad Shahverdy[3]

[1]Member of Faculty, Department of Management, Islamic Azad University Saveh Branch and President of Islamic Azad University Tafresh branch Iran.Email: shafiezadeh@iautb.ac.ir

[2]Ph.D Student of Management, Faculty of Economic and Demography Sciences, Academy of Sciences of the Republic of Tajikistan, Assistant of Self-Sufficiency and Employment, Imam Khomeini Relief Foundation: ssf@emdad.ir

[3]Member of Faculty, Department of Computer Engineering, Islamic Azad University Tafresh Branch, Iran shahverdy@iautb.ac.ir

Abstract. *In modern world the entrepreneurship think and using it in organizations is inevitable matter. As birth and death of organizations is depended on sight, vision and abilities of their originators, however the growth and duration of these organizations is depended on factors such as ability, creativeness and innovation of their human source. If planners, decision makers and employees of an organization be entrepreneur they can understand economical opportunities better and they will more able to use available sources for innovation, thus they will grow faster and can be persistence in competition arena.*

From late of 1980's the small financial institutions as one appropriate and effective solution for economical empowerment in development programs reached to special place in developing countries; so that during two last decades the number of these institutions rigorously increased. These programs due to making proper financial services and conveniences for poor groups in society and by redistributing the incomes and increasing the self occupation and thus by increasing the production, could provide income in reduced the unemployment. For empowering the susceptible people for being entrepreneur, it should promote the entrepreneurship activities, nurturing the entrepreneurship moral and finally an entrepreneurship environment should be dominated by Imam Khomeini Relief Foundation. This require to cognition, contrast and description the entrepreneurship sense and process for job through empowering the susceptible people that have minimum economical and financial resources. This article try to describe process entrepreneurship sense and also it want to offer a model for promote and nurturing this sense through empowerment in job environment and small and medium sized enterprises.

Keywords: *entrepreneurship, job entrepreneurship, empowerment, job environment, self adequacy*

1. INTRODUCTION

Due to occurrence various events in social, cultural and job levels, nowadays there is a special interest to entrepreneurship and entrepreneurs in different countries and supporting to current entrepreneurship in job and making proper beds for development is among economical developing tools for nations particularly in developing countries. Entrepreneurs are present in any environment and it should try to increase their ability and more important, the economical- organizational structures should be let to entrepreneur for express itself and its abilities. Those who believe to their gifts frequently affect to create things themselves. They desirous to responsibility and they have a rigorous need to introduce themselves and more freedom. When they haven't such freedom and their needs aren't supplied, they will be unhappy and this situation cause to reduce the person productivity and even person may become depress and may not be look for useful work. Sometimes those entrepreneurs that aren't supported may go out of economy round by supporting from risky investigators and these entrepreneurs may decided to passivity or exit from economy market. For preventing from such problems and for keeping the capable and creator human resources, some methods for promoting the entrepreneurship moral are considered that these methods can bring worthwhile advantages.

The occupation and entrepreneurship subject is so serious for human nations and is considered as an indicator for measuring the development in nations and most cases lake the job is considered as violating the poor line. Based this in present article we tried to introduce the empowering conditions for subsistent persons (that are prone to entrepreneurship) under cover of Supportive Organizations in empowering plan for entrepreneurship. In this view supportive organization included in charity, NGOs and governmental institutes.

2. ENTREPRENEURSHIP DEFINITION

Entrepreneurship definitions that were introduced in different books and articles from several theorists significantly are similar. McKensy and Dikambo (1986) believe that entrepreneurship activity can be includes developing a new product so that making a process can be effective. Jing and Yang (1990) define entrepreneurship as a process for developing the products or new markets. Coratiko, Montagno and Horensby (1990) describe entrepreneurship as making new jobs in framework of mother companies. McGrath, Bolind and Vankatarman (1992) define entrepreneurship as a tool for companies to increase their economical stability in a long period and Arilla (1960) believes that entrepreneurship has three dimensions that are: innovation, extending new products, processes and services, and risk taking. All definitions that were offered for entrepreneurship significantly are consistence and Zahara by investigating the entrepreneurship history found that most definitions that were presented in entrepreneurship field, introduce it as an innovation activity in job environment or organization (Hisrich, Peters, 2002, p22).

3. EMPOWERMENT AND ENTREPRENEURSHIP CULTURE

The social and job condition came to a new arena. This era is entrepreneurship period. Entrepreneurship is known as a key factor for development and growth in modern age. One action that is necessary for using the entrepreneurship tool is bedding and one of the most important aspects of it is culture bed making for entrepreneurship. The culture bed is the most important infrastructure agent or even is the base of other necessary beds for entrepreneurship. Culture is a set of rules that specify how an organization or job environment should do its tasks and what is unappealing or acceptable. In traditional culture the conservative decision making is favorable; in other word in such culture the emphasis is on gathering a lot of information as a base for logical decision making and crucial decisions typically are delayed until gathering enough information (Histerich, Pitters, 2002, p 48-49). These instances may chill the prone persons for entrepreneurship due to having minimal financial possibilities so that in this case the empowerment essence is visible more than any other time.

4. EXPERIENCE OF OTHER COUNTRIES AND EMPOWERMENT ROLE FOR ENTREPRENEURSHIP:

1. Bangladesh: intellect credits

Bangladesh can be considered as intellect empowerment start point. The experience of this country in providing financial resources for small units, poor people and special groups particularly for women, caused that other countries consider Bangladesh as a model for taking proper guideline about small credits specially successes of Gramine Bank in this country. For evaluating the performance rate and service quality of small financial institutions in Bangladesh we can mention to some projects such as Gramine bank, rural development committee of Bangladesh, rural development project "12", reconstruction organization of Bangladesh, Shakti institute, rural services of Ranjpoor Donyajpoor, and development project of small and marginal agriculture systems (Kautz et al, 2003).

2. India

Until before starting the financial reform programs (1990's), empowering the susceptible people as a governmental plan in a subvention model was prevalent in India. This vision was dominated among most of bankers and politicians; but regulation removing from financial system could transform perspectives of financial system gradually; for example by liberating the interest rates, many banks by supporting of rural and agricultural developing national bank communicated links with informal groups of self aided poor people for featuring the poverty guarantees and paying credits to them with proper interest rate .

3. Pakistan

In 1989 Pakistan established the first women bank with a capital equal to 100 millions rupee for empowering this susceptible group. In years after it by increase the capital of this bank, the structure of its capital changed so that 90% of it provided by five main banks of Pakistan and reminding 10% provided by government. Establishment of this bank was considered necessary from economical, social and cultural aspects because this country regarded to juridical aspects. The main aim for establishing this bank was eliminating the prejudice from women in credit problems for bank bonds.

4. Indonesia

Increasing trend of crowd growth in Indonesia that reached to its maximum in 1970's resulted to facing with a high rate of unemployed young work force in this country. In other hand dependence of national income on oil export and so little contribution of agriculture in this income (while 70 percent of employed people in this country are working in agriculture segment) faced Indonesia to additive crisis such as reduction of national income due to falling the oil price, and a wave of unemployed young people. From meddle of 1970's the Indonesia government acted for developing the industry and job making through developing the small firms by making basic changes in immense economical programs. Needing to limit worth sources, needless to many skilled manpower, and enjoying from creature innovator and entrepreneurship management, all are among prominent features of small industries so that Indonesian statesmen respect to this fact tried for developing this part (Asian Development Bank, 2000).

5. EMPOWERMENT ABILITIES OF ENTREPRENEURS

1. Planning and purpose defining: Planning is means that manager already thinks about objects and desired activities and his/her tasks are based on a logic, program or method (Stoner, Freeman and Gilbert, 2000, p12).
2. Decision making: Process decision making is selecting a particular method for solving a special problem or project (Heresy and Blanchard, 2000).
3. Human communications: Based on significant researches that were done in 1930's and 1940's, it can conclude that the job environments factually are complex social contexts that understanding behaviors in these environments is possible by considering to employee's perspectives, social communications, informal communications and other variables. Marry Prakter Fault believes that in any collective work, the important problem is making and keeping the stable and orchestrate human links (Alagheh Band, 1999).
4. Marketing: In Bennett vocabulary, marketing is a process of planning, designing, pricing, enhancing and distributing ideas, goods and services for making an exchange to meet individual and organizational objects. The marketing skill is one of other necessary skills for entrepreneurs (Islam, 2003).
5. Job making: Many factors such as government, financial resources that are available for person, role models and etc have effect in making new jobs. Also entrepreneur should have necessary contest for operating job (Hisreach and Pitters, 2004).
6. Accounting and financial skills: Accounting is including record technique, sorting and précis the financial activities of an institute in framework of measurable numbers as money and interpreting the results that are obtained from considering these numbers . Accounting is named as trading language. Whatever entrepreneurs can learn this language more, they will dominate better on their life and job (Poordariani , Azizi, 2004).
7. Management: The management process is related to a task that is based on trust gain about activities means that these activities are done in a manner that will caused to meeting the certain purpose (Pirnia, 2003, p21).
8. Control: Control is interesting to work results (feedback) and pursuit them for comparing the conducted works with programs and applying appropriate modifications in any offset respect to prospects (Alagheh Band, 2000). Control helps to entrepreneur for monitoring the effectiveness, planning, organization and directing the activities (Stoner, Freeman and Gilbert, 2000).
9. Negotiation: Negotiation is a very complex connecting process and is an important skill for entrepreneur success. In trade as a part of life, the negotiation starts based on this fact that people or individuals need to each other (Haggy, 2003, p79).
10. Develop management: In the last managers worked in a relatively stable and predictable world for reach to success but today they are faced with precipitous changes. They are faced with continuous innovations in computer and information technology and a stormy world, variable markets and unstable life styles of consumers is places against them (Harvey and Brown, 1998).

6. THE NECESSARY ENVIRONMENT FOR EMPOWERING ENTREPRENEURS

For creating entrepreneurship it is should be proper conditions in environment. Thos agents that affect the entrepreneurship extend are named entrepreneurship environment and empowerment is one these agents (Spilling, 1998, p59). Now we want to see how it can make an environment for entrepreneurship in job. Doing this task entails certain factors and features of empowerment. The typical specifications of organizational entrepreneurship environment are summarized in table 1-1.

One of main ways for supporting the entrepreneurship management for entrepreneurs is that without any fear and with a proper program establish his/her desired job. (Shabani, 1998,p154)

Table 1: organization entrepreneurship environment
• Organization should be coordinate with advanced and updated technologies • New ideas should be encouraged. • Test and try should be encouraged. • Failures and loses should be accepted. • No barrier should be against making and developing new products • Multi purpose team work method • Long term horizon time • Voluntary program • Proper compensation system • Existence of supporter and backer • Supporting and bickering should be done

7. EMPOWERING MODEL OF ENTREPRENEURS

The ideal model is that can define all constituents of a system and all relations between them. Practically it can not to have such model and if we have a model that can determine 70% of relations between system constituents it will be a good model but 100% isn't possible (or it can be reached difficulty) (Nateghi et al, 2010). The empowering model that was used in Supportive Organizationshas a proper effectiveness and proficiency. Aims of this model are:

1. Enhancing the economical, cultural and social knowledge of subsistent persons
2. Enhancing the technical knowledge and professional skills of subsistent persons
3. Making proper context for efflorescence the hided creativity of subsistent persons
4. Increasing the economical power and authority in individuals and families under cover until self adequacy

This model is based on a continuum and defined process; a process that all administrative body and its staff are deal with it directly or indirectly and all of them support it. Now the conceptual model of economic empowering for entrepreneurship is showed , Fig.1

In refer to role of desirable raw materials in quality of made goods and its effect in stability of jobs, speedup the timely productivity of job plans and fostering the executive ability of subsistent persons, the preoccupation and self adequacy assistant of Supportive Organizations tried on supporting program of occupation plans with a supply framework; and in this direct he could provide various kinds of machines and equipments required for conducted plans with lower price and with higher quality for subsistent persons during this period. For this purpose the empowering model of entrepreneurs could be conducted by follow guidelines.

1- Help for marketing and selling products of subsistent persons

The Supportive Organizationsby establishing the trading and producing services center of Imam's Supportive Organizations and through making constant stores and seasonal small markets effectively helped to subsistent persons for selling their products in massive production and this action caused to selling a massive volume of produced goods of subsistent persons thus these persons insured about selling their product goods and they were pursuit their works with more confidence.

2- Standardizing and enhancing the quality

For parallelism in production and for enhancing the products quality, the assistant of self adequacy and preoccupation assigned the first prefer to standardize the subsistent persons' products in current plans of assistant zone and in this regard all plans and available production maps imparted for reconsidering and standardized according to market needs.

3- Marketing

Marketing for subsistent persons' products is one of very useful services of Supportive Organizations committee. Center of trading and producing services of Imam's Supportive Organizationsby its presence in national and international special exhibitions, introduces products belong to subsistent persons and it could have a good contribution of markets in country and abroad. This action in handicraft industry sector was significance and salient. Presence in Ramazan ceremony small market, making exhibition in margin of superior entrepreneur and Supportive Organizations experts' celebration, and contribution in yearly sell exhibition of country, are among these actions. Also presence in abroad exhibitions is among programs of trading and producing center of Supportive Organizationsand each year different exhibitions are considered so that if presence in these exhibitions is cost effective, the committee will participate in it.

4- Products sell

By extending the self preoccupation and by increasing the various products in this sector, it seems that help for marketing and product sell is necessary for subsistent persons and in this regard very good actions performed and self adequacy and preoccupation assistant of committee by making continuum stores and by presence in seasonal small markets and exhibitions aided to subsistent persons.

The mentioned rate is except provincial sell that its statistical isn't considered in this part.

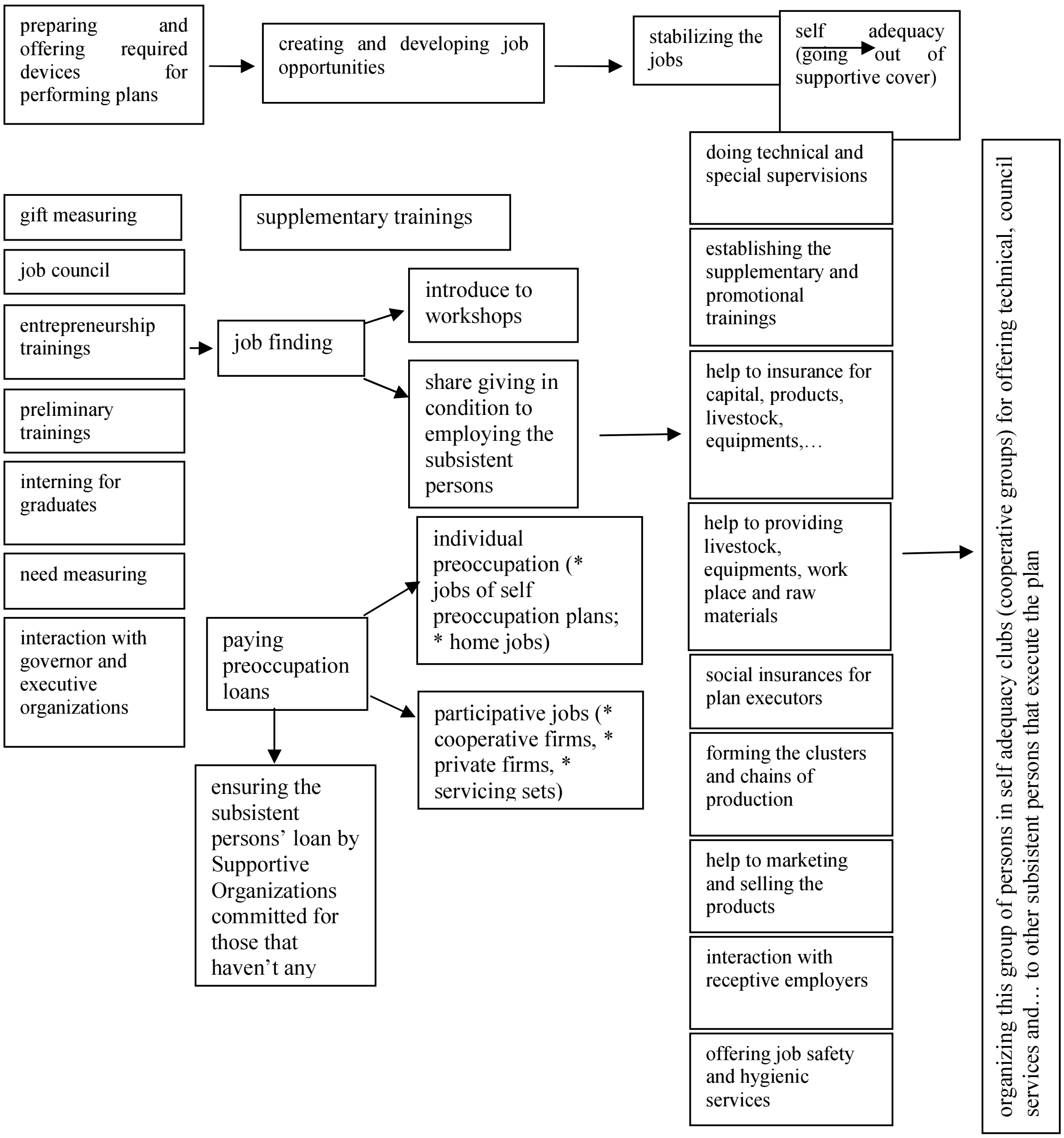

Figure 1: Conceptual model of economical empowering of Supportive Organizations with central emphasis on preoccupation(Imam Khomeini Relief Foundation, Self-Sufficiency and Employment)

8. SUPERVISION ON PERFORMING PREOCCUPATION AND SELF ADEQUACY PLANS

To be sure about good performing the preoccupation and self adequacy plans, the quality control for subsistent person's products and stability of created jobs and also surveillance about worth (gifted conveniences) all are among task works of committee assistance for supervision and continuum survey to self adequacy and preoccupation plans for subsistent persons and this committee was resolute. Totally 9448166 visits were done from 2005 to end of 2012 autumn. Performing this program caused to yield these conducted plans in determined time and it was so effective in durability of created jobs. Among the most important yields of this program during 2005-2011 period we can mention to: products' quality, resounding disadvantages and inadequacies in performed plans to related responsible and understanding the quantity and quality of plans, supervision on individual and environmental hygiene in workshops and vaccination program for livestock, interesting to professional insurances and workshop events, watching for investments and also offering technical council for subsistent persons. The performed supervisions were done in three levels as follow.

a) Direct supervision by technical supervisors, responsible persons and branch experts

In this type of supervision that mainly is workshop supervision and has a technical aspect, technicians and responsible persons of self adequacy in branches with related job description and recipes have adequate supervision on all performing stages for self adequacy and preoccupation plans and provide a visit report for each plan after accomplishment the mission and they offer this report to their superior responsible person.

b) Supervision by responsible persons in province

In this type of supervision, the assistance of self adequacy of committee and experts of province are bounded to revisit all current plans of province according to certain schedule and evaluate these plans. In addition to technical supervisions for instances such as evaluating the preoccupation activities, regarding to recipes, they should evaluate the performance of staffs in preoccupation department in each executive units.

c) Supreme supervision by preoccupation responsible of center

Supervision on performance of executors in self adequacy sector of province administration and its branches and confident on favorite performing and directing plans and activities related to job making, regarding to issued recipes in all provinces and their accessory executive units, all are undertake by responsible persons and experts of preoccupation sector of center office that these activities are performed according to a regular scheduling table. Responsible and experts of assistant headquarter visited preoccupation department of all province administration offices and also their accessory branches. These activities are done systematic as follow, Fig 2.

Objects:

1. Enhancing the scientific and cultural knowledge and vocational skills in subsistent persons;
2. Enhancing the economic power of individuals and prone families until full self adequacy so that the poverty and privation signs eliminate from their life;Creating effort and work culture in subsistent persons for reaching to a better life;
3. Maintaining the family strength resurrecting the individual, domestic and national honor and munificence.

A) Executive programs:

1. Gift measuring, job guidance and determining the level of skill and executive power in subsistent persons;
2. Enhancing the scientific level and vocational skills in subsistent persons;
3. Establishing the Intern system for university graduates (children of subsistent persons);
4. Job finding for ready subsistent persons for work (headman of family and children);
5. Loan donating and making proper job opportunities for subsistent persons (performing job making plans);
6. Preparation and technical supporting to entrepreneur subsistent persons;
7. Identifying the market need (inside and outside the country);
8. Help in marketing and selling products belong to subsistent persons
9. Preventing from falling again to poverty cycle through executive social insurance for subsistent persons;
10. Supervision on favor performing the job making plans and self adequacy and quality control for products;
11. Identifying resources, possible and potential features of different areas of country for exploiting them in extending job opportunities;
12. Improving the systems and executive methods.

B) Executive policies

C.1) subsistent part:

1. Segregating and classifying the self adequacy and preoccupation plans proportionate to subsistent persons' executive power;
2. Identifying job capabilities in subsistent persons and their skill level through council;
3. Making proper context for preoccupation and stable gaining for subsistent persons through job finding and executing preoccupation and self adequacy plans with preference for rural subsistent persons;
4. Directing the children of subsistent families to useful and productive preoccupation and helping them until self adequacy;
5. Directing the subsistent persons toward performing economical small plans in an individually or family manner;
6. Cooperation in performing collective plans that is more cost effective than individual plans.

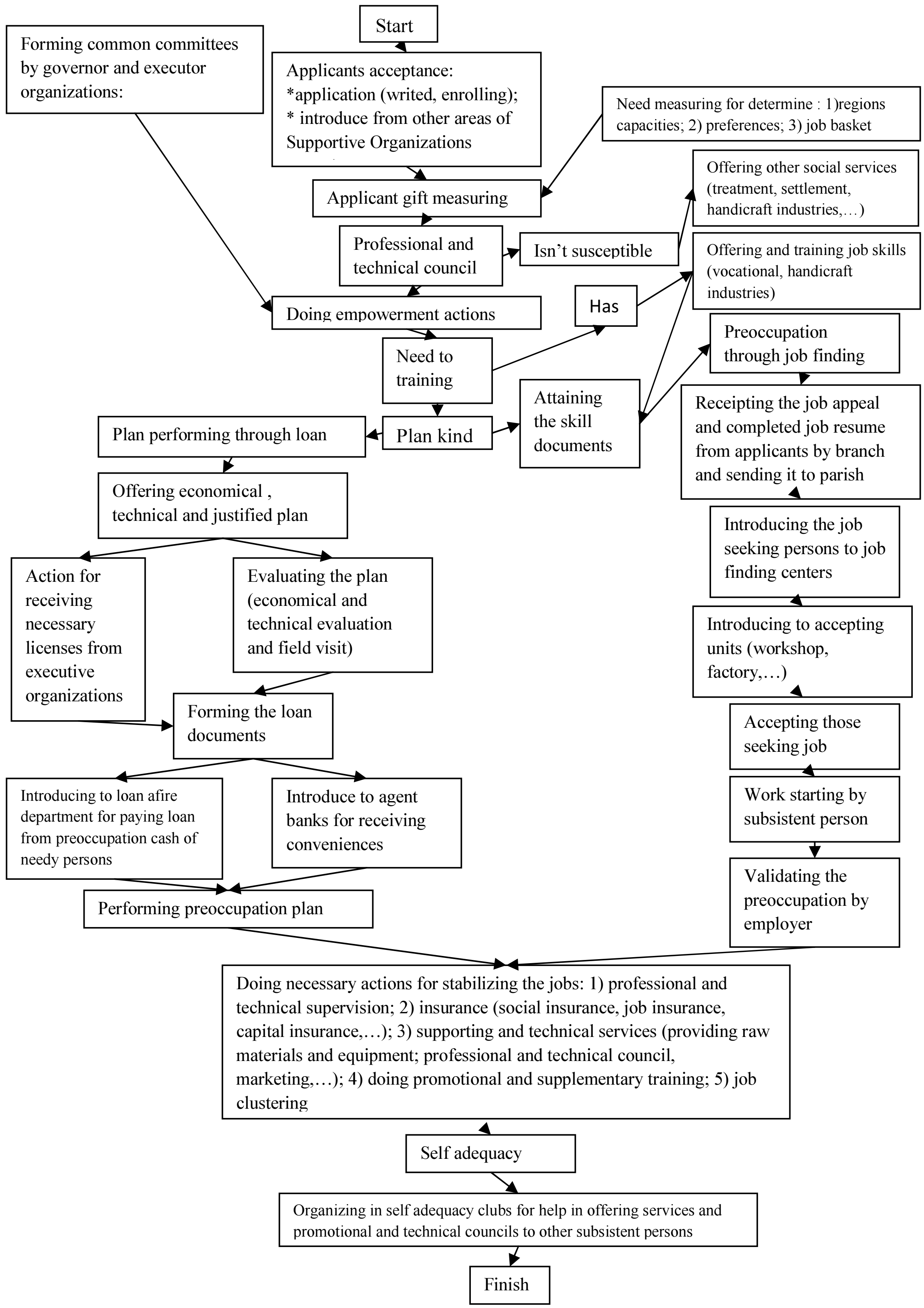

Figure 2:Empowering procedure for entrepreneurs
(Imam Khomeini Relief Foundation, Self-Sufficiency and Employment)

C.2) organizational part:

1. Marketing and help for selling products belong to subsistent persons and also effort for gaining more share of national and global markets pro introducing products that are made by subsistent persons;
2. Help for providing raw material and work tools that are needed for subsistent persons;
3. Improving the structure and executive methods in self adequacy area (executive and headquarter departments) according to assigned missions;
4. Endeavor of headquarter areas for better policy making, planning and supervision;
5. Continuum supervision on favorite performing the self adequacy plans to be sure about success of plans and products quality by using real and legal persons out of organization;
6. Preventing from falling again to poverty cycle and taking proper tactics for establishing the performed plans through executor social insurances and by using life insurance, event insurance and capital insurance for subsistent persons.

C.3) regional part:

1. Identifying and exploiting the possible and potential features of different parts of country particularly the habitat of subsistent persons to developing job for them;
2. Exploiting the potential training features of country for enhancing scientific knowledge and level of technical and vocational skills of subsistent persons;
3. Effort for attract and directing the state credits, public, cooperation firms and banks for job making particularly in deprived regions;
4. Cooperation for performing special provincial and regional plans that is positive and cost effective and subsistent persons can do these plans;
5. Diversity and variety in self adequacy and preoccupation plans and developing the self adequacy services proportional to contexts and features of regions;
6. Preoccupation of subsistent persons through job finding by exploiting the job opportunities available in production and services sector;
7. Making more variety in self adequacy and preoccupation plans with an Identifying approach for jobs and new technologies proper to gifts and features of region.

9. EXECUTIVE GUIDELINES

a) possible measuring and determining the skill level of subsistent persons

For performing this policy the following programs and activities were predicted.

- Identifying susceptible subsistent persons for work and their family members that have work ability
- Performing the council program and job guidance for subsistent persons covered by committee
- Introducing the proper, useful and productive jobs in different fields to families' children
- Ordering and rehabilitation program for elderly persons by performing preoccupation plans
- Identifying the skill and technical abilities of job applicants
- Making entrepreneurship centers in sight of Supportive Organizationsand purchasing required services.

b) designing and performing pervasive courses of vocational training and interning and promoting the work culture

For performing this policy the following programs and activities were predicted.

- offering vocational trainings to those subsistent persons that haven't any skill
- offering supplementary trainings to executors of preoccupation plans
- offering vocational trainings through un personal method
- offering cultural trainings and life skills
- codifying the training standards
- performing supplemental trainings and special updating for expert forces that are practitioner in preoccupation sector
- training need measuring program in a constantly manner along with needs of work market and developmental programs
- remote and media training
- evaluating the offered vocational trainings
- information technology development program in training procedures
- developing in service trainings (vocational trainings) for high school students
- the program of gradual training for preoccupation plans executors in quick yielding firms
- the program of developing informal training courses
- the program of attracting public participations and benefactor persons
- identifying possible and potential training features of regions

c) performing preoccupation plans proportional to executive power of subsistent persons

The preoccupation plans in aspects such as definition, execute process, applicable models, maximum level of payable loan and etc, and proportional to executive power and features of target groups are divided to three classes as: work stimulus plans, power adding plans and self adequacy plans.

1- work stimulus plans

These are plans that are performed for increasing the moral and expectancy index for those subsistent persons that are faced with moral and physical problems or senility age and in these plans attaining to economical income and economical self adequacy isn't considered. The mold and model of performing these plans is including "small plans of self preoccupation" and "small plans of home jobs".

2- power adding plans

These plans in small jobs framework are performed in two parts of self preoccupation and home jobs with aim of enhancing and helping to family economy. By performing these plans it isn't expect to self adequacy of family in a certain time period but it can provide self adequacy context for family and in other word it can say that these plans promote the effort and work culture among families and provide context for operation bigger jobs. Creating these job opportunities can be considered as a context for growth of self adequacy plans so that after certain period by increasing the plan capital and supplemental trainings, the family self adequacy will be occur. Mold and model of power adding plans are include: self preoccupation plans, home job plans, virtual jobs, rural jobs, seasonal and temporal works and etc.

3- self adequacy plans

These are plans that provide income and self adequacy for family after certain period time and cause to exit the family from supporting covers of Supportive Organizationsand provide self adequacy for family. Model and mold of these plans are include: individual plans such as self preoccupation jobs, home jobs and other similar cases; collective or group plans such as family jobs, cooperative plans, various kinds of firms (public joint stock and private firms,…), production service associations, participative plans, continuum and cluster plans, production plans without factory and other cases.

10. PROVIDING GEOGRAPHICAL MAP OF PLANS SOCIETY

For performing geographical map of plans society and quick yield, various, low capital, stable jobs with low risk in our country, the following programs and activities were predicted and now are undergone.

- Identifying possible and potential features of different regions of country;
- Codifying the job development document for Supportive Organizations;
- Creating data base for job opportunities and quick yielding jobs
- Gathering, adjust and codifying instruments relating to preoccupation (inside and outside of organization);
- Positioning the individual and group self preoccupation plans in different regions of country;
- Codifying logistic plan of country for preoccupation opportunities by Supportive Organizations;
- Identifying market needs (inner consumption) and other countries (export)
- Dividing available jobs based on sex and age
- Forming specialty work groups including professors and theorists for identifying the potential aspects of different regions in country;
- Identifying active industrial clusters in region and those clusters that can be formed in future;
- Providing bylaw for identify job opportunities;
- Identifying available job opportunities in region and providing demography of exist jobs;
- Positioning the transformational industries respect to native products of different regions of country;
- Identifying supportive institutions and unprofitable organizations and active welfare institutions in field of preoccupation in different regions of country;
- Exploiting the experiences of other supportive organizations inside and outside of country in preoccupation field;
- Identifying capabilities of habitants in different regions of country for enhancing their participation in investment;
- Identifying active, semi active and work stopped industrial factories and investigation their status for using their capacities to make jobs for subsistent persons by supporting from Supportive Organizations committee;
- Investigation and identifying production plans and raw materials that need for big industries;
- Investigation the demography status and immigration type in different regions of country.

11. SELECTING THE INCOME MAKING APPROACH IN SELF ADEQUACY PLANS

FOR PERFORMING THIS POLICY, follow programs and activities were predicted.

- The program of enhancing quality level of subsistent persons' products;
- Codifying production standards for subsistent persons;
- Directing the subsistent persons toward working in traditional and native industries in villages;
- Increasing per capita of payable loans;

- Reclamation the potential features of subsistent persons and their family members in villages;
- Creating seasonal exhibitions and stores in provinces centers;
- Providing a program for presence of subsistent persons in native different markets for introducing produced goods;
- The computer plan for recording data of income-cost relate to self preoccupation plans.

12. PROVIDING NEEDED CREDIT FOR PERFORMING PLANS OF JOB MAKING BY USING BANK LOANS, PUBLIC PARTICIPATIONS AND RELATED ORGANIZATIONS

For exploiting the bank loans, public participation and other related organization in making and developing useful plans of job making for subsistent persons, the following programs and activities were predicted.

- Paying bank loans to subsistent persons under cover of committee;
- Paying a part of revenue and wage of bank loan as bounty;
- Identifying benefactors for investment in job making;
- Assigning some public incomes to preoccupation plans;
- Attraction program for investments in preoccupation sector;
- The program of making industrial centers with aim of abandoning them to subsistent persons in long term.

13. JOB FINDING FOR READY TO WORK SUBSISTENT PERSONS

For performing this policy, the following programs and activities were predicted and now are undergone.

- Finding jobs for subsistent persons under cover of Supportive Organizations(those are ready to work);
- Performing intern program for university graduates;
- Creating job finding and job council centers in different regions of country;
- Interaction with employers (offering required trainings to employed forces, paying a part of insurance).

14. CREATING COOPERATIVE, COLLECTIVE AND ORGANIZED PLANS

For performing this policy, the following programs and activities were predicted.

- Paying a part of gifted loans' revenue to subsistent persons that want to create cooperative firms;
- Establishing and operating the pervasive cooperative production firms for subsistent persons and those are in three first clusters of society;
- Developing the workshops for gathering and maintenance the products and creating workshops for packaging industries;
- Helping to subsistent persons' marketing in cooperative sectors;
- Offering required trainings in subsistent persons' cooperative firms;
- Exploiting the financial loans as incoming share of subsistent persons in collective plans for more exploiting of bank loans;
- Sympathy with subsistent persons in performing collective plans until exploiting stage and later supervisions.

15. MAKING EFFECTIVE SOLUTIONS FOR INSURANCE OF JOB STABILIZING EXECUTORS

For making effective solutions for providing optimum future of family and maintaining the capital and guarantee the products and for insurance the plans and inclusive families and for trustable marketing for introducing products favorably, the following programs and activities were predicted.

- Social insurance program for active subsistent persons and executors of preoccupation plans;
- Establishing the insurance for reimbursement the loans;
- Establishing the events insurance including livestock insurance, agricultural products insurance, aquatic animal and fishes nurturing, guild jobs and industries insurance; third person and car body insurance for executors of transport plans;
- Payment program for employer share of insurance for subsistent persons that have job.

16. HELPING FOR MARKETING AND SELLING THE PRODUCTS

- Directing the executors toward performing those plans that are along with current needs of market and future requirements of consumers;
- Providing a context for introduce those subsistent persons' products that have presence capability in national and abroad markets;
- Providing the strategic marketing plan and systematic sell for increasing the presence share of subsistent persons' products in regional, city, provincial, national and abroad markets;
- Creating different exhibitions for produced goods in national and abroad levels.

17. HELPING TO FORM PRODUCT CHAINS AND CLUSTERS

- Identifying the jobs that can be transform to clusters
- Justifying practitioners for clustering
- Organizing the executors within clusters

Supportive Organizations along with assigned tasks offered valuable services in framework of economical empowering to poor peoples and other unemployed persons from 2005 to end of 2011 that the main of them discussed in follow. The vocational trainings in Supportive Organizationshave a high prefer and experts in this committee try to identify the potential gifts of subsistent persons and by enhancing their vocational skills and scientific level direct them in a manner so they can learn necessary techniques and sciences and transform from a job seeking person to an active and entrepreneur person. In this regard the assistant of preoccupation and self adequacy sector agreed with providing training possibility for 1068472 subsistent persons from 2005 to end of 2011. These were offered as preliminary trainings (585659 persons) and supplementary trainings (482813 persons) so that 48% of them were women and 52% were men.

Table2: Number of trained persons during 2005-2011

Year	Preliminary trainings			Supplementary trainings			Total trained subsistent persons
	Woman	Man	Total	Woman	Man	Total	
2005	285	3310	6167	354	399	7534	137025
2006	247	2795	5273	302	341	6445	117193
2007	298	3978	6966	386	511	8979	159458
2008	3146	2617	5764	404	509	9138	149028
2009	5624	5012	1063	206	292	4992	156299
2010	590	5473	1137	157	263	4216	155914
2011	6933	5447	1238	390	306	6974	193555
total	299310	286349	585349	220432	262381	482813	1068472

18. CREATED JOB OPPORTUNITIES

Social workers of this committee from 2005 to end of 2011 created more than 615000 job opportunities for subsistent persons and other needy and unemployed people through performing self adequacy and preoccupation plans that 5.6% of them are in gardening and agriculture field, 31.8% in livestock nurturing field, 0.3% in fishery, 12% in handicraft industries, 16% in mineral and industrial activities, 27.9% in service sector and 6.4% in other activities.

Table3: Number of entrepreneurship plans that performed by credit provided by Supportive Organizationsand other resources (based on job activity and year and kind of economical activity)

Activity group	2005	2006	2007	2008	2009	2010	2011	Total
Agriculture	3817	3907	4291	2617	3356	3919	12135	34042
Livestock and poultry	1398	19217	2278	8626	1786	24616	88616	195713
Fishery	319	250	232	102	151	276	367	1697
Handicraft industries	5018	6427	6784	6984	4986	3948	39858	74005
Industrial	9956	14890	1363	6662	11050	12831	30149	99173
Services	3876	1880	2260	10668	19036	23344	73063	171399
Other	1944	3993	3507	1932	2823	2692	22274	39165
Total sum	38918	67488	73838	37591	59271	71626	266462	615194

19. CONCLUSION

Through empowering it can prepare a primary and proper bed for making a small job and work starting in susceptible persons. Of course is should be defined the proper process from start to supporting and stabilizing stage of each job that these are determined in model offered here. Performing the self adequacy and preoccupation plans in addition to empowering the subsistent persons influenced on many factors that its different results are completely visible. Among the positive effects of this action we can mention to creating culture of effort and work, self belief, self confidence among individuals and families that are covered by Supportive Organizations and these plans created happiness and expectancy to a better future in executors and families of subsistent persons and made an equal opportunity for them in economical and social contexts so in turn had an significant effective role in growth and self adequacy of them. Of course the social effects of this plan are too, and performing this plan in addition to preoccupation and enhancing the economical power of families cause to reclamation and social development in villages and economical thrive in regions. Preoccupation of unemployed subsistent persons through job finding is considered as a favor method because with least capital (offering vocational trainings) and by using empty capacities of executive organizations, it can make jobs for job seeking subsistent persons. The assistant of preoccupation and self adequacy department in addition to entrepreneurship and making more than 615000 job opportunities (from 2005 to end of 2011), throve to provide job opportunities for 105786 persons of unemployed young men through job finding method. The statistical of unemployed graduates show that most of them due to lake the experience or un adaptation between their field and work market needs can not be attracted to services and production units. Thus for resolving some these problems, performing the intern and novitiate plan for university graduates started in 2007 after that approved in supreme council of preoccupation.

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CYBER PHYSICAL MANUFACTURING – INTEGRATED QUALITY APPROACH

Vidosav Majstorovic[1], Jelena Macuzic[1], Slavenko Stojadinovic[1], SrdjanZivkovic[2], TatjanaSibalija[3], Valentina Marinkovic[4]

[1]University of Belgrade,Faculty of Mechanical Engineering, Belgrade, Serbia; [2]Military Institute, Belgrade, Serbia; [3]Metropolitan University, Faculty of Management, Belgrade, Serbia; [4]Belgrade University, Faculty of Pharmacy, Belgrade, Serbia;

Abstract. *Cyber-Physical Manufacturing System (CPMS), relying on the newest and foreseeable further developments of computer science, information and communication technologies, on the one hand, and of manufacturing science and technology, on the other hand, may lead to the 4th Industrial Revolution. In order for that to happen we must face the challenges of operating sensor networks, handling big bulks of data, as well as the questions of information retrieval, representation, and interpretation, with special emphasis on security aspects. Novel modes of man-machine communication are to be realized in the course of establishing CPMS.In our Laboratory, in CPMSs we doingnext researches areas: (i) Digital Manufacturing – Towards Cloud Manufacturing (base for CPMS), (ii) CPMS – Cyber-Physical Quality Model (CPQM) our approach and (iii) Intelligent model for Inspection Planning on CMM as part of Cyber-Physical Manufacturing Metrology Model (CPM3) concept. In this paper we shall show some research results for these areas.*

Key words:*Cyber-Physical Manufacturing, Quality, CMM.*

1.INTRODUCTION REMARKS

Digital quality, as a key technology for CPMs represents virtual simulation of digital inspection in digital company, based on a global model of interoperable products (GMIP). GMIP represents the integration CAD-CAM-CAI models in the digital environment. The essence of this research is solved the concept of metrology integration into GIMP for the coordinate measuring machine (CMM) inspection planning, based on CPM3 [8-11,12a,30].Today's business structure is much more complex and dynamic than ever before, because market demands of the industry's rapid changes in new products, which is directly reflected in the factory. On the other hand, digitalization and information technology (IT) provide new, unimagined possibilities, engineers in the field of design and planning. The two approaches have led to two concepts that have since emerged: digital factory and digital manufacturing [1,23,24,30].

For a manufacturing system with typical machining operations, factory-wide engineering knowledge integration requires an connection CAD-CAPP-CAM-CNC-CAI and integration with other production-related information systems such as enterprise resource planning (ERP), manufacturing execution system (MES), advanced planning and scheduling (APS), etc [25,30]. A standard for the exchange of product data model (STEP), along with a STEP compliant numerical control (STEP-NC), has been developed to enable integration and exchange of design and manufacturing numerical data. STEP is based on feature technology, and it provides a neutral and interoperable format of product data, independent of any system and suitable for transfer, processing and communication among different systems. Feature technology provides us to associate not only geometric and topological information, but also form features and tolerances that could be used in CAD-CAPP-CAM-CNC-CAI chain [4,8-11,26-30].

2.CYBER PHYSICAL MANUFACTURING SYSTEMS (CPMSs) - BASIC CONCEPT

Developed and implement ’’advanced manufacturing concept’’ as a base for Cyber - Physical Manufacturing Systems (CPMSs), will be to evolve along five directions [13,18-22,27,28,30]: (i) on – demand manufacturing: Fast change demand from internet based customers requires mass-customized products. The increasing trend to last-minute purchases and online deals requires from manufactures to be able to deliver products rapidly and on-demand to customers; (ii) optimal and sustainable manufacturing: Producing products with superior quality, environmental consciousness, high security and durability, competitively priced. Envisaging product lifecycle management for optimal and interoperable product design, including value added after-sales services; (iii) human - centric manufacturing: Moving away from a production-centric towards a human-centric activity with great emphasis on generating core value for humans and better integration with life, e.g. production and cites; (iv) innovative products: From laboratory prototype to full scale production – thereby giving competitors a chance to overtake enterprises through speed, and (v) green products: for example Manufacturing Strategy 2020/30 needs focused initiatives to reduce energy footprints on shop floors and increase awareness of end-of-life (EoL) product use, and there are framework for CPMSs.The merging of the virtual and the physical worlds through CPSs and the resulting fusion of manufacturing processes and business processes are leading the way to a new industrial age best defined by the INDUSTRIE 4.0 project’s “smart factory” concept [7,27-30].

Smart factory manufacture brings with it numerous advantages over conventional manufacture, as example [3,6,27-30]: (i) CPS - optimized manufacturing processes: smart factory “units” are able to determine and identify their field(s) of activity, configuration options and manufacture conditions as well as communicate independently and wirelessly with other units; (ii) Optimized individual customer product manufacturing via intelligent compilation of ideal production system which factors account product properties, costs, logistics, security, reliability, time, and sustainability considerations; (iii) Resource efficient production; and (iv) Tailored adjustments to the human workforce so that the machine adapts to the human work cycle.

3.RESEARCH IN THE FIELD OF CYBER-PHYSICAL MANUFACTURING QUALITY MODEL IN OUR LAB

Feature-based technology and STEP standard could be considered as a main integrator in terms of linking the engineering and manufacturing domain within various CAx systems. To specify the part data representation for a specific application, STEP (ISO 10303) uses Application Protocols (AP). Beside STEP APs, the following standards and interfaces are important for CAI. A vendor-independent Dimensional Measuring Interface Standard (DMIS) provides the bidirectional communication of inspection data between systems and inspection equipment, and is frequently used with CMMs. It is intermediate format between a CAD system and a CMM’s native proprietary language[11,26],

Dimensional Markup Language (DML) translates the measurement data from CMMs into a standardized file that could be used for data analysis and reporting. I++ DME-Interface provides communications protocol, syntax and semantics for command and response across the interface, providing a low level inspection instructions for driving CMMs [15,16], On Fig. 1. show the working process with the integration of design, production and coordinate inspections. Master Assembly represents the mechanical assembly with all associated parts. This assembly consists upper and lower tools and wind turbine. The experiment was done on the bottom of the tool CAM or CAI is executed in a separate part-file that consists the original geometry of the part. Only this way it is possible to make changes on the original geometry that can reflect on some of the engineering activities. Part file CAD/CAM is usually obtained as STEP AP203 or AP214. It represents the basis for the preparation of manufacturing technology. At the same time a geometry inspection is being prepared so that when a part is manufactured, its inspection can be implemented on the CMM. As an output from CAD/CAM, STEP AP203/214 is obtained which is the input for PC-DMIS Wilcox. S/W Wilcox PC-DMIS uses its integrated translator to convert it into DMIS format. At this stage GD&T and the motion of measurement probe are defined. Based on the acquired measurements, „DMIS output“ was generated which can be a printed report or STEP too, but now with measured geometry. This STEP can be loaded again into a CAD/CAM system or some other coordinate system for inspection, and contents for the same part of DMIS file (Figure 14), give procedure CMM inspection.

The measurement was performed in Decartes coordinate system XYZ and measurement analysis is presented in the on Fig. 2. Measured values should be within a tolerance field +0.15mm -0.35mm as shown in the flowchart with a blue dashed line.Blue solid line represents the theoretically ideal surface while the red line represents the measured value. By analyzing the flowchart, we can conclude that the measured values are within the limits of the tolerance field.

The analysis of the measured values indicate that the measured surfaces are within the limits of specified tolerance field.

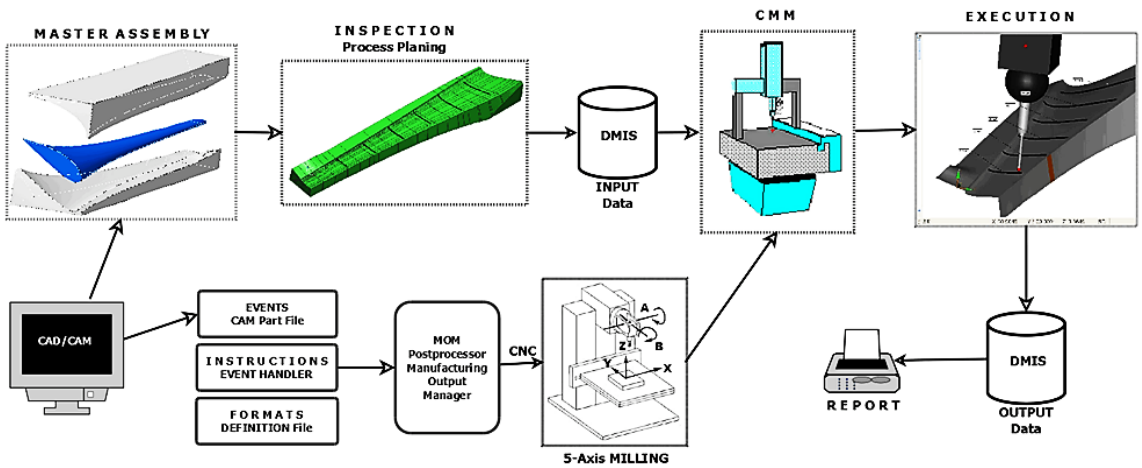

Figure1. Process with the integration of design, production and CMM inspections

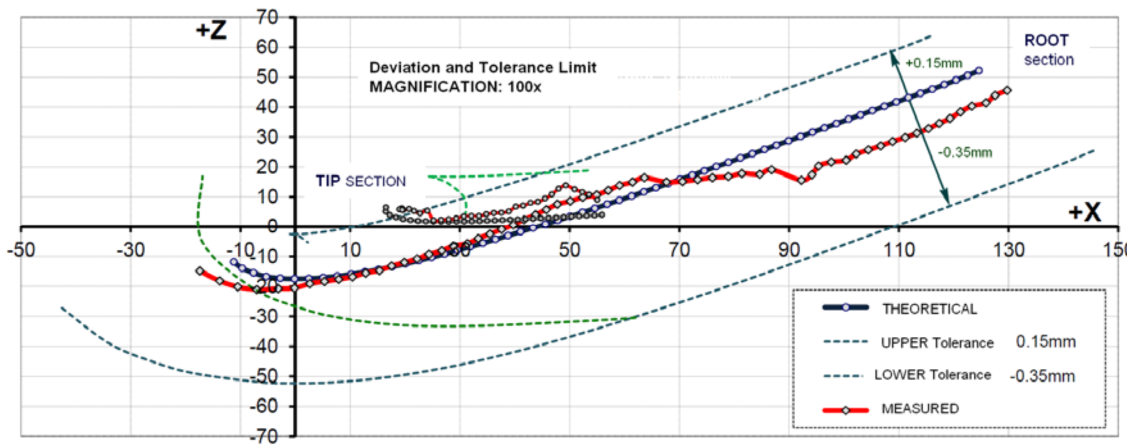

Figure 2. Graphical presentation of measurement results

The development Intelligent model for Inspection Planning (IMIP) for prismatic parts involve following activities: (i) development ontological knowledge base presented in [12,16]; (ii) local and global inspection plan, and (iii) optimize path of measuring sensor. Output from the local and global inspection plan (LGIP) is initial measuring path. The first element LGIP's is sampling strategy or model for the distribution of measuring points for features presented in [14-16], and second element define the principle for collision avoidance between workpiece and measured probe. By modifying the Hemmersly sequences [17], we define the distribution of measuring points for basic geometric features such as plane, circle, cylinder, cone, hemisphere, truncated hemisphere and truncated cone.

4.CONCLUSION

In the first part of the research it was shown SPMSs for quality as a CAI model, it is important to consider the newly developed AP242 that is designed to improve the interoperability in STEP, support model-based GD&T and allows for CMM programming based on the inspection features. AP242 enables 3D product manufacturing information (PMI) with semantic representation and 3D model-based design and data sharing on service-oriented architecture (SOA).

The complex geometry of the PP by IMIP changes to the set of points whose sequence defines the measuring path of sensors without collision with workpiece. Presenting measuring path by set of points with a defined order is optimizing by solving TSP with ants colony. Finding the shortest measuring path, the main criteria for optimization, influence to the reduction of the total measurement time, which is one of the goals of this research. The ISIP is especially suitable for use in case of measuring path planning for geometrically complex PPs with large numbers of tolerances. The simulation provides a visual check of the measuring path.

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ISO 50001 AS A TOOL TO ESTABLISH AN ADEQUATE ENERGY MANAGEMENT SYSTEM

Milovan Medojevic[1], Jovan Petrovic[1], Nenad Medic[1], Milana Medojevic[1]
[1]Faculty of Technical Sciences, University of Novi Sad, Serbia

Abstract. The aim of this paper is to point out the possibilities that ISO 50001, as a powerful tool, brings in order to define more closely the role and connections of the relevant government and state services, other international standards and regulations in the process of establishing and implementation of energy management systems. The concept of energy management is widely accepted in the progressive world and is the basis for rational energy management, continuous increase of energy efficiency, integration of renewable energy sources, environmental protection to reliably satisfy the energy needs and economically responsible behavior in part of any energy consuming sector.
Key words: Energy Efficiency, Energy Management System, ISO 50001.

1.INTRODUCTION

Energy Management Systems (EnMS) have emerged over the last two decades as a proven best practice methodology to ensure sustainable and progressing energy efficiency performance in industrial enterprises as well as in other organizations [1-5]. EnMS outlines a structured and systematic approach on how to integrate energy efficiency in an enterprise management culture and daily practices providing a framework for understanding energy use and consumption; Action plans to continually improve energy performance, including energy systems and production processes; Metrics to track and quantify energy performance against a baseline of energy consumption as well as Data and documentation to sustain and demonstrate energy performance improvements over time. In addition, EnMS seek to apply to energy use and consumption the same culture of continual improvement that has been successfully used by organizations to improve quality, environmental and safety practices. Since 2000 national EnMS standards and associated certification schemes were developed in a number of countries and proved to be an effective policy-driven, market-based mechanisms to promote dissemination of energy management best practices in variety of organizations and to support energy efficiency. Taking stock of the good results achieved through EnMS and standards at national level, in 2007 UNIDO launched a global initiative to advocate and promote the development of an international/ISO energy management system standard [3]. This initiative created the momentum for and catalyzed the ISO process that subsequently led to the release of ISO 50001 Energy management system – Requirements with guidance for use [6].

2. THE REASONS FOR INTRODUCING THE ENERGY MANAGEMENT SYSTEM

There are many reasons for establishment and implementation of EnMS while the most important ones are related to energy, economic and environmental issues.

2.1 Energy reasons for introducing the energy management

Only the introduction and regular, systematic and planned practice in implementation of activities of energy management systems guarantee a long-term, continuous and effective results in increasing energy efficiency and ongoing rationalization of energy resources utilization. This contributes to the conservation of existing energy resources, extended the service life of fossil fuels and reduction of the total required amount in energy balance at national, regional, local and micro level.

2.2 Economic reasons for introducing the energy management

Well-established and implemented energy management system represents the guarantee in the energy costs minimization process. This applies equally to individual, local to national, regional and international levels. Reducing the required amount of useful energy simultaneously reduces costs of purchased energy or fuel. This, in the case of an industry, means less resource allocation for these purposes and the "liberation" of a part of energy expenses for other purposes.

2.3 Environmental reasons for introducing the energy management

Any reduction of energy losses and need for final useful energy, as well as by applying activities of the energy management, leads to a reduction in the amount of fuel to be combusted in the process of securing final energy. The direct result of this is reduction in emissions of combustion products that creates the greenhouse effect, reducing the energy share in the existing climate change, environmental and any other balance changing process on the Earth and in general reduction of environmental pollution. It is the most direct interest of each individual, stakeholder and community from the local to the broadest international community. As energy management practice entails the introduction of renewable energy sources, thus, their use, further contribution to environmental protection will be ensured.

3. THE ROLE OF THE STATE AND REGULATION, SERVICE ENTERPRISES AND ISO 50001 IN THE ESTABLISHMENT OF EnMS

The primary role of the state in the establishment of the energy management system is to create a proper environment for the introduction and effective functioning. What does that mean? In the first place is certainly a leadership role in establishing EnMS, which must be expressed to the moment when the process enters the regular routines of all energy users and relevant subjects for EnMS. To achieve this goal, countries should adopt adequate energy policy and establish the regulatory environment and framework that prescribes rules in terms of competences, rights and obligations, procedures, technical, logistic, personnel and other conditions for implementation and management of EnMS. For example, the Republic of Serbia has ensured adequate basis for the introduction of EnMS by improving the current Energy Law and introducing the Law on the efficient use of energy as well as by introducing secondary legislation through the 12 Rulebooks to further regulate this area. Formally and legally all conditions for the start of EnMS practice are fulfilled. Forthcoming practical step is setting of energy management services, training of personnel (Energy managers and authorized energy advisors), while within the secondary regulations additional regulations for this area were adopted [5]. In the case of companies, in establishing and maintaining practices of EnMS competent authorities and the responsible persons should fully cooperate with other services of the enterprise. Maintenance and quality services of an enterprise have a particularly important role in the establishment and proper functioning of EnMS. A good and continuous cooperation with the maintenance service, regardless of whether it is internal or external, is a guarantor of the preservation of the existing view of energy performance systems and subsystems in the company. Therefore, the energy manager must have a horizontal connection directly with the most competent entity responsible for maintenance service with defined responsibilities. On the lower hierarchical levels, persons responsible for maintaining and team members responsible for specific objects in EnMS should be in direct mutual contacts to exchange relevant information on changes in performance or any other changes in the building, which are in their jurisdiction while simultaneously informing the vertical structure on competence and responsibility. It is particularly important and can be very prolific the good collaboration with company's service for quality. This service has a number of tasks, which somehow overlap, while its jurisdiction is very similar and in touch with certain steps in the establishment and functioning EnMS. Therefore the support and good cooperation with this important service is prerequisite for efficient EnMS operation. This particularly applies to all activities during the establishment of the system and performance of control functions. For instance, quality service can have a decisive role in the introduction of standards in the implementation of the EnMS. In addition, one of the most important standards in the implementation of EnMS is the ISO standard 50001.

ISO 50001:2011 specifies requirements for establishing, implementing, maintaining and improving an EnMS, whose purpose is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy use and consumption. ISO 50001:2011 specifies requirements applicable to energy use and consumption, including measurement, documentation and reporting, design and procurement practices for equipment, systems, processes and personnel that contribute to energy performance. ISO 50001:2011 applies to all variables affecting energy performance that can be monitored and influenced by the organization. ISO 50001:2011 does not prescribe specific performance criteria with respect to energy. It is designed to be used independently, but it can be aligned or integrated with other management systems. ISO 50001:2011 is applicable to any organization wishing to ensure that it conforms to its stated energy policy and wishing to demonstrate this to others, such conformity being confirmed either by means of self-evaluation and self-declaration of conformity, or by certification of the energy management system by an external organization.

4. THE BASICS OF EnMS PROCESS

Whether following a customized approach or the ISO 50001 standard, the basic EnMS process is based on the Plan-Do-Check-Act continual improvement framework (Figure 1.)

Figure 1 - Plan-Do-Check-Act continual improvement framework

Here Plan means to conduct energy review and establish the baseline, benchmark against similar sites, set objectives and targets, develop resources and action plans necessary to deliver results in accordance with the organization's energy policy. Do means to implement the action plans. Check means to monitor and measure processes, review the level of target achievement and the effectiveness of the EnMS against the objective of the energy policy. Finally, act means to recognize achievements, take action to continually improve energy performance and the EnMS, as well as to derive new objectives. This Plan-Do-Check-Act framework provides a procedure for companies to:

- Develop a policy for more efficient use of energy;
- Fix targets and objectives to meet the policy;
- Use data to better understand and make decisions concerning energy use and consumption;
- Measure the results;
- Review the effectiveness of the policy; and
- Continually improve energy management.

Within the Plan-Do-Check-Act framework the successful implementation of an EnMS depends on a sequence of steps to ensure the process of continuous improvement is achieved (Figure 2.).

The key steps of the process are senior management commitment (Step 1), and having an accurate baseline of energy use (Step 4). No EnMS will work effectively without the commitment of senior management and energy savings are very difficult to achieve and verify without having an in-depth understanding of the current energy usage on-site.

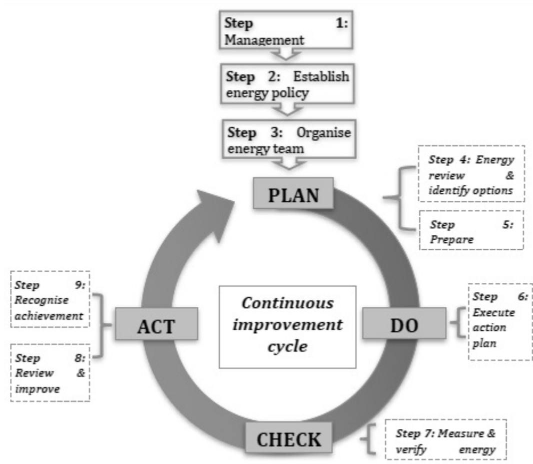

Figure 2 - Illustration of the EnMS Plan-Do-Check-Act framework

5. THE POSSIBILITY OF ISO 50001 INTEGRATION WITH OTHER MANAGEMENT SYSTEMS

ISO 50001 is based on common elements of ISO management system standards that ensure a high level of compatibility between ISO 9001 and ISO 14001. As a result, organizations that already have ISO 9001 or ISO 14001 can easily integrate the ISO 50001 system in its existing structure. ISO 9001 is a quality management system that provides organizations a systematic approach to meet the objectives of customers and quality assurance. On the other hand, ISO 14001 system for environmental management, provides a system for measuring, evaluating and improving influence of the organization on the environment. What should be bared in mind is a key difference between ISO 14001 and ISO 50001, which is that standard ISO 50001 yet detailed focuses on only one aspect of the environment - the energy use, oriented to the possibility of achieving financial savings, while standard ISO 14001 covers all aspects of the environment equally, oriented exclusively to environmental protection. Energy is by ISO 50001 recognized as very important and in this way separated from issues of environmental protection with the aim not only to reduce its consumption and environmental impact but also because of cost rationalization that leads to better competitiveness of products and services on the market. Having in mind that ISO 50001 is compatible and desirable for integration with ISO 14001, it can be also implemented and conducted with the EMAS (Eco Management and Audit Scheme) and LEED (Leadership in Energy and Environmental Design) certification programs. EMAS is a voluntary program for managing the environmental protection and control, which enables organizations to verify their system of environmental management in accordance with the relevant Regulation of the European Parliament and the Council. EMAS includes all the requirements of ISO 14001 standard, as well as additional requirements (more "austere" then the ISO 14001). LEED is an internationally recognized mark of excellence that provides owners and operators of facilities framework for the identification, implementation, evaluation and design of "green buildings", including the construction, operation and maintenance. When an organization implements the EnMS, it needs to ensure that the key characteristics of its operations that determine energy performance are being monitored (Section 4.6.1 "Monitoring, Measurement and Analysis"). This section is a key component of the LEED program. Furthermore, it is also desirable to integrate and simultaneously implement other standards from ISO 50000 series [5,7].

6. CONCLUSIONS

The introduction and effective functioning of the energy management system is the basis for changes in energy-efficient, sustainable and environmentally friendly energy utilization. The detailed international regulatory environment for this already exists, while the Republic of Serbia is in the final stages of realization of conditions for its proper implementation. In addition to the regulatory environment, human resources are crucial for the complete success of this activity where it is needed to be very careful in setting the criteria for selection and development of all levels of staff, giving the authorization, control and verification of all activities, transitory and final results. If true significance hasn't been provided, all the effort and results could be challenged and ultimately depreciated. Without effective progress in the implementation of EnMS formal restrictions in the process of Serbia's EU accession could occur, while expensive energy and the high specific energy consumptions could become a serious threat to the development of our economy.

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EMPLOYEES MOTIVATION AND TRANSITION OF ISO 9001 QMS TOWARDS TQM

Marija Stanojeska[1], Robert Minovski [2], Zvonko Sajfert[3], Dragan Ćoćkalo[3], Sanja Stanisavljev[3], Bojan Jovanoski[2]
[1]Zito Polog AD, Tetovo, Macedonia,
[2]Faculty of Mechanical Engineering, University of Cyril and Methodius, Skopje, Macedonia
[3]Technical faculty "Mihajlo Pupin", Zrenjanin, University of Novi Sad, Serbia

Abstract. *Employees motivation enables improvement in the effectiveness of the implementation process of Total Quality Management (TQM). Orientation towards process and their control, without significant emphasis of the employees, generates problems with the team work and communication, failure to meet or delaying of deadlines, increasing the total costs etc. Emplyee motivation means incentive for their complete and dedicated inclusion in the operation that contributes towards improved quality implementation of the TQM practices in a shorter period of time. Although aforementioned aspects are treated in the literature, still, the influence of the employees motivation on the transition from ISO 9001 QMS towards TQM is almost not covered at all. In that direction, the main objective of the paper is to create a generalized conceptual model for considered transition. For that sake, identification of the influential factors of ISO 9001, TQM and employees motivation as well as their analysis and determination of the most influential factors is carried out. The final set of factors is used as initial set of variables for creation of generalized conceptual model. The model introduces the correlation dependencies between the variables of treated areas. The created conceptual model in the advanced research will serve as a basis for design of a dynamic SD model which will enable experimentation in direction of transition of ISO 9001 towards TQM practices depending on the motivation of employees.*

Key words: *TQM, ISO 9001, transition, employees motivation.*

INTRODUCTION

In the contemporary dynamic environment, the traditional business organizations are not capable of coping with the challenges of the modern corporate operations. Advanced managerial concepts emerged in many world-class companies as mechanisms for reaching the objectives. One of them is the Total Quality Management (TQM). Oakland (1995) defines TQM as an approach for market sustainability of the organisations which improves the efficiency, flexibility and the working competitiveness, and for which meeting the clients' requirements represents a major objective. The TQM implementation enables the organizations the ability for rapid adaptation to the changes in the environment, which enables TQM organizations to become competitive on the global market. Quality management systems like the ISO 9001 standard in many organisations represent additional stimulation for further TQM development. The ISO 9001 standard became commonly accepted in the management of the organizations. Indeed, with the ISO 9001 standard, organisations demonstrate quality and confidence while meeting the expected requirements of the clients. Adequate preconditions are needed for introduction of advanced managerial concepts. Employee motivation is one of them. Inclusion of employees gives them an opportunity to improve their personal abilities, to gain appropriate knowledge, to increase their confidence, to express the individual creativity and to participate in solving specific problems. The opportunity to participate represents an inspiration for active engagement of the employees, thus generating drastic quality approach change in their performance. TQM philosophy represents an integral part of the creation of a climate in which employees are encouraged to locate the quality problems and find a solution for them.

CONNECTION BETWEEN TQM, ISO 9001 AND EMPLOYEE MOTIVATION

Numerous studies in the last period are oriented towards determination of the connection between the ISO 9000 series and the human resources management in the context of quality management (Spasojević-Brkić, 2009). Papers that are of concern are found by searching the literature available at Ebsco and Scopus. Key words of the research are the following: connection, TQM, ISO 9000, employees motivation. The paper of the author Martinez-Costa (2008) investigates the connection between the TQM and the ISO 9000 series, their reflection on the performance and implementation motive, however, it does not treat the level of effective operation of ISO 9001 as a basis for transition to TQM. In the paper of Brown et al. (1996) it was concluded that the motive for certification of the ISO 9000 series stimulates the introduction of the TQM concept. Thus, the role of the top management whose responsibility is to provide adequate training for the employees for transition from the ISO 9000 series towards the TQM is emphasized. The paper of Sila and Ebrahimpour (2003) claims that the top management plays a crucial role in the successful implementation of the TQM within the organizations. A similar view is confirmed in the paper of Fotopoulos et al. (2010), which states that the role of the top management in the application of the TQM practices in the performance is significant. However, the inclusion of employees is not treated. According to Pool (2000), the implementation of the TQM principles in organisations with developed organisational culture is proportionally dependenton the organizational learning, which enables successful start in introducing advanced methodologies. The view of Rice (1993) is that “only the employees can improve the process, and just only if they are motivated”. Tang et al. (2010) highlights that TQM practices increase loyality of the employees, which leads towards increasing of their level of satisfaction. Chen (2009), represents similar views in his study. The continuous improvement within the organisations is enabled through introduction of mechanisms for motivation of the employees, according to Swartling (2013).

In the reviewed papers the assumption suggests that the introduction of ISO 9001 is a precondition for transition into TQM and the motivation of the employees has a positive impact on the successful implementation of TQM. This brief literature overview brings several conclusions. The successful operation of ISO 9001 is a precondition for integration of TQM practices in the organization. The role of the employees as operation carriers can be of significant importance in the process of transition from ISO 9001 to TQM within the organizations. Therefore, inclusion of employees should be continuously encouraged and strengthened. Motivation is the mechanism that can increase the involvement and dedication of the employees in the process of transition from ISO 9001 to TQM. Still, no papers with structuralized generalized conceptual model of the transition from ISO 9001 towards TQM depending on the motivation of the employees, have been found.

RESEARCH METODOLOGY

In order to identify influential factors, analysis of the literature in the field of TQM, ISO 9001 and employee motivation has been conducted. Upon identification of numerous key factors, a selection of the most influential factors has been made and the connection between them has been studied. In the following step, the conceptual model for the transition from ISO 9001 towards the TQM depending on the motivation of the employees has been created.

IDENTIFICATION OF THE INFLUENTIAL FACTORS IN THE AREA OF TQM, ISO 9001 AND EMPLOYEE MOTIVATION

After the conducted comprehensive research of the literature based upon Emerald, Scopus and Ebsco, in the period from August 2012 to February, 2015, a total of 25 papers in the area of TQM, published in English, have been found, according following key words: TQM, elements, influential factors and critical factors, used during the research. Eight TQM influential factors, whose importance is confirmed by various authors, have been identified (Table 1).

Table 1. TQM influential factors

TQM influential factors	Literary source
Strong commitment of top management	Soltani (2005), Talib et al. (2010), Kanji (2001), Saraph et al. (1989), Flynn et al. (1994), Anderson et al. (1994), Chase (1993), Yasamis et al. (2002), Black et al.(1996), Koh et al. (2009), Burati et al. (1992) Spasojevic-Brkic et al. (2012).
Customer focus	Oakland (1994), Flynn et al. (1995), Ahire et al. (1996), Chase (1993), Yasamis et al. (2002), Black et al.(1996), Koh et al. (2009).
Employee involvement	Randy (1993), Chang (2010), Chen (2009), Psychogios et al. (2009), Dubey (2012), Swartling et al. (2013), Pool (2000), Saraph et al. (1989), Ahire et al. (1996), Arawati (2005), Chase (1993), Yasamis et al. (2002), Black et al.(1996), Koh et al. (2009), Burati et al. (1992).
Supplier management	Zhang et al. (2000), Saraph et al. (1989), Flynn et al. (1994), Ahire et al. (1996), Chase (1993), Yasamis et al. (2002), Black et al.(1996), Koh et al. (2009), Burati et al. (1992).
Quality information management	Flynn et al. (1994), Saraph et al. (1989), Ahire et al. (1996), Yasamis et al. (2002), Black et al.(1996), Koh et al. (2009), Burati et al. (1992).
Process management	Mardani et al. (2012), Yasamis et al. (2002), Black et al.(1996), Koh et al. (2009), Chase (1993)..
Organizational learning	Senge (1990), Edmondson et al. (1999), Andersson (2011), Barson et al. (2000), McLaughlin et al. (2008), Sila et al. (2002), Black et al.(1996).
Continuous improvement	Das et al. (2008), Pheng et al. (2004), Juran et al.(1995), Powell (1995), Anderson et al. (1994), Crosby (1979), Chase (1993), Yasamis et al. (2002), Black et al.(1996), Koh et al. (2009), Burati et al. (1992).

TQM concept is based on quality management principles of ISO 9000 series of standards, which are stimulation for further implementation of TQM. The eight quality management principles of ISO 9000 series are:

1. Customer focus
2. Leadership
3. Involvement of people
4. Process approach
5. System approach to management
6. Continuous improvement
7. Factual approach to decision-making
8. Mutually beneficial supplier relationships

The influential factors in ISO 9001 are listed in the requirements of the quality system i.e. they are included in the items of the standard and referring to Table 2.

Table 2. ISO 9001 influential factors

ISO 9001 influential factors	Point
Responsibility, authority and communication	5.5
Planning	5.4
Management review	5.6
Resource management	6.1
Human resources	6.2
Infrastructure	6.3
Work environment	6.4
Planning of product realization	7.1
Customer – related processes	7.2
Design and development	7.3
Purchasing	7.4
Production and service provision	7.5
Monitoring and measurement	8.2
Conform of nonconforming product	8.3
Analysis of data	8.4
Measurement, analysis and improvement	8.5

If employees are familiar with the benefits of TQM, their motivation to participate in the TQM implementation is on a higher level. Research of the literature based upon Ebsco and Scopus, in the period from July, 2014 to February, 2015 has been conducted in order to identify the influential factors in the area of motivation of employees. A total of 29 papers published in English have been found, according to key words: motivation, involvement, satisfaction and employees. It has been determined that the authors are oriented towards researching the effects of the different factors that affect the motivation of the employees and are represented in Table 3.

Table 3. Employees motivation influential factors

Influence factor of employee motivation	Literary source
Training	Chapman (1991), Daily (2003), Hynes (2012), Miller (2006), Spasojevic-Brkic et al. (2012).
Teamwork	Murphy et al. (1996), Daily (2003), Pietrese (2013), Osterloh (2002), Spasojevic-Brkic et al. (2012).
Empowerment	Manzoor (2011), Baldoni (2005), Hill (2004).
Rewarding	Aselstine (2006), Bonnie (2002), Rice (1993).
Working Environment	Korzinsky (2013), Yajaweera (2015).
Recognition	Manzoor (2011), Milne (2007).
Encouragement	Milne (2007).
Respect	Maslow (1954).
Well-being	Lu (1999), Sheperd (2013), Rice (1993).
Trust	Manzoor (2011), Jafri (2015).
Autonomy and skill variety	Hackman et al. (1976), Sultan (2012), Osterman (2001).
Job satisfaction	Chen et al. (2009), Elias (2012), Johnson (1997), Sultan (2012), Christ (2012), Yperen (2002), Chang (2010).

CONCEPTUAL MODEL OF TRANSITION

The identified influential factors in the area of TQM, ISO 9001 and the motivation of employees are used for the creation of the conceptual model presented in Figure 1. It can be noticed that the model is too complicated and up to a level of non-functionality.

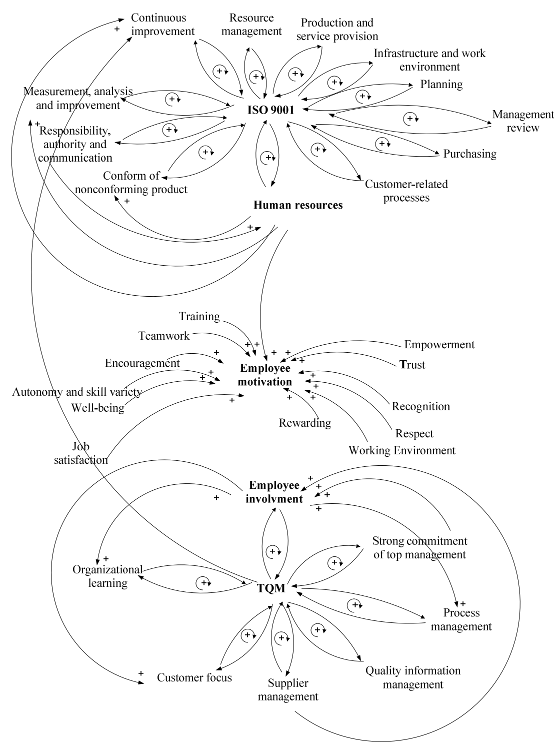

Figure 1. Conceptual model of transition from ISO 9001 towards TQM depending on the motivation of employee by all influential factors

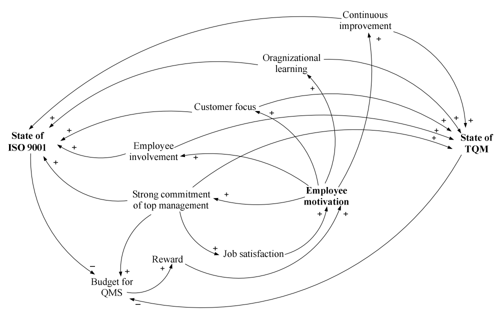

Figure 2. Conceptual model of transition from ISO 9001 towards TQM depending on the motivation of employee by critical factors

Therefore, a process for simplification of the model has been initiated, which means, assumption of the most critical influential factors and deciding which factors can be simplified due to their low-level impact on the treated area or because some of the factors are part of previously identified features. Factors with status “critical” are listed in the List of included factors (Table 4). All remaining factors that have a certain influence on the treated areas and which can be simplified in accordance with chosen criteria are part of the List for simplification (Table 5).

The conceptual model constructed only by the critical factors is presented in Figure 2:

The validation of the model of transition from ISO 9001 towards TQM under the influence of the motivation of employees is made based upon the existing studies with quantified correlation dependencies between most of the specific variables (Table 6).

DISCUSSION

Numerous influential factors have been identified in the study. The simplification enables a kind of filtration of the essential factors that have strongest influence on the treated problem out of all identified influential factors. In doing so, the study becomes oriented and strongly focused.

A total of eight influential factors have been identified in the area of TQM, out of which, five have been identified as critical and the remaining three factors have been evaluated as factors with an impact on the successful implementation of TQM. However, they are not of significant importance for the motivation of employees. Sixtheen influential factors have been identified in the area of ISO 9001. Nevertheless, each one of them represents an integral part of some of the TQM factors in accordance with the eight principles of quality management in the ISO 9000 series. Eleven factors that lead towards increase of the motivation have been identified in the area of motivation of employees. Only two factors (rewarding and work satisfaction) that can impact the increase of motivation in a short period of time have been separated due to their similar nature.

The positive mutual influences of the critical factors in the area of TQM, ISO 9001 and motivation of employees are presented in the conceptual model. It is obvious that the inclusion of the employees shall increase if their motivation is on a higher level. On the other hand, the motivation of the employees will increase through rewards and work satisfaction. The rewarding depends on available budget for the system of quality management, which positively affects to the state of the ISO 9001 and TQM. Based on the positive correlation it is very clear that the increase of the motivation will lead towards higher level of inclusion of employees, higher dedication of the top management, strengthening the focus on the clients, intensifying the organizational learning that leads towards continuous improvement of the quality management system, and generally improvement of the organizational performance. The states of TQM and ISO 9001 are negatively correlated with the budget for QMS, because the higher investment in QMS, cause budget cuts.

The validation of the model is made in accordance with literary sources. Thus, for most of the mutual connection between the variables certain correlation dependencies studied from different authors have been found.

CONCLUSION

From the created conceptual model one can conclude that the inclusion of the employees is one of the critical factors for successful implementation of the TQM, and the motivation of the employees represents a sort of “initiator” that encourages their involvement and dedication to the work. The top management is responsible for identification and provision of the necessary resources for successful operation of ISO 9001 and transition towards TQM. Employees from other hierarchical levels are also implementers of decisions adopted by the top management, enforcers of defined principles and objectives of the highest level to the other organisational levels and direct participants and carriers of the operations. If the employees are not motivated enough, their participation in the improvement of ISO 9001 will be only formal and will not lead to further development of the system for quality and integration of the TQM practices in the process. Poor motivation of the employees may cause inertia and resistance to change leading to introduction of new methodologies such as the TQM. For those reasons, the creation of the conceptual model of the influence of the level of motivation of the employees who can, with their inclusion, influence the transition of the organizations from ISO 9001 towards TQM, is of significant importance. In the next study, this model will serve as a basis for designing a dynamic model for transition of the organisations from ISO 9001 towards TQM, under the influence of the motivation of employees.

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Table 4. List of factors

TQM critical factor	Description of TQM critical factor
Strong commitment of top management	According to Kanji (1998), the commitment of top management is a key driver for TQM implementation and successful business. The employee`s motivation of is very addictive with top management.
Customer focus	Customer focus is expressed as the production of goods that fulfill the customer`s need. Market research is essential because it is not easy to meet customer expectations (Oakland, 1995). Organizations have to express customer`s concerns and respond to the customer demands and to measure their satisfaction (Zhang, 2000). Collecting the informations about customer needs is one of the TQM practices to improve the business performance (Hackman et al., 1995). Customer focus is closely related with employees motivation because employees are customers at the same time.
Organizational learning	Organizational learning covers skill for creating, acquiring and transferring knowledge to employees, and ability to create the new knowledge (Senge, 1996). Organizational learning is positively correlated with TQM concept (Hafeez 2010), enables successful TQM implementation (Pool, 2000) and significantly affect the employee motivation.
Continuous improvement	The factor of continuous improvement means evaluation of the processes performance and collection of all data related to the quality (Das et al., 2008). According to TQM concept, quality is the measurable category. The effect of the improvement means measurement of the initial and the expected level (Pheng et al., 2004). The process of the employee motivation to participate in the implementation of TQM practicies is a dynamic process, with the point of beginning, but without the point of end. The only way to keep the level of customer satisfaction is the continuous improvement (Talib et al., 2010). According to Swartling (2013), motivation affect to the continuous improvement. The emloyees are treated as a customers, because they are internal customers.
Employee involvment	Involvement of employees allows usege of the entire capacity of the employees and encourage their commitment to organizational success (Cotton, 1993). Part of the TQM philosophy is motivating employees to locate problems in terms of quality and find a solution for them. The integral part of TQM philosophy is the motivation of the employee to identify the problems related to quality. Motivating employees lead to higher quality, better productivity and increase the competitiveness of the market organizations (Daily, 2003).
Rewarding	The system of rewarding should be tailored to the needs of the organization according to the achievements of the employees.
Job satisfaction	Job satisfaction leads to better organizational performance and have a significant impact on employee motivation (Chen et al., 2009).

Table 5. List of simplification

Influence factor	Description of the influence factor	Reason for simplification
Process management	The production process should be organized to ensure the defined quality products and prevention of nonconformities, so the quality should be built into the process. Quality product can be produced in the quality process.	Top management is responsible for the process approach and therefore, this factor will not significantly affect to the motivation of employees.
Quality information management	Access to data is very important in terms of sharing the informations and knowledge between employees or customers and it is one of the preconditions for the implementation of TQM (Koh, 2010).	Quality information management increase the motivation of employees, but it not be treated in the simplified model, because the impact on motivation is not so high, compared to other TQM included factors listed in Table 4.
Supplier management	TQM philosophy supports the principle of long term relationships with suppliers (Zhang, 2000).	The supplier management have a influence on the TQM implementation, but it have not major impact on the employee motivation.
Responsibility, authority and communication	ISO 90001:2008 (5.4) Top management have a fully involvement in the quality management system. They have to make sure that the requirements of the management system are integrated into the organization's processes and that the policy and objectives are compatible with the strategic direction of the organization	It will be treated within the factor strong commitment of top management.
Purchasing	ISO 90001:2008 (7.4) The organization shall ensure that purchased product conforms to specified purchase requirements. The type and extent of control applied to the supplier and the purchased product shall be dependent upon the effect of the purchased product on subsequent product realization or the final product.	It will be treated within the factor supplier management.
.....	.....	.....
Training	The training enables strengthening of teamwork and involvement of employees in TQM implementation (Chapman, 1991). According to Daily (2003), the training of employees, indirectly by the teamwork, have a positive impact on reinforcing the employee involvement.	It will be treated within the factor organizational learning.
Teamwork	Team working, is a kind of tool for expansion of the knowledge base. Team working increase the individual contributions of employees and provides solving of the organizational issues (Murphy et al., 1996). According to Daily (2003), teamwork is positively correlated with successful employee involvement in TQM implementation.	It will be treated within the factor employee involvement.
Well-being	Emotional decline of the employees have impact of the work performance and leads to achieving poor results (Lu, 1999).	Well-being is closely related to job satisfaction factor, because the welfare of employees arise from their satisfaction due remuneration. Well-being will be treated within the factor rewarding.
.....	.....	.....

Table 6. Validation of correlations in the conceptual model

Correlation between variables		Author	Factor analysis value
Substantial commitment of top management	State of ISO 9001	Kimutal et al. (2013)	>0,5 (significant correlation), confirmed by 76% of interviewed organizations
	State of TQM	Das et al. (2008)	>0,815 (>0,50 significant correlation)
	Employee motivation	Mezher (2004)	0,551 (0-1)
Organizational learning	State of ISO 9001	Tamayo-Torres (2014)	0,57 (>0,50 significant correlation)
	State of TQM	Das et al. (2008)	>0,850 (>0,50 significant correlation)
	Employee motivation	Malik et al. (2010)	0,68 (>0,5 significant correlation)
Customer focus	State of ISO 9001	Piskar (2007)	0,69 (>0,5 significant correlation)
	State of TQM	Das et al. (2008)	>0,838 (>0,50 significant correlation)
	Employee motivation	Ugboro et al. (2000)	0, 5103 (>0,50 significant correlation)
Continuous improvement	State of TQM	Das et al. (2008)	>0,830 (>0,50 significant correlation)
Employee involvement	State of ISO 9001	Respati (2014)	0,77 (>0,50 significant correlation) addict between behavior and ISO 9000
	State of TQM	Das et al. (2008)	>0,828 (>0,50 significant correlation)
Employee motivation	Reward	Das et al. (2008)	>0,844 (>0,50 significant correlation)
	Job satisfaction	Kappelman et al. (1995)	0.343 1 (>0,9 significant correlation) chi square method

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OVERVIEW OF ISO/DIS 9001:2015 CHANGES

Branislav Tomic
Senior Quality Coordinator, Bombardier Aerospace, Toronto, Canada

Abstract. *The next revision of ISO 9001, the international standard specifying requirements for quality management systems is under development and currently at the Draft International Stage (DIS) with a scheduled publication date of September 15, 2015. While a new structure of the standard demonstrates the significant visual change, the standard also uses different words to explain requirements that have already existed in the current revision ISO 9001:2008. Some of the changes are based on the fact that the text related to certain concepts is part of the standard structure and definitions that have been established for every management system standard to follow. This paper highlights the major changes that are expected in ISO 9001:2015.*

Key Words: *ISO/DIS 9001:201, ISO 9001:2008, Quality Management System*

1. INTRODUCTION

Draft International Stage (DIS) of ISO 9001:2015 the international standard for quality management systems (QMS) has been released. The scheduled date for publication of the final revision is September 15, 2015. The new structure of the standard exhibits the significant visual change and the standard has incorporated different terminology to explain the requirements that have always been stipulated in ISO 9001 standard. All ISO standards have been reviewed every five years to determine its competency and if a new revision is required to keep it up-to-date. ISO/DIS 9001:2015 provides the answer to the latest trends on the market and also is compatible with the other management systems such (i.e. ISO 14001). SO/TC 176, the committee that is responsible for ISO 9001 QMS standard, is currently reviewing the standard and preparing its final release. Industry related standards such as aerospace standard AS9100 or telecommunications standard TL9000 will probably be revised to reflect the changes in this "base standard". The new revision of ISO 9001 will follow a new, higher level “standardized” structure to make it easier to use in combination with the other management system standards. Organizations will be granted a three-year transition period after the final revision is released to transition their QMS to the new revision of the standard.

Since ISO 9001 standard incorporates the best business practices from different industries, it slowly influences the transition process from QMS to business management system. If ISO 9001 is effectively implemented it could be profound cost savings tool. Businesses and organizations grow through innovation and competition, neither of which can thrive without standards – the shared vision, understanding and vocabulary for meeting the needs of key stakeholders. Certification to ISO 9001 standard is often an expected condition of doing business and it is a common criterion for qualifying suppliers.

All ISO standards are periodically updated to maintain relevance. Regarding ISO 9001:2015 in particular, the revision will respond to the increasing diversity of users, ensuring that needs of all user groups and industry sectors are met and to allow easier integration with other management system standards. The revision will use a common structure defined for management system standards such as environmental, health and safety, energy, and emergency preparedness. During development of ISO standards the interests of all interested parties are taken into account, including companies, suppliers, users, consumers, consultants, testing facilities, governments, engineering professional societies, research organizations and many other parties.

This paper summarizes the major changes that can be expected when the final revision of ISO 9001 is finally released.

2. ISO/DIS 9001:2015 CHANGES

2.1. ISO/DIS 9001:2015 New Structure

The new ISO 9001 standard will be aligned with high-level organizational structure and this trend will be applied to all new ISO management system standards. The following table shows some of the key differences between ISO/DIS 9001:2015 and the existing ISO 9001:2008:

Table 1. ISO 9001:2015 and ISO 9001:2008 Structure Comparison

Structure Comparison	
ISO/DIS 9001:2015	**ISO 9001:2008**
1. Scope	1.Scope
2. Normative References	2. Normative References
3. Terms and definitions	3. Terms and definitions
4. Context of the organization	4. Quality Management System
5. Leadership	5. Management responsibility
6. Planning	6. Resource management
7. Support	7. Product realization
8. Operation	8. Measurement, analysis, and improvement
9. Performance evaluation	
10. Improvement	

The clauses of ISO 9001:2015 have been renumbered but technically it is just the stuff that has been moved around the standard. It is the general recommendation that if the organizations want to renumber their procedures according to the new system they can go ahead and do it, but if they do not want, they can just keep them as they are.

The use of new common structure for management system standards is because their smoother integration with other management standards. The entire arrangement of the standard that includes standardized core text, structure and definitions increases from eight clauses to ten.

2.2. Defining the Context of the Organization

Context of the organization is one of the new concepts and differences between the ISO 9001:2008 and ISO 9001:2015. The context of the organization as described in the ISO 9001:2015 requires top management to define influences of numerous elements on the organization and its QMS like organizational culture, quality objectives and goals, flow and interaction of the processes, organizational structure, markets, potential customers, etc. The output of this context evaluation will be determination of the scope of organization's QMS. When the organization defines its context, it will outline its boundaries, where does QMS apply and where does not apply. This will be the hard part but also this is going to be the core of establishing QMS along with the identification of all interesting parties, who is going to be interested in the results of the company. The customers will be number one on the list of course, than the employees of the company, the owners, investors and many other parties as well.

2.3. Removal of Quality Manual

Certain requirements for quality manual from ISO 9001:2008 are included in different clauses of ISO/DIS 9001:2015. The new revision of the standard does not require the documented information of quality manual. Even though the new standard is not going to require quality manual, quality manual is going to be profoundly beneficial and the recommendation is to keep a quality manual which is not against the rules - it is just not prescribed anymore in the standard. There is no necessity to eliminate quality manual if it serves its purpose and works well. There are still requirements that need to be kept as documented information, such as the scope of the QMS, quality policy and others. While these requirements can be documented separately as documented information, it is acceptable to document them together in a quality manual if a company finds this helpful. A manual is not required to be documented for some other management standards as well. In an effort to ensure synchronization between different management system standards the requirement to have documented quality manual will no longer exist after the release of new revision of ISO 9001.

2.4. Diminishing Requirements for Documented Procedures and Records / Introduction of Documented Information

The requirements related to control of documents and control of records in ISO 9001:2008 are included in different clauses of ISO 9001:2015 as documented information. Since there are substantial changes related to control of documented information, the difference between a document and a record has become more difficult. Both of them are considered "documented information" but when standards refers to documents it uses the term "maintain" while when it refers to records, it uses the term "retain". Organizations that have a QMS that is in compliance with ISO 9001:2008 requirements should be compliant to ISO 9001:2015 requirements as well.

With the current standard ISO 9001:2008 there are six required documented procedures. The wording of the new draft standard does not include these requirements, but does not mean they are not needed. The new draft revision of ISO 9001:2015 uses the phrase "documented information" to indicate when a company needs to document and retain such information. Even though there is no requirement for documented procedures, there is a requirement to retain documented information as evidence.

This increased flexibility regarding the use of documentation provides more freedom to the companies regarding creating QMS that fits their needs.

2.5. Elimination of Management Representative

ISO/DIS 9001:2015 has shifted the role of Management Representative to the top management of the organization and the organization does not require an individual to be particularly assigned as a Management Representative. All requirements related to management representative from ISO 9001:2008 are included in the new revision of the standard with some minor improvements. The ISO/DIS 9001:2015 just does not define the term Management Representative considering that not only one person but everybody in the company and especially top management is ultimately responsible for QMS.

2.6. Incorporated Risk-Based Thinking / Approach

In new revision of ISO 9001 standard there is a greater emphasis on risk-based thinking as a basis for the management system

The organizations have to apply risk-based thinking, an approach that includes mechanisms for managing risks. There are many elements of risk-based thinking in the draft international standard of ISO/DIS 9001:2015 that may affect organizations as they work toward compliance to the revised standard. ISO/DIS 9001:2015 defines risk as the "*effect of uncertainty on an expected result*." An important element of the ISO/DIS 9001:2015 is the process approach, which requires an organization to "determine the processes needed for the quality management system (QMS)" and its application of those processes throughout the organization. This includes identifying:

- inputs, outputs and resources,
- sequence and interaction,
- effective operation,
- responsibilities and opportunities for improvement and
- risks and the opportunities and actions needed to address them.

ISO/DIS 9001:2015 requires that top management must "demonstrate leadership and commitment with respect to customer focus by ensuring that the risks and opportunities that can affect products, services and the ability to enhance customer satisfaction are determined and addressed" and also to "determine the risks and opportunities" that must be addressed to ensure that QMS can:

- achieve its intended results,
- prevent or reduce undesired effects and
- achieve continual improvement.

Actions taken to address risks and opportunities must be proportionate to the potential effects on conformity of goods and services and customer satisfaction. Furthermore, the organization should implement changes in a "planned and systematic manner," identifying risks and opportunities, and reviewing the potential consequences of changes. Options for addressing risk can include avoidance, eliminating the source, sharing the risk and deciding whether to take the risk.

According ISO/DIS 9001:2015, when applicable, an organization must determine and meet requirements for post-delivery activities associated with the nature and intended lifetime of the goods and services, accounting for:

- risks associated with the goods and services,
- use and lifetime,
- customer feedback and
- statutory and regulatory requirements.

ISO/DIS 9001:2015 also requires that an organization must consider the effectiveness of the actions taken to address risks and opportunities. This includes:

- determining what needs to be monitored and measured so the organization can demonstrate conformity of goods and services to requirements,
- evaluating the performance of processes,
- ensuring conformity and effectiveness of the QMS and
- evaluating customer satisfaction.

The new revision of the standard similarly requires that an organization has to "plan, establish, implement and maintain an audit program," and establish the "frequency, methods, responsibilities, planning requirements and reporting." The audit program must consider the quality objectives, importance of the processes concerned, related risks and results of previous audits.

Section A4 of Annex A describes a risk-based management approach consisting of:

- requiring the organization to understand its context consisting of internal and external issues,
- understanding that one of the key purposes of a management system is to act as a preventive tool,
- determining its risks and opportunities and
- addressing the risks and opportunities identified.

2.7. Applicability

In ISO 9001:2008, organizations could exclude certain requirements if they do not affect an organization's ability to provide products or services that conform to requirements. In the ISO/DIS 9001:2015, an organization can determine that a requirement from the standard does not apply if it does not affect the organization's ability related to product or service conformance to requirements. This determination has to be maintained as documented information.

2.8. Exclusion of Preventive Actions

The main idea behind ISO/DIS 9001:2015 is that QMS acts as a preventive tool itself resulting that the formal requirements associated with preventive action do not exist in the current draft revision of the standard. This has been replaced with risk-based approach. Formalized preventive action process will be excluded in the official revision of ISO 9001:2015 and preventive actions have to be addressed in different ways in order to assure compliance with the new revision of the standard. Preventive actions will be established on “risk-based thinking”. The new revision of the standard integrates risk analysis and identifies opportunities for improvement as preventive tool in all aspects of QMS. Continuous improvement and preventive actions are not going to disappear or become less important or replaced by some new mandate but rather they are going to progress into a more effective and practical application of QMS.

3. CONCLUSION

The interest in the new ISO 9001:2015 revision is significant given that the draft has important changes comparing to the existing revision. There are some additional requirements in the new revision and those requirements are pretty important. New structure of the standard, context of the organization, removal of quality manual as mandatory requirement, introducing documented information instead of documents and records, elimination management representative, adopting risk-based thinking in all aspects of QMS, determining applicability and exclusion of preventive actions are considered the major changes in the new revision of the standard. Even though to a very large degree companies could keep what they already have as a part of documented QMS, they should start the transition process as soon as possible in order to save significant time later on since there will be given three year period to incorporate this standard. The new revision of ISO 9001 is less prescriptive and leaves to the organizations choice how they are going to run business and meet the requirements.

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FACTORIAL DESIGN OF EXPERIMENT VS. TAGUCHI APPROACH IN FILAMENT WOUND COMPOSITES

S. Risteska[1], M. Stefanovska[1], B. Samakoski[1]
Institute for advanced composites and robotics, 7500 Prilep, Macedonia

Abstract *Main purpose of this paper is to present a valid comparison between full factorial design of experiment (2^2) and Taguchi approach (L_4) in determination of the influence of manufacturing parameters on hoop tensile strength and hoop tensile modulus of carbon fiber/epoxy resin NOL ring samples. Samples were manufactured with filament winding technology with winding speed and winding tension as control parameters and tested on universal testing machine. Results received from mechanical tests represented with factorial design of experiment were in good correlation with results received from Taguchi method.*
Key words: *filament winding, hoop tensile strength, hoop tensile modulus, NOL ring samples.*

1 INTRODUCTION

Composite materials are finding various applications in different industries due to their advantages which include lighter weight, improved fatigue life, the ability to design the final product for optimum strength and stiffness, corrosion resistance and reduced assembly costs due to fewer detail parts and fasteners [1, 2].

In composite parts produced with filament winding technology many factors can influence on mechanical properties of final part. In order quantitatively to determine how many factors and their interaction impact on the end product, design of experiment (DOE) can be used [3, 4]. Another method to investigate how different parameters affect the mean and variance of a process performance is Taguchi method, where instead of having to test all possible combinations like factorial design of experiment, pairs of combinations are tested [5, 6].

In this paper has been given a comparison between factorial DOE and Taguchi method in determination of parameter influence on hoop tensile strength and hoop tensile modulus of carbon fiber/epoxy resin NOL ring samples.

2 MATERIALS AND METHODS

For the manufacture of NOL ring samples were used carbon fiber T700S 24K from Toray and three component epoxy resin system Araldite® LY1135-1/ Aradur® 917/ Accelerator 960 from Huntsman. Wet filament winding process was conducted on laboratory filament winding machine MAW FB 6/1 manufactured by Mikrosam AD. For more precise control on fiber tension, electrical creel was used. From the creel carbon fiber was transported to roller impregnation bath with resin temperature of 37°C and finally it was wound on rotational mandrel specially designed for manufacture of NOL ring samples according to ASTM D2290 standard [7]. All samples were manufactured with 146 mm inside diameter, 22.86 mm width and 3 mm thickness with parameters given in Table 1 and constant resin mass fraction of 25 w% during winding.

Table 1: Level of control parameters

Symbol	**Winding parameter**	**Parameter level**	
		1	**2**
V (x_1)	Winding speed (m/min)	3.5	10
F (x_2)	Fiber tension (N)	20	85

Mechanical tests were performed on universal testing machine AG-Xplus Series from Shimadzu with maximal load of 250 kN and loading speed of 10 mm/min. Split disc fixture, specially adapted to testing machine was used to hold NOL ring samples. For each sample force-deflection diagram was received, where maximal break load was detected.

2.1 Factorial design of experiment

Combination of winding parameters specified in Table 2 has been used in the production of NOL ring samples according to factorial DOE with 2^2 permutations. DOE was used due to it superiority to the traditional one-variable-at a time method, which fails to consider possible interaction between filament winding factors.

Table 2: Combinations of winding parameters using factorial DOE 2^2

N°	X_1 (m/min)	X_2 (N)
1	V_2	F_2
2	V_1	F_2
3	V_2	F_1
4	V_1	F_1

2.2 Taguchi method

Taguchi orthogonal array L_4 is given in Table 3, where parameters affecting the process and their levels are specified. This method was used as a comparative method to DOE, due to its simplicity.

Table 3: Taguchi orthogonal array L_4 (2^2)

N°	X_1 (m/min)	X_2 (N)
1	V_1	F_1
2	V_1	F_2
3	V_2	F_1
4	V_2	F_2

3 RESULTS AND DISCUSSION

Experimental hoop tensile strength (σ_{exp}) of NOL ring samples was calculated according to (1) [7], whereas experimental hoop tensile modulus of elasticity (E_{exp}) of NOL ring samples was determined with help of (2) [8]. Received results are represented in Table 4.

$$\sigma = \frac{F}{2tw} \tag{1}$$

$$E_{\exp} = \frac{0.1257 r_{mean}^3}{wt^3}\frac{F}{\Delta} \tag{2}$$

In (1), F (N) is maximal break force of NOL ring sample, whereas t (mm) and w (mm) are the thickness and width of NOL ring sample, respectively. In (2) r_{mean} (mm) is mean radius of manufactured NOL ring sample.

Table 4: Hoop tensile strength and hoop tensile modulus of NOL ring samples according to DOE 2^2

N°	$\sigma_{exp.}$ (MPa)	$\sigma_{exp.med}$ (MPa)	E_{exp} (GPa)	$E_{exp.med}$ (GPa)
1-1	1921.9	1909.6	124.85	129.84
1-2	1869.8		130.17	
1-3	1945.3		132.16	
1-4	1865.8		125.73	
1-5	1945.3		136.29	
2-1	2142.4	2111.5	145.78	144.07
2-2	2123.7		143.58	
2-3	2151.0		149.74	
2-4	2081.5		140.27	
2-5	2059.0		141.02	
3-1	1815.8	1907.3	127.24	134.81
3-2	1949.9		133.54	
3-3	1877.8		128.19	
3-4	1967.3		141.08	
3-5	1925.6		144.00	
4-1	2067.2	2058.0	136.87	139.61
4-2	1957.6		131.07	
4-3	2133.1		144.67	
4-4	2129.6		148.73	
4-5	2002.5		136.70	

3.1 Factorial design of experiment

From results shown in Table 4, value of hoop tensile strength dispersion (S_σ^2) and minimal value of winding parameters (Δb_i) can be calculated [9]. These values are given in Table 5.

Table 5: Results from factorial DOE 2^2 for hoop tensile strength

N°	σ_{exp}	σ_{cal}	S_σ^2	Δb_i
1	1909.62	1908.45	1550.69	26.90
2	2111.52	2084.76	1580.04	
3	1907.28	1908.45	3748.04	
4	2058.00	2084.76	6002.91	

From results represented in Table 5 can be noticed that minimal calculated value for parameter's coefficient is 26.90. According to this value, winding speed (x_1) performs an influence on hoop tensile strength of manufactured samples which is specified with (3).

$$\sigma = 1996.6 - 88.15 x_1 \tag{3}$$

Homogeneity of dispersion and adequacy of represented model are expressed through Cochran criteria ($G_{cal} < G_{tab}$) with G_{cal} equal to 0.466 and Fisher criteria ($F_{cal} < F_{tab}$) with F_{cal} equal to 0.22, respectively.

Table 6: Results from factorial DOE 2^2 for hoop tensile modulus of elasticity

N°	E_{exp}	E_{cal}	S_E^2	Δb_i
1	129.84	132.33	22.22	2.83
2	144.08	141.84	14.76	
3	134.81	132.33	56.63	
4	139.61	141.84	49.42	

Further, Table 6 presents the experimental and calculated values of hoop tensile modulus of elasticity of NOL ring samples, together with calculated dispersion (S_E^2) and parameter's coefficient (Δb_i). In this case, calculated Δb_i is 2.83. Here also, winding speed (x_1) manifest an influence on hoop tensile modulus of elasticity of NOL ring samples which is given with (4). Cochran criteria ($G_{cal} < G_{tab}$), with G_{cal} equal to 0.396 confirm the homogeneity of dispersion, whereas Fisher criteria ($F_{cal} < F_{tab}$) with F_{cal} equal to 0.31 affirm the adequacy of represented model.

$$E = 137.08 - 4.76x_1 \quad (4)$$

3.2 Taguchi method

According to results given in Table 4, but in correspondence to Taguchi orthogonal array L_4, standard deviation (S), log(S) and signal-to-noise ratio (S/N ratio) were calculated for each NOL ring sample (Table 7). S/N ratio was determined following larger-the-better category with help of (5) [10].

$$S/N_{ratio} = -10\log\sum\left[\frac{1}{y_i^2}\right] \quad (5)$$

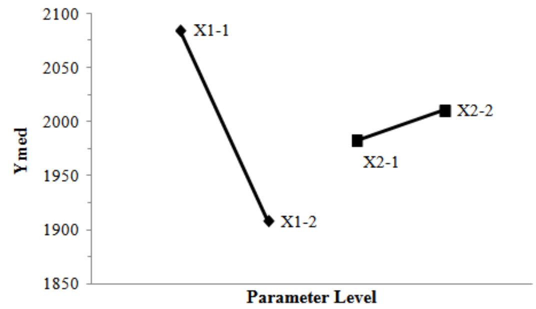
Table 7: Sample statistic according to Taguchi method for NOL ring samples

Nº	σ_{exp}			E_{exp}		
	S	**log (S)**	**S/N ratio**	**S**	**log (S)**	**S/N ratio**
1	77.5	1.9	66.3	7.0	0.8	42.9
2	39.7	1.6	66.5	3.8	0.6	43.2
3	61.2	1.8	65.6	7.5	0.9	42.6
4	39.4	1.6	65.6	4.7	0.7	42.3

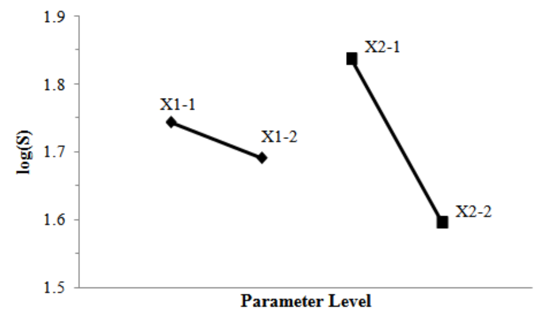
In Fig.1 and Fig. 2 are represented S, log(S) and S/N ratio of calculated σ_{exp} and E_{exp} for each sample. It can be noticed that winding speed (X_1) at level 1 has pronounced influence on mechanical characteristics on standard deviation and S/N ratio, in comparison to winding tension (X_2) which can be negligible. Contrary to this, X_2 has more pronounced influence on log(S) at level 1 for hoop tensile strength and hoop tensile modulus.

Table 8: Rang of parameters according to Taguchi method for NOL ring samples

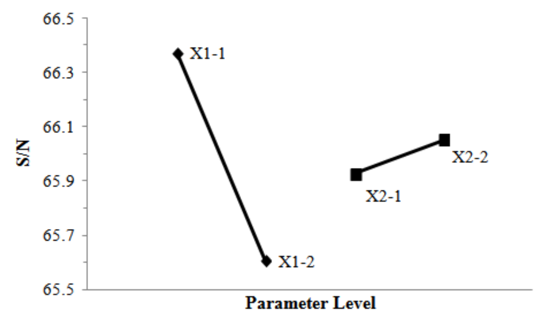
Level	σ_{exp}		E_{exp}	
	X_1	X_2	X_1	X_2
1	66.4	65.6	43.1	42.8
2	65.6	66.1	42.5	42.8
Δ	0.8	-0.5	0.6	0.0
Rank	1	2	1	2



a) Estimated factor effects

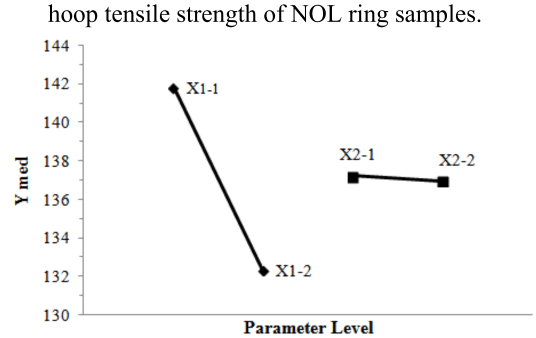


b) Factor effects on log(s)

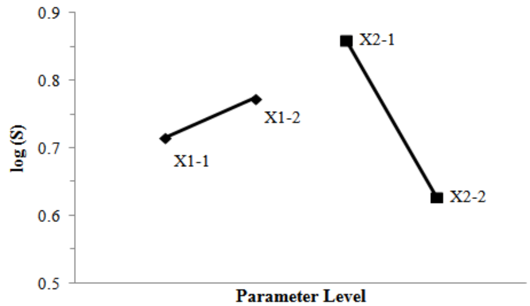


c) Factor effects on S/N ratio

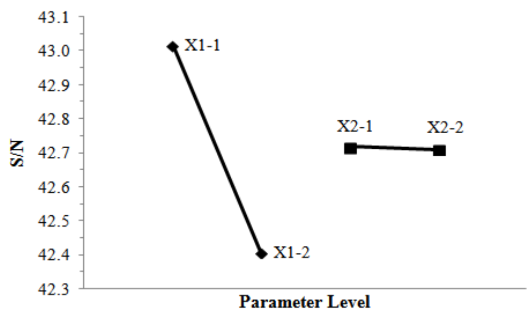
Fig.1: Graphical presentation of factor effects on hoop tensile strength of NOL ring samples.



a) Estimated factor effects



b) Factor effects on log(s)



c) Factor effects on S/N ratio

Fig.2: Graphical presentation of factor effects on hoop tensile modulus of NOL ring samples

4 CONCLUSION

Experimental methods described in this work are suitable to predict the influence of winding parameters on mechanical properties of NOL ring samples manufactured with help of filament winding technology.

Good agreement between both methods was received, where winding speed shows more pronounced influence on mechanical characteristics in comparison to winding tension.

According to factorial DOE interaction between both parameters does not demonstrate an influence on mechanical properties of composite samples, whereas Taguchi method shows that winding speed at level 1 (3.5m/min) demonstrate an effect on mechanical properties of composite samples.

Taguchi method is a structured approach for determining “the best” combination of inputs to produce a product or service. It is based on a Design of Experiments methodology for determining parameter levels and requires small number of experiments. In the same way, DOE is an important tool for designing processes and products. But it is a method which quantitatively identifies the right inputs and parameter levels for making a high quality product or service and requires bigger number of experiments.

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METHOD FOR COLUMN CONSTRUCTION OF FULL FACTORIAL DESIGNS FOR FACTORS ON TREE LEVELS USING TAGUCHI'S ORTHOGONAL ARRAYS

Zorica A. Veljković[1], Slobodan Lj. Radojević[1]
[1] Faculty of Mechanical Engineering, University of Belgrade, Serbia

Abstract. *This paper present one of the methods for construction of columns for matrices of full factorial designs with factors on tree levels. Method is based on Taguchi's approach to construction of orthogonal arrays using Latin squares. Therefore it is applicable for both approaches when orthogonal arrays are viewed as a full factorial designs, rather than it's original form as a fractional factorial designs. This enable construct and use of matrices for full factorial designs or fractional factorial designs for tree level factors. This, further enables use of experimental matrices for full factorial designs with any number of factors.*

Key words: *open and closed full factorial designs, standard Latin squares, tree level factors, partition of interaction, characteristic rows*

1. INTRODUCTION

Theoretical basics for design of experiments, namely factorial designs are initiated on the beginning of the 20th century [1], while broad use, especially in industry are ignited by introduction of Taguchi's methods in late 1980-ties and 1990-ties [1]. Despite grate critique of Taguchi's approach to experimental design [1, 2, 3]

Theoretical reviews and development of experiments are slowed down and reoriented on books [4, 5]. On the other hand use of Taguchi's methods are wide in use in engineering and other research fields [6, 7, 8], with more frequent use of factors on three levels.

This paper presents one of the methods for construction of Taguchi's orthogonal arrays (OA) for tree level experiments, as well as full factorial designs for tree level factors. It is proven that full factorial designs for tree factors correspond to OA $L_i\left(3^j\right)$ [9].

Use of OA for Taguchi's method is standard procedure. In contrast to that, use of matrices (derived OA) in full factorial designs to a large degree facilitate non statisticians use of this experimental designs by avoiding Yates algorithm [1] or system of modules [10].

Construction of OA is based on Latin squares [11]. Latin squares are two dimensional matrices with letters [1] or numbers [10], i.e. *p*x*p* matrices (*p*=2,3,...), where every number appears only once in every column and in every row [1,10,12].

Elementary Latin squares are the standard or reduced Latin square. In standard Latin squares numbers constructing them are arranged in ascending order in first column and first row, with main diagonal from top right point to lower left point. Every standard Latin square generates set of *p*!(*p*-1)! derived Latin squares [1].

2. METHODOLOGY

For tree level OA, Taguchi uses 3x3 Latin squares [11]. For 3x3 Latin squares there exists only one standard Latin square, with $3!\left(3-1\right)!=12$, with 11 of them are nonstandard [10]. For construction of Taguchi [11] uses standard Latin square, and one nonstandard, denoted as *p* and *q* (Table 1).

Table 1. Latin squares in use to construct 3^s OA [10]

	p				*q*	
1	2	3		1	3	2
2	3	1		2	1	3
3	1	2		3	2	1

Taguchi's OA were considered as a full factorial designs. Difference is in factor allocation. Taguchi's OA are named closed full factorial designs due difficulty to expand them for further research. Full factorial designs represented as OA-s are named open designs, since they allow fold over, i.e. expansion of existing experiments if needed.

Further development of columns in matrices [13] is divided by factorial effects. Basic columns, i.e., columns contain main factorial effects have two degrees of freedom. Therefore interactions, depending of number of factors have more degrees of freedom and therefore occupy more than one column. Basically, they divided in certain number of partitions. Every partition occupy one column and have two degrees of freedom.

2.1. Construction of basic columns

For construction of factor levels basic columns of Taguchi's OA, from defined Latin squares 1, 2, 3, 1... results change of factor levels according the following sequence

$$\frac{3^k}{3}, \frac{3^k}{3^2}, \ldots, \frac{3^k}{3^{k-1}}, \frac{3^k}{3^k} \qquad (1)$$

For open factor levels in full factorial designs basic columns follow the sequence

$$\frac{3^k}{3^k}, \frac{3^k}{3^{k-1}}, \ldots, \frac{3^k}{3^2}, \frac{3^k}{3} \qquad (2)$$

2.2. Two factor interactions

Every two factor interaction have four degrees of freedom. Since every column in design have two degrees of freedom two factor interactions are divided on two partitions, that occupy those columns.

In order to construct factor levels for those columns, matching Latin squares from Table 1., can be expressed by columns (Table 2.)

Table 2. Adapted Latin squares for 3^k factorial design

p		
1	2	3
2	3	1
3	1	2
$\boldsymbol{p_1}$	$\boldsymbol{p_2}$	$\boldsymbol{p_3}$

q		
1	3	2
2	1	3
3	2	1
$\boldsymbol{q_1}$	$\boldsymbol{q_2}$	$\boldsymbol{q_3}$

Latin squares are divided by columns. Standard Latin square *p* becomes primary basic Latin square (Table 2), with elements representing columns

$$p_i = p_{(j)\downarrow}, i, j = 1,2,3 \qquad (3)$$

Other Latin squares in use - *q* is secondary basic Latin square (Table 2), with elements representing columns

$$q_i = q_{(j)\downarrow},\ i = 1,2,3,\ j = 1,3,2 \qquad (4)$$

Depending on partition in column elements of primary or secondary Latin square are placed one above other.

Example of two factor interaction for smallest tree level OA (L_9) are presented at Table 3., where AB is partition I, while AB^2 is the partition II of interaction.

Table 3. Interaction columns for OA (L_9) with arrangement of parts of Latin squares p and q

AB		**AB^2**	
1		1	
2	p_1	2	q_1
3		3	
2		3	
3	p_2	1	q_2
1		2	
3		2	
1	p_3	3	q_3
2		1	
p		***q***	

In case of two factor interactions for first partition *p* is transformation for AB. For second partition of Latin squares *q* was used, and therefore it is transformation for AB^2. Two factor interactions have only one transformation. Larger interactions have more than one transformation *p* and *q*.

2.3. Three factor interactions

Tree factor interactions have eight degrees of freedom. They have four partitions, i.e. occupy 4 columns of factorial design. For three factor interactions it's necessary to determine two combination of transformations. Two consecutive transformations define mode of construction of partition of interaction column. For interaction ABC transformations for individual partitions are shown in Table 4.

Table 4. Method for construction of transformations of Latin squares elements for construction of partitions for tree factor interactions

ABC			**AB^{2}C**			**ABC^2**			**AB^{2}C^2**		
$p_1\ p_2\ p_3$		1 2 3	$q_1\ q_3\ q_2$		1 3 2	$p_1\ p_3\ p_2$		1 3 2	$q_1\ q_2\ q_3$		1 2 3
$p_2\ p_3\ p_1$	$\mapsto$	2 3 1	$q_2\ q_2\ q_3$	$\mapsto$	2 1 3	$p_2\ p_1\ p_3$	$\mapsto$	2 1 3	$q_2\ q_3\ q_2$	$\mapsto$	2 3 1
$p_3\ p_1\ p_2$		3 1 2	$q_3\ q_1\ q_1$		3 2 1	$p_3\ p_2\ p_1$		3 2 1	$q_3\ q_1\ q_1$		3 1 2
		$p_1\ p_2\ p_3$			$q_1\ q_2\ q_3$			$q_1\ q_2\ q_3$			$p_1\ p_2\ p_3$
p	$\mapsto$	***p***	***q***	$\mapsto$	***q***	***p***	$\mapsto$	***q***	***q***	$\mapsto$	***p***

2.4. Five factor interactions

Five factor interaction have 32 degrees of freedom, therefore 16 partitions is distributed in 16 columns in OA. Smallest OA for this design is L_{234}. Since large amount of factor levels in columns it was needed to reduce way of presentation. Let rows which represent begin of transformation element of Latin square be called *characteristic row*.

Characteristic rows are such that first transformation results from first and second characteristic rows (1 and 4). Second transformation is obtained from first transformation and characteristic row 3 (row 10 in OA), Third transformation is result of second transformation and characteristic row 4 (row 28 in OA) etc. Complete transformations are presented at Table 5.

Table 5. Characteristic rows for five factor interaction

Char.row	**ABCDE**	**AB²CDE**	**ABC²DE**	**AB²C2DE**	**ABCD²E**	**AB²CD²E**	**ABC²D²E**	**AB²C²D²E**
1	(1)↓	(1)↓	(1)↓	(1)↓	(1)↓	(1)↓	(1)↓	(1)↓
4	(2)↓	(3)↓	(2)↓	(3)↓	(2)↓	(3)↓	(2)↓	(3)↓
10	(2)↓	(2)↓	(3)↓	(3)↓	(2)↓	(2)↓	(3)↓	(3)↓
28	(2)↓	(2)↓	(2)↓	(2)↓	(3)↓	(3)↓	(3)↓	(3)↓
82	(2)↓	(2)↓	(2)↓	(2)↓	(2)↓	(2)↓	(2)↓	(2)↓

Char.row	**ABCDE²**	**AB²CDE²**	**ABC²DE²**	**AB²C²DE²**	**ABCD²E²**	**AB²CD²E²**	**ABC²D²E²**	**AB²C²D²E²**
1	(1)↓	(1)↓	(1)↓	(1)↓	(1)↓	(1)↓	(1)↓	(1)↓
4	(2)↓	(3)↓	(2)↓	(3)↓	(2)↓	(3)↓	(2)↓	(3)↓
10	(2)↓	(2)↓	(3)↓	(3)↓	(2)↓	(2)↓	(3)↓	(3)↓
28	(2)↓	(2)↓	(2)↓	(2)↓	(3)↓	(3)↓	(3)↓	(3)↓
82	(3)↓	(3)↓	(3)↓	(3)↓	(3)↓	(3)↓	(3)↓	(3)↓

Based on Table 5, combinations of transformation of elements in used Latin squares are shown in Table 6.

Table 6. Transformations for five factor interaction

ABCDE	$p \circ p \circ p \circ p$	ABCDE²	$p \circ p \circ p \circ q$
AB²CDE	$q \circ q \circ p \circ p$	AB²CDE²	$q \circ q \circ p \circ q$
ABC²DE	$p \circ q \circ q \circ p$	ABC²DE²	$p \circ q \circ q \circ q$
AB²C²DE	$q \circ p \circ q \circ p$	AB²C²DE²	$q \circ p \circ q \circ q$
ABCD²E	$p \circ p \circ q \circ q$	ABCD²E²	$p \circ p \circ q \circ p$
AB²CD²E	$q \circ q \circ q \circ q$	AB²CD²E²	$q \circ q \circ q \circ p$
ABC²D²E	$p \circ q \circ p \circ q$	ABC²D²E²	$p \circ q \circ p \circ p$
AB²C²D²E	$q \circ p \circ p \circ q$	AB²C²D²E²	$q \circ p \circ p \circ p$

2.6. Pattern of transformation construction

For construction of combination of transformations following applies:

- For construction interaction with i factors there exists 2^{i-1} possible combinations of transformations
- Number of combinations in one transformation is i-1
- Pattern of transformation behavior could be defined according the rules which can be delivered on the basis of previous transformation as

$$\begin{aligned} &\left(p \wedge (2)\downarrow\right) \Rightarrow p \\ &\left(p \wedge (3)\downarrow\right) \Rightarrow q \\ &\left(q \wedge (2)\downarrow\right) \Rightarrow q \\ &\left(q \wedge (3)\downarrow\right) \Rightarrow p \end{aligned} \qquad (5)$$

- Pattern also can be developed based on next transformation as

$$\begin{aligned} &\left(p \wedge (2)\downarrow\right) \Rightarrow p \\ &\left(p \wedge (3)\downarrow\right) \Rightarrow q \\ &\left(q \wedge (3)\downarrow\right) \Rightarrow p \\ &\left(q \wedge (2)\downarrow\right) \Rightarrow q \end{aligned} \qquad (6)$$

3. CONCLUSIONS

Presented methodology is convenient for development of large orthogonal arrays for factors on tree lever either for Taguchi's or traditional approach for full factorial designs since:

- Simplify existing techniques by avoiding use of Yates algorithm or system of modules
- Unify experimental designs in matrix regardless of the number of factor levels
- Connects two similar techniques Taguchi's and traditional approach (closed and open designs)
- Enables construction of matrices with any number of factors larger than one
- Facilitate easier application in practice during the preparation, planning, executing, data collecting and analysis, especially for engineers that are only a users, with limited knowledge in statistics

Shortcomings of methodology is that is applicable only for prime numbers. Reason for this lies in selection of adequate standard Latin squares. Yates and system of modules is applicable only on prime numbers, therefore it is possible to obtain appropriate standard Latin squares for construction of Orthogonal arrays. For composite numbers problem is selection of standard Latin squares for factorial designs as for example for Orthogonal arrays for four level factors [14].

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THE CONCEPTUAL MODEL FOR SMALL AND MEDIUM SIZED ENTERPRISESF OR THE PURPOSE OF PROJECT MANAGEMENT

Hrvoje Puskaric[1], Marija Zahar Djordjevic[1], Aleksandar Aleksic[1]
[1]Faculty of Engineering, University of Kragujevac, Serbia

Abstract. *The aim of this paper is to explain a model for evaluating project success of small and medium enterprises. These projects are considered in small and medium enterprises of process industry that operate in an uncertain and variable environment. Project success is evaluated through determining the project performance respecting international standard ISO9001:2008 for process organized enterprises and new ISO21500 and ISO10006as guidance for project management.*
Key words: *Project management, Project performances, ISO 9001, process organized SME's*

1.INTRODUCTION

Project management is an area of industrial engineering that has beena very popular field of research in the terms of science and practice in last decade, as proved by many papers ([3],[4],[12],[17]).
Project management, as a term, can be defined as the measuring project performance and taking appropriate management actions that should lead to an increase of the effectiveness of the project, i.e. to increase the level of feasibility of predefined project goals.
This paper discusses the project management of process-oriented SMEs in the manufacturing sector which operate in an uncertain and changing environment while respecting the appropriate standards and goals and proposes new organizational model for project performance evaluation.
The objectives of the project may be designated as the output performance of the project ([5], [6], [7]) and measuring these goals can deliver adequate assessments and strategies for improvement.
Generally, projects' results increase the effectiveness of business activities within the business process at either the SME or the state level. On the other hand, they enable the development and sustainability of the company over time. Implementation of these projects and measuring their performance canlead to harmonization of development objectives with the strategic goals of the company.

2. PROBLEM STATEMENT

Standard ISO9000 [9] gives the basic considerations and guidelines for understanding the concepts, aims, and applications of process approach using the concept of business processes in order to develop strategies to improve the quality of the processes within each manufacturing enterprise. Guidelines that this standard provides can be implemented in companies that differ in size and type.
According to this document (ISO 9000 Document: ISO / TC 176 / SC 2 / N 544R3; ISO9001: 2008) [9] process is defined as a set of interrelated activities that transform inputs into outputs, and desired results can be achieved more effectively if managing these activities and organization resources is seen as a group of business processes. A clear definition of such process network provides a more effective provision of outputs from processes which meet the needs of all stakeholders.
The model for the assessment of performance is applied in enterprises operating under ISO 9001: 2008 which are defined by a network of business processes. Thus, this paper proposes a model with process network inside of an organization that includes following processes [1]: Process Management, Concept Design and Development, Purchasing, Production, Marketing and Sales and Support processes.
Respecting this business processnetwork, we get an organized company that can apply a model for assessing the performance of projects that exist in these types of companies.

3. MODEL FOR EVALUATING PROJECT SUCCESS

Development of SME's, represents an expression of complete devotion of those companies to foster company growth which can allow further improvement of the business environment, strengthening financial support, entrepreneurial education andadvisory services, to provide additional support in the development of business.

There are manycritical success factors that influence development success of described enterprises such as: project-related factor, client-related factor, consultant-related factor, contractor-related factor, supply chain related factor andexternal environment-related factor.

Fulfillment of these factors can be achieved by using appropriate activities for improvement which is defined by the project management.

Project management need to define the proper action in finding key performance indicators (KPI - Key Performance Indicators) in order to assess the actual performances of business processes.

The overall performance of the projectscanbe separated into input performance that define project objectives before its implementation and output performance, which should reflectthe set goals.

Model to measure the performance of projects in this paper is based on the theory of fuzzy sets ([8], [13], [18], [19]), fuzzygroup decision and Analytic Hierarchy Process ([2], [16]). Determination of the input and output performance of projects is based on multiple regression analysis. For determining of optimal values of input performance, the genetic algorithms were usedwhiledetermining the prediction ofproject performance resulting from the optimization of input performance is obtained by using artificial neural networks and various software packages.

3.1. Identifying input performance

After identification it is assumed that it is necessary for input performance to be hierarchically structured and to have their key performance indicators definedwhichis defined according to the paper [15]. Input performances are modified and structured according to the issues in which they are observed.Authors showed that project performance of projects wereevaluated on the basis of six KPIs namely project time, cost, quality,safety, site disputesand environmental impact. These KPIs address the economic, social and environmental dimensions of publicsector. Not all the KPIs are significant in terms of their relationship with project performances and there is significant evidence and support for measurement of project performance on the basis of time, cost, quality and site disputes.

3.2 Identifying output performance

In literaturethe commonly used output performance is as follows: improving existing business processes, business process reengineering, the development of new products and services, continuing education, human resource development, etc..

Output performance of the projects is defined using the results of the research presented in the [14]. Mir and Pinnington (2014) [14] after giving definition to project success were looking for a definition for project management performance and it is decided that PMPA model of Bryde ([5], [6], [7]) would be more suitable for the analysis. This model PMPA (Project Management Performance Assessment) is based on five enablers (output performance) of high performance PM (Project management); PM leadership, staff PM, PM policy and strategy, PM partnerships and resources and project life cycle management of processes. Additionally, there is another area in this framework - PM Key Performance Indicators which is based on actual measurements of achievement in project management activities.

Project Success variables in this paper were analyzed and the results are important because this paper is the first research that analyzes the relationship between the PMPA framework elements and Project Success variables. Project Management KPIs have the most wide ranging impact across the different variables of Project Success since it has the highest correlation amongst other variables. Besides Project Management KPIs, Project Management Lifecycle Management Processes and Project Management Staff also contribute a reasonable amount of variance in the Project Management Success variables. It was concluded that Project Management KPIs was the most important variable that affected the success of the projects therefore companies should invest in such area to develop methods that measure mentioned KPIs.

3.3. Project management in ISO 21500 and 10006

By the definition projectsare complexuniquebusiness venturethat is being undertakenin the futurein order to achieve objectives in the allotted time and with projected costs.

In real life there are generally two types of projects: investment projects, which change the way organizations work and commercial projects which directly generate income for performing organization.

Benefits realization is at customer side only. But for organizations performing commercial projects just collecting benefits is the main reason for performing projects.

ISO 21500:2012 [11], *Guidance on Project Management*, is an international standard that was intended to provide generic guidance, explain core principles and what constitutes good practice in project management.

This standard divides project processes into five process groups which are described as: Initiating, Planning, Implementing, Controlling and Closing.

Standard ISO 10006:2003 [10], *Quality management systems - Guidelines for quality management in projects*is applicable to projects of varying complexity, small or large, of short or long duration, in different environments, irrespective of the type of product or process involved but it is not a guide to project management itself.

They are applicable to projects which can take manyforms from small to very large, from simple to complex, from being an individual project to being part of aprogram or portfolio of projects. They are intended to be used by personnel who have experience inmanaging projects and need to ensure that their organization is applying the practices contained in theISO 9000 family of standards, as well as those who have experience in quality management and are requiredto interact with project organizations in applying their knowledge and experience to the project.

4. THE INTEGRATED MODEL FOR IDENTIFICATION AND MEASUREMENT OF PERFORMANCE

As being said standards ISO 21500 and 1006 are applicable to ISO 9001 oriented companies. By ISO 9001 organizations must havea developed network of business processes ([1],[9]) which in reality is not always true case. This paper presents a conceptual model (Figure 1) of organizational management in production organizations that operate in Republic of Serbia through the use of network business processes which are inaccordance with ISO9001. Only then it is possible to apply the standards ISO21500 and 10006 for the project management in these types of businesses and to measurementioned key performance indicators if these organizations operate in such way.

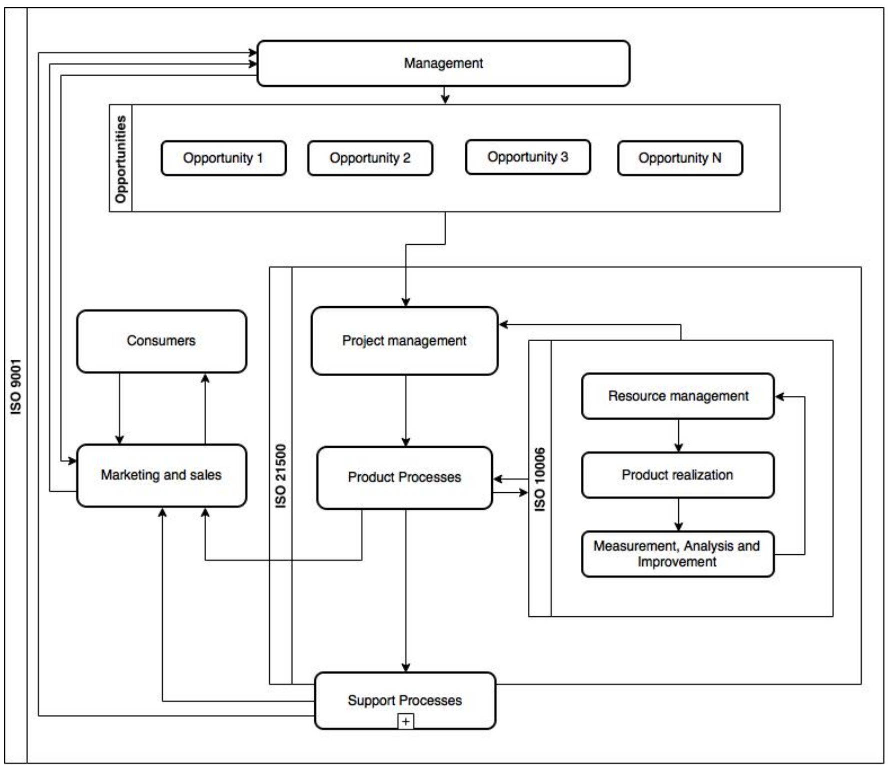

Figure 1. Conceptual model in which project performance can be evaluated respecting organizational scheme and standards ISO 9001:2008, ISO 21500 and ISO 10006

Figure 1 shows that management team have total control over business process network and project realization through utilization of standards ISO21500 and ISO10006 for project management.The measurementof key performance indicators is criticalthing to doin order to know the currentstate of the organizationand the measuresand strategies for improvement.

5. CONCLUSION

This paper propose concepts of organizational structure for enterprises which operate in Republic of Serbia and proposethe model for project success evaluation through measuring reviewed input and output performances of project and finding the right correlation between those subjects using mathematical models based on the theory of fuzzy sets, fuzzy group decisions, Analytic Hierarchy Process and multiple regression analysis. After getting the real values of this correlation, genetic algorithms can be utilized in order to find which is the strongest and which is the weakest link between input and output performance. Based on all this data given from the enterprises and data obtained through mathematical model, neural networks can be used to see future state of the project and projection on the goals set by project management before project realization so the proper strategies can be made in order to improve the organizational business model.

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CREATING THE AGILE PROJECT ENVIRONMENT: DEVELOPMENT OF EFFECTIVE AGILE TEAMS

Slobodan Morača, Jelena Grujić, Angela Fajsi
Faculty of Technical Sciences, Trg Dositeja Obradovića 6, Novi Sad, Republic of Serbia

Abstract: *Agile methodology is a very significant part of project management approach. This methodology inquiries different model of project teams organization, in a certain way different from traditional methods. Effective teams are main chain in agile development approach, so they are in direct connection to success or failure of project. This paper shows main directions of human resources development within agile project management.*

Key words: *Human resources, Agile project, Productivity*

1. INTRODUCTION

Modern concept of organization and processes management is based on Information and communication technologies (ICT). Unpredictability and dynamism of the environment requires implementation of new organization and management methods and techniques in business processes.

Also, new agile methodologies of product development are required. ICT become an indispensable part of most processes with a significant influence on rapid development of ICT products.

Changes are constant and technologies advanced intensively, which make R&D processes more complex regardless of whether these processes are in enterprises or Universities. These new methodologies require creation of multidisciplinary development teams who have a significant experience and clear development vision. Agile team must be formed from people who are ready to work in highly variable environment.

Creation and development of effective agile teams represent both a considerable challenge and a significant opportunity for organizations of the 21st century.

2. TEAM ORGANIZATION AND COMMUNICATION CHANELS BEETWEN MEMBERS

Efficiently organized team represents the base of agile development in domain of IT industry. The goal of each software business organization is to maximize team productivity due to cutting expenses and increased profitability [1].

The main characteristic of agile approach is that team work in small groups. Small teams are more flexible to performing activities than larger ones. Therefore, smaller number of people in a team provides easier communication than when we have many people. The advantage of small team is in better interaction among their members. With smaller number of people, everyone is in interaction with each other. Forming effective team is crucial activity in agile project management.

Characteristics of agile team are ability to change roles in team in case that individual person is not successful in some field. Agile teams easier conduct work strategy, because they consist of smaller number of people.

The agile management approach works in way that teams have high level of autonomy, and members are independent from leader. Important thing to say is that those teams have not straight hierarchy between members. The leader primarily must protect team from negative influences and give useful advices related to business. Relations in agile team should be based on cooperation, mutual respect and tolerance. As this team function without a leader, members of team must make a decision independently.

The advantages of agile team:

– Getting faster information;
– Easier to change opinions;
– Better decision understanding;
– Considerate different problem solutions.

One of the most important performances for people which are members of agile team is communication. When we speak about communication channels within agile projects, efficient control of these channels is the most important element in that particular field.
For project to be considered as agile, it is need to be formed communications channel between users, development team and stakeholders. Therefore, it is a significant to choose right way of communication such as a "face to face".
Communication between members must be in both directions. In this way information are carried directly and members get instant recurrent information.
Another way of communication that is serious for agile management is organization of meetings. Meetings are good way for a controlling realization of project and getting information necessary for further improvement.
Agile development methodology demands from members to communicate casually. For an example, every day in Scrum teams they have meeting where is discussed about achievements and what next shall be done.
Informal team has several advantages as follows:
- Development of team can express their creativity;
- There are positive atmosphere in team;
- Increase productivity;
- In this way the team is adopted faster and easier to changes (Fig 1.).

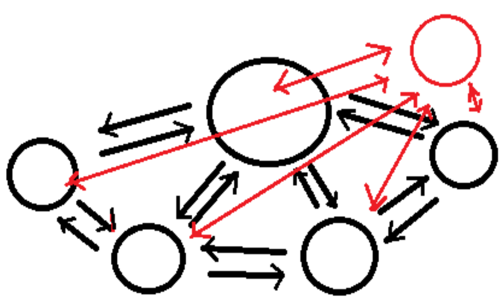

Fig 1. Informal communication channels

In order to develop effective agile teams it is necessary that information be provided at the right time and at the right place. Also, formal communication channels need to be described in more details.
Number of informal communication channels is a significantly higher than number of formal channels. These channels need to be identified; it is necessary to provide smooth communication among team members. Special attention is put on communication channels between "product owner" and team. This is needed to be organized as a formal type of communication.

3. MOTIVATIONAL FACTORS OF AGILE TEAM

Members of team should be motivated in a way to maximize their potential. Motivated people and their satisfaction are basic source of competitive advantage on the market. Each particular job affects employees differently. There are a lot of circumstances that affects work. Employees are mostly motivated with personal achievements, which support them for advancement.
Programmers and other members of team want to work freely without pressure of leader. On the other hand, their independency need to be followed by high quality of their work Thus, it can be said that quality of their work depends on level of their motivation.
Most of ten motivation factor for IT experts (from the strongest to the weakest) are [2]:
- Achievement;
- The potential for growth;
- Individual work;
- Recognition;
- Progress;
- Technical supervision;
- Responsibility;
- Relationships with colleagues;
- Relationships with subordinates;
- Salary.

The relationship between communication and motivation in agile team is very strong. It is high level of connection, because communication is very important for exchanging information, feelings and thoughts. Without good communication channels, in agile team, is not possible to motivate people. This feedback is highly important and represents key of success.
Leader a team the end every sprint, must to indicate the importance of good job and to give employees stimulus to continue working. One manager describes this as one of the most significant changes with Scrum "Pushing and motivating the team members to organize and take responsibility instead of organizing the team" [3].
Conflicts are common in team and can reduce speed project development. Most common cause is a conflict between members of team which spend too much time together.
Because of that in some cases leader is a mediator between members. He is a person who is in charge for cooperation inside team and controls every clash adequately. At the same time he reconciles participants (Table 1.).
The most common causes of stress in agile team are
- Constant interpersonal conflicts;
- Too much control;
- High responsibility;
- Unclear tasks;
- The conflict about redistribution of roles in the team;

– Excessive workload;
– Untapped potential;
– Wrongful system rewarding business.

Table 1. Expression coflict on each level [4]

Coflict level	Successful response options
Level 1. Problem to Solve	Collaboration. Seeking a win-win situation. Consensus. Learning where every team member's head is with regard to the issue and, in time, arriving at a decision everyone can back.
Level 2. Disagreement	Support. Empowering the other to resolve the problem. Safety. Anything that restores a sense of safety, such as collaboration games or regrounding in the team's shared values.
Level 3. Contest	Accommodate. Yielding to the other's view when the relationship is more important than the issue. This is a successful short-term strategy only and becomes a liability if used often over the long term. Negotiate. When the "thing" the conflict is about is divisible, such as the use of shared resource, negotiation can work. Negotiation will not work when the issue revolves around people's values. Values are not divisible, and one person giving is to another in violation of their own values feels like a sellout. Get factual. Gather data about the situation to establish the facts.
Level 4. Crusade	Establish safe structures again. Use "shuttle" diplomacy, carrying thoughts from one group to the other until they are able to de-escalate and use the tools available at lower levels of conflict.
Level 5. World War	Do whatever is necessary to prevent people from hurting one another.

Decreasing amount of stress in organization means that accomplishment is improving. Also, there is appearance of increasing motivations for jobs.

4. PRODUCTIVITY AND FOCUS ON ACHIEVING GOALS

An organization is always streaming to improve the overall organizational productivity. Organizational productivity is dependent on individual and team productivity. Thus improving software development team's productivity results into improved organizational productivity. The productivity improvement is part of team development. Hence, one should try to increase the productivity of software development teams resulting into the better organizational productivity and performance. [1]
Agile team must be constantly focused on what they are doing. The increased productivity and demands for personalized products are the main issues related to the achievement benefits from flexibility [3].
The average agile team focus is about 80%. The picture shows focus beloved 80% which means some influence on it or solving problems in other way. It is possible to achieve focus at 100%. That explains maximum dedication to goals. Also, it is not good because it can neglect responsibilities (Fig 2.).

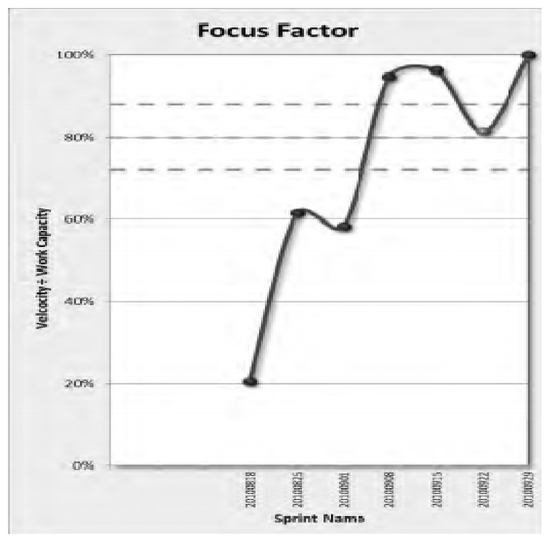

Fig 2. Level of focus in Scrum team [5]

Productivity of agile team entirely depends on human resources. This must be devoted completely. Here is just some guidelines for positive and negative influence. Setting goals to the programmer, providing training, giving periodic feedback on his or her performance improves the individual productivity of programmer [6].
Members must be experts for work in team and must have certain skills which improve productivity [6]:
– Kindness;
– Creativity;
– Dedication;
– Tolerance;
– Initiative;
– Enterprising;
– Communication abilities;
– Optimism.
People who are similar by their nature are not welcome in agile teams because their attitude decreases productivity. People who work at agile

teams must have certain quality and not to give up easily. Changing things in team not only affect productivity, it can also change identity of team. One person can be very important for team in productivity and if he is also motivator and actuator, it can be crucial for success.

Agile team for productivity due to must have cohesiveness. Cohesiveness is increasing with more cooperation in team. Communication is also a measure of productivity. Clear tasks are precondition for productivity.

Some of factor which affect productivity are [6]:

– Identity of the team
– Personnel changes on the team
– Cohesion team
– Communications team
– Clear objectives
– Support for innovation

Innovation increases productivity of agile team in both technology and management. There are some others factors that affect productivity and can be critical in developing teams. Setting goals to the programmer, providing training, giving periodic feedback on his or her performance improves the individual productivity of programmer [6].

Here are a few signs of burnout [7]:

– Excessive overtime; becoming the norm with long term duration;
– Rising mistakes: bugs, poor design choices, and hurried implementations;
– Rising temperatures, increasing levels of team stress and conflict;
– Lack of humor / fun, team is too focused and lost any playfulness;
– Lack of refactoring or quality investments;
– Excessive negotiation (or avoidance) of your Done-Ness, rushing at the ends of Sprints;
– Excessive time-off, high levels of team stress seeping into home
– Not taking time off / not taking or cancelling vacations;
– Increased paranoia; “they” are after us, we have no choice;
– Lack of transparency, honesty, openness, and continuous improvement.

5. FINAL CONSIDERATIONS

In this paper has been shown in which way an agile team works when it is not productive. Unintended consequences should be prevented on time.

Research is show next results [9]:

– Productivity: 68% of respondents reported Scrum is better or much better; 5% reported Scrum is worse or much worse; 27% reported Scrum is about the same.
– Team Morale: 52% of respondents reported Scrum is better or much better; 9% reported Scrum is worse or much worse; 39% reported Scrum is about the same.
– Adaptability: 63% of respondents reported Scrum is better or much better; 4% reported Scrum is worse or much worse; 33% reported Scrum is about the same.
– Accountability: 62% of respondents reported Scrum is better or much better; 6% reported Scrum is worse or much worse; 32% reported Scrum is about the same.
– Collaboration and Cooperation: 81% of respondents reported Scrum is better or much better; 1% reported Scrum is worse or much worse; 18% reported Scrum about the same.

This paper is about principles of agile projects and it presents significance for creating agile development teams. There is a guideline how to develop and implement positive results in team.

ACKNOWLEDGMENT

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LEAN PRINCIPALS AND RFID USAGE FOR IMPROVEMENT OF DISASSEMBLY EFFICIENCY

Milovan Lazarević, Nemanja Sremčev,
Gordana Ostojić, Đorđe Lazarević
[1]Faculty of Technical Sciences, University of Novi Sad, Serbia

Abstract. *The efficiency of the system for disassembly is constantly open question. There are many problems, and their elimination can significantly increase efficiency of these systems. The paper proposes the application of LEAN principles and Radio Frequency Identification Technology (RFID) with supporting Product Life Administration - software solution (PLA), for the identification and analysis of problems which need to be overcome, in an effort to increase the efficiency of production systems for the disassembly of the product.*
Key words: *RFID, LEAN, disassembly, efficiency.*

1. INTRODUCTION

Disassembly is defined as the process of dismantling of the product into its constituent parts or subassemblies [1]. It also includes the analysis of product's state and selection of separate parts. It is a set of operations that are performed on the work stations for disassembly with the help of specific tools.

To effectively carry out a disassembly process, technological process of disassembly was established after the complete determination of influential factors on disassembly. Influential factors in disassembly are [1]:

- materials and parts (hazardous materials, valuable - expensive materials, re-usable parts),
- structure and connections (type of parts, number of parts, the connection method),
- disassembly method (non-destructive, partial destruction, destruction),
- costs of disassembly (disassembling time, disassembly location),
- the state of the disassembled parts (purity, erosion regard, the level of quality for recycled parts),
- disassembly technological process data (quantity, existing disassembly system, cost effectiveness),
- used technologies (regeneration techniques, depositing methods, re-use, cost of reprocessing),
- disassembly equipment (machines for disassembly, disassembly tools, disassembly accessories),
- disassembly technological process, and
- disassembly process (the content of the operation, the direction of disassembling, disassembly forces, tips).

All the assumptions for the effective execution of the disassembly process are basically appropriate informations. Their ensuring is necessary in order to achieve a balance between efficient use of labor, tools, machinery and space. Systems for disassembly can have various configurations, complexity and size. Major contribution to the success when designing large and complex disassembly system is achievement of economic goals and efficient use of resources, which is achieved basically by reducing the effects of the eight losses according to LEAN philosophy [2].

To achieve these objectives, in the paper will be presented the results of research into the possibility of applying RFID technology as a support to collect the necessary information with the use of appropriate software solutions - PLA (Product Life Administration - software for product lifecycle information processing) and User Interface - RFID (UI - RFID) as well as his part for the implementation of the system for disassembly. In addition, the use of RFID technology is suggested and as a support for effort to apply the basic principles of LEAN philosophy.

Basic elements of each RFID system are [4]:

- tag - as a carrier of information, represents a mandatory component,

- reader - also a mandatory component,
- antenna (required),
- controller - mandatory component, but most readers of new generation has this component built,
- sensor, indicator and actuator – These optional components are needed for external input and output of system, and
- software support.

2.1 The software structure for application of the RFID

Software for processing information from the product life cycle consists of two parts.
The first part is a central part, and it is used for the processing of information in both directions - to users and receiving information from the user. This software is PLA software (Product Life Administration - Information processing software during product life cycle).
The second part of the software is planned for communication with users and is called User Interface - RFID (UI - RFID) (Fig.4.). UI-RFID also processes information in both directions, but the information that UI-RFID forwarded to the PLA is shorter.

2.2 User program in disassembly - UI-RFID-D

Products that come in disassembly system do not carry any information about their lifetime who have just finished, and on the other hand there is no information either about the structure of the product - parts and materials. For this reason, the process of the product disassembly is substantially hampered due to lack of knowledge about: the disassembly process, condition of each component and the type of material which has the effect of reducing the quality of selection of the disassembled components and materials in the appropriate flows [1].
Therefore, the application of RFID technology can significantly help overcome the problem.
UI-RFID-D software was developed to help overcome the problem of information lack, and also to enable the optimization of product management, materials and its individual components.
The user interface in the disassembly (UI-RFID-D) aims to provide information on the procedure for product disassembly, the necessary tools and selection of components on the one hand, and on the other hand, that the manufacturer receives information about the status of a product that has arrived in the disassembly system (Fig. 4.).
It is this segment which creates a better perspective of the possibilities for product management throughout the life [4].

3. BASIC LEAN PRINCIPALS

LEAN philosophy is basically based on five principles:

1. Value – focus on customers (the ability or the possibility to meet the requirements of customers with products and/or services at the right time and with the proper price);
2. Value stream – effective and efficient work processes of determining the needs and expectations of customers, and to their fulfillment;
3. Flow — continuous flow, so that the product passes all processes, without stopping, rejects, poor quality, etc;
4. Pull – start production at the request of customers;
5. Perfection – perfection in the work through continuous search for perfection.

Moving towards the fulfillment of these principles is a long way to go, and the model that is being proposed is simply a step in that direction.

3.1 Causes of lower disassembly process efficiency

Workplace losses are numerous and vary. Every type of losses on the work places could be recognized trough 7 basic wastes: Overproduction, Wait Time, Transportation, Overprocessing, Inventory, Motion, and Defects/Rejects [4], [5].
Each of 7 wastes affects the inefficiency of whole system and contributes to lack of productivity and employee safety. Some of basic causes of losses (wastes) of the system are [1]:

- Lack of information about the product,
- Lack of knowledge about the structure of the material,
- Lack of knowledge about special procedures
- Wrong selection of materials,
- Slowing down the process due to variable product selection, and
- Losses due to inappropriate movements during the operation.

The most common case with which is faced disassembly systems is the presence of different types of products that result in efficiency reduction of workers.

Figure 1. Numerous electrical and electronic products

This causes problem to the workers at the disassembly stations during operations, which consist list of sequences shown on figure 2.

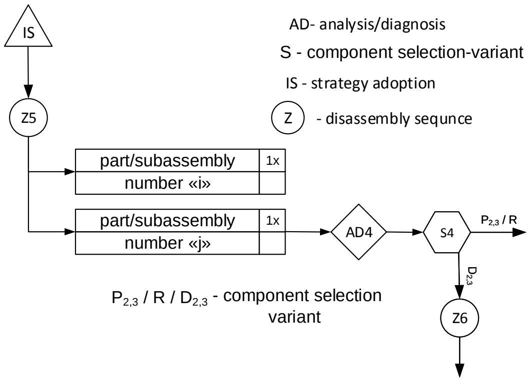

Figure 2. Disassembly standard procedure

For this reason, the process of the products removal due to lack of knowledge is significantly hampered, because of the lack of knowledge of technology for disassembly of products and regarding this, necessary tools, status of individual components and the type of material (which has the effect of reducing the quality of disassembled components and materials in the appropriate flows [4]).

Observing an individual work in the process of the product disassembly, it is very easy to identify individual losses according to LEAN definition (see 3.1). Figure 4 shows a usual situation with which workers are faced in the process of product disassembly.

Figure 3 shows usual situation with the presence a number of tools at the work stations. One of the reasons lies in the problem of the impossibility of planning the necessary tools for disassembly of products which arrive into the process.

Figure 3. Typical work station in the operations of products disassembly

Hence, there is the need for supplying working places with a large number of tools.

Due to the presence of a large number of tools in the process, comes to the extension of required time for work, as a result of the search for the appropriate tools by the workers. "Crowd" of other tools required for disassembly of particular types of connection in the product complicates and slows down the process (eg. different dimensions tools for unscrewing).

Therefore, the application of RFID technology to a large extent can help to overcome the above problems by providing information which tools are needed and how an operation and selection of components should be performed.

4. APPLICATION UI-RFID-D IN THE SISTEM FOR DISASSEMBLY

UI-RFID-D software was developed to help to overcome the problem of lack of information and also to enable the optimization of product management, materials and its individual components.

Systems for disassembly of products have a problem that they need to process a large number of different varieties and types of products. For most of products, as already mentioned above, there is no any information on the procedure of disassembly and after that how to conduct separation of components and materials which are obtained through disassembly of products.

In addition, in most cases there is not even any information about the status of the manufacturer product in its life cycle. The user interface in the disassembly (UI-RFID-D), aims to provide information on the process of removing the product, the necessary tools and selection of components on the one hand, and on the other, to transmit the information to manufacturer about the status of products which has been received in the system for disassembly (Fig. 4.).

This segment creates a better perspective of the possibilities for product management throughout their life [4]. On the Figure 4 has been shown the principle of designing UI-RFID, and concept that only the most basic information should be distribute toward the work stations, which are needed to correctly execute working operations.

Also, the use of a software interface does not burden the process of work and activities of the worker are reduced to a minimum. Reading the tag in front of certain workers in the process, at the screen appears: marking the start of the operation (start time) (Figure 4), a request for a description of the technological process and the necessary tools-description (if necessary) and marking the end of the operation mode (end time). This allows rapid decision making in the process of disassembly, which has so far largely been the reason for the prolonged processing of certain products. Longer time of the product disassembly will directly affect the cost of processing the product [2]. Observing and analyzing processes of disassembly through use of data obtained by application of UI-RFID-D, could be monitored the performance of each work stations.

Analysis of this kind of data, could help to identify the problems and their causes, which has resulted in some of the above mentioned seven types of losses (3.1).

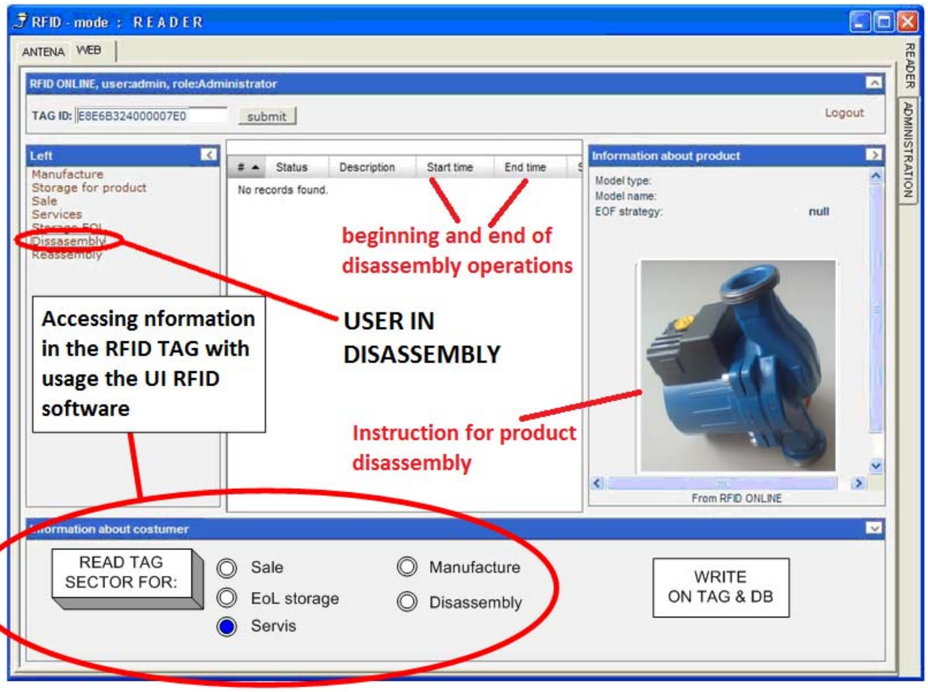

Figure 4. UI-RFID-D software interface

Application of such kind of solution is directly affected on the elimination of losses according to the LEAN philosophy; such are overprocessing, movement, wait time, defects/rejects.

4. CONCLUSIONS

First step in an attempt to increase the efficiency in operations of systems for disassembly should be sought in the solution or at least reducing the impact of the following problems:

- The question of the efficient tool selections,
- The question of availability of tools for disassembly (the availability of the selection is made)
- Availability of information's in the form of instructions on how to perform the product disassembly.

In other words, how to disassemble specific connection, on the product in the fastest possible way. For this purpose it is necessary to define, exactly on time, necessary tools, in the shortest time, which should be immediately available. Instructions on how to separate certain connection, with the selected tool should be equally available and clear in the description of how to perform a specific procedure of disassembly. The first step in that direction is to provide necessary information by using RFID technology and the corresponding software solutions. In this way, the race against time has begun. That is the first prerequisite for the implementation of LEAN principles, with the aim to increase the efficiency of the system for the disassembly of the products.

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DEFECTIVE ITEMS, INSPECTION ERRORS AND YIELD

Moshe Eben-Chaime[1]
[1]Department of Industrial Engineering & Management, Ben-gurion University of the Negev
P.O. Box 653, Be'er Sheva 84105, Israel, even@bgu.ac.il

Abstract. *Quality is a principle subject in industrial engineering (IE). There exists no perfect process and some extent of failures, including the production of defective items is unavoidable. A defective item for the purposes of this presentation is an item that cannot be used as it is, as planned. A detective item is either scraped, sold for lower price, reworked or repaired and in any case involves loss of money. Rather unnoticed is the fact that costs of poor quality are accumulated prior to the production of any defective item. A common method to improve quality is to inspect the items and remove those that found defective. Inspections, however, are also imperfect and prone to errors, which have devastating effects. Despite their significance, these effects are rather unnoticed, too. In this study, long term repercussions of both the existence of defective item and of inspection error are examined.*

Key words: *Defect rates, Inspection errors, Quality costs.*

1. INTRODUCTION

Feigenbaum [1] (page 47) minted the term "*hidden plant*", and defined it as "the proportion of plant capacity that exists to rework unsatisfactory parts, to replace product recalled from the field, or to retest and re-inspect rejected units;" i.e., consequences that are incurred after an item is detected as defective. However, capacity is used before the item was even damaged. Moreover, when inspections are used, conforming units are falsely rejected due to inspection errors. The production capacity consumed to produce these falsely rejected units is also wasted! Feigenbaum estimated that *hidden plant*s amount "to 15 percent to as much as 40 percent of productive capacity". Here, means to quantify this figure and more important to evaluate and compare alternatives are provided.

2. DEFECT RATES AND I/O RATIOS

Let d_i denote the average defect rate of operation/activity i. (The defect rate depends on both the activity and the station chosen to perform it but let's assume the stations are already selected for each activity.) Note that defects due to ***common***, or chance, or random causes are considered here, not quality deterioration due to *assignable* causes as in [4]. Assume also that:

1.activities/operations are independent;
2. the processing of different items in a station are independent, too.

Then, if activity i is performed on Q units, the mean number of acceptable units is only (1- d_i)Q. Averages are proper measures since long term performance is considered. The calculation can easily be extended to serial processes. If Q_0 units enter the first activity in a serial process of n operations, the mean number of acceptable units at the end is

$$Q_n = Q_0 \prod_{i=1}^{n} (1 - d_i) \qquad (1)$$

Freiesleben [3] used this term to develop a cost model, which led him to the conclusion that "the total costs of production actually decrease if we have quality problems and therefore a defect rate greater than zero"! Even worse, "Although at first this might sound surprising, the decreasing total costs of production for poorer quality levels are to be expected"!!

Certainly, no cost decrease due to poor quality. Cost increase because larger quantities should be processed to compensate for the poor quality, but IE/operations management perspective is required to see it. Figure 1 portrays a serial production process chart; e.g., [2], where each node represents an operation.

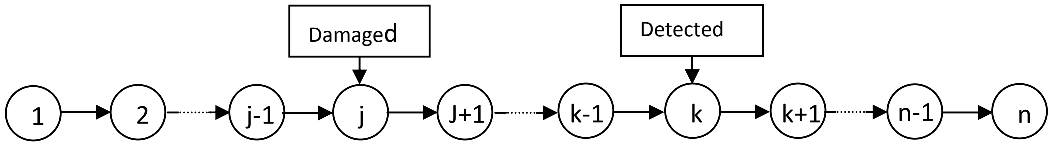

Figure 1. A defect item divides the production process into three segments

d \ n	10	20	30	40	50	60	70	80	90	100
0.001	1.010	1.020	1.030	1.041	1.051	1.062	1.073	1.083	1.094	1.105
0.005	1.051	1.105	1.162	1.222	1.285	1.351	1.420	1.493	1.570	1.651
0.01	1.106	1.223	1.352	1.495	1.653	1.828	2.021	2.235	2.471	2.732
0.02	1.224	1.498	1.833	2.244	2.746	3.361	4.113	5.034	6.161	7.540
0.03	1.356	1.839	2.494	3.382	4.586	6.219	8.433	11.436	15.508	21.029
0.05	1.670	2.790	4.659	7.781	12.996	21.706	36.253	60.550	101.129	168.904

Table 1. Q^{in}/Q^{out} ratios

Each defective item divides its production process into three segments. In the first segment the item is conforming. This segment ends when the item is damaged. The second segment starts right after the end of the first, and ends when the defective item is detected, and the third segment is after detection. Both last segments cannot exist – be empty, but the first segment contains at least one activity: $j \geq 1, j \leq k \leq n$. If inspections are made, defective items that are detected can be removed and thereby save the costs associated with, and the capacity required for future operations. A defective item can either be scrapped, used as it is for lower price, reworked or repaired. The last two cases involve costs and require capacity, additional to the regular production capacity and costs, while in the first two cases capacity is wasted and income is lost, which is equivalent to cost increase. Moreover, inspection and corrective actions can affect only the last two segments and the corresponding cost. Only process improvement can affect the first segment and its corresponding cost.

Further, there are sales targets and/or orders to deliver. "One of the customer's highest priorities is timely delivery of usable material." [9] The operations management community developed material requirements planning (MRP); e.g., [8], to meet this challenge. "MRP ... represented a huge step forward in the planning process. For the first time, based on the schedule of what was going to be produced ... the compute could calculate the total need" [9]. That is, production planners know how many end items are needed. From these figures, order quantities are calculated backward. The principal argument of this paper is that similar approach should be taken when quality is considered. Whenever defective units are not used as intended, more units should be produce to replace these units. A reworked unit is just as an additional one with, perhaps, additional preparation activities, and repair requires additional repair capacity. Thus, (1) should be re-written as in (2), where d_i is the fraction of defective units that are not repaired:

$$Q_j^{in} = Q^{out} \Big/ \prod_{i=j}^{n} \left(1 - d_i\right), \tag{2}$$

This calculation accounts for all items that will be damaged, and not repaired, in operation j and subsequent operations up to the last activity, n. Furthermore, this is the minimal quantity – larger quantity maybe processed in activity j if defective items from preceding operations have not been removed earlier. Suppose $j = n$-19; i.e. there are 20 operations to go, including j, and all share the same defect rate of 1%. Then, $Q^{in} = Q^{out}/0.99^{20} = 1{,}226\ Q^{out}$. Namely, 1226 units will be processed, knowing that only 1,000 of them will be useful!

Additional illustrations of this impact are presented in Table 1, were common defect rates, d is shared by n operations. Notice the stepped line in the table – the numbers to its right are larger than 2, implying that (often, much) more than half the processed items will eventually be defective!! Again, no inspection can change these figures, only process improvement can reduce the quantities Q_j^{in}.

Paradoxically, attempts to fix the situation may worsen it! A defective item can be detected either in a coincidental manner; e.g., incompatibility during assembly, or by inspections. Inspections, however, are, too, imperfect and involve errors; e.g., [9]. It turns out that inspection errors can reduce the yield of the process, often even more than the defect rates.

3. EFFECTS OF INSPECTION ERRORS

There are two major types of inspection errors: Type I - disqualifying conforming units and Type II - missing nonconforming items and let them slip through to proceeding operations. These nonconforming items were referred to in noting that the numbers of Eq. (1) are minimal. Here, Type I error - disqualifying conforming units, is of more concern. Further, when inspections are considered, inspections are often used for process monitoring; e.g., [12], while here, inspections are used for cleaning - detection and removal of defective units. As noted, defective units cannot be used as intended. Hence, more units must be produced to replace them. This conclusion is, now, extended to include items that are falsely disqualified, too. Enlarged production facility and infrastructure to make extra production capacity is required to compensate not only for defective items but also for good items that are falsely rejected!

How bad is it? Suppose the type I error probability is α, then $\alpha \cdot(1- d)$ of them are falsely disqualified. To illustrate, let d = 1% and α = 5%. Then, of 1,000 units, 10 are defective and another 49.5 units, about 5 times more, are falsely rejected, on average! No wonder, thus, that Type I errors are termed the producer's risk; e.g., [7]. Further, there is another similarity between false rejections and defective items - both accumulate along the production processes. Schorn [10] considered a processes which consist of a single casting operation in the foundry industry. More often however, many more operations are involved. In wafer fabrication in the semiconductor industry, for example, "each process flow contains 300-700 process steps" and "many inspection steps are added to the process flow" [6]. Consider for instance, a process of 70 operations, with a defect rate of 1%, each. The yield of this process is about 50%. This implies that if 1,000 units are required, 2,021 units should enter the process. Note by passing the magnitude of nonconformance! Further, consider the contribution to costs of this part of Feigenbaum's *hidden plant*. If seven inspections are added, say after each ten operation, with α = 5%, each, then the good intention results in a yield decrease to 34.55%! Consequently, the number of units that should enter the process, to yield 1,000 units, grows from 2,021 to 2,894, knowing in advance that 1,021 units will turn defective and another 894 will be falsely rejected, on average, leaving the 34.55% yield. Of the 2,894 units that enters the process, about 277 are defective after 10 operations - upon arrival to the first inspection. Another 131 units are falsely rejected in this inspection. This pattern continues until the last inspection which falsely rejects 52.6 units before passing the required 1,000 units.

Besides, false rejections are of conforming units. Hence, their number grows larger as quality improves: $\alpha \cdot(1- d)$ grows larger as d decrease. Luckily, the increase is rather small when the defect rate approaches zero. It grows only to 49.75 when d = ½%. But the question remains: does the detection of up to 10 defective units worth the rejection of almost 50 conforming units? This indicates the need for strong inspection tools - less error prone. However, often the two error types stand in conflict. That is, when the probability of one decrease the probability of the other increase.

A note before closing regards another difference between both error types. Falsely rejected items are removed while missed defective items continue to flow in the process. In the example, 14 defective units, on average, slip through the first inspection, letting 2,500 units to continue to the eleventh operation. Some 6 defective units to slip through the last inspection, in addition to the 1,000 required units.

4. CONCLUSIONS

While six defective units is much less than 1,021, this reduction is achieved at a huge price - 894 units are falsely rejected. If, the defect rates are reduced, instead, the yield grows. To illustrate, if all the defect rates are reduced to ½%, the yield grows to 70.4%. Feed of only 1,420, rather than 2,021, units will yield 1,000 conforming units, and with inspections the required feed is of only 2,034 units.

As indicated in the introduction, cost are accumulated up to the rejection point by each rejected item, either defective or false reject. These are part of the internal reject costs, which, thus, seem to be much higher than in e.g., [10]. Moreover, rejected units cannot used as intended. Hence, more units must be produced to compensate for them. These extra units require to enlarge the production facility and infrastructure to add production capacity. This requires both larger capital expenditure - for construction, equipment, etc., and higher operation cost, beyond the direct capacity increase, to support the larger infrastructure - energy, material handling, etc.

These repercussions of inspection errors advocates alternative approaches to improve quality. Such emerging alternative takes advantage of advances in sensing technology and uses sensors to apply a diagnosis oriented strategy, which focuses on the creation of a near-zero level of defective production [5].

In this note, a serial process was used for demonstrations. Studying the ramifications of inspection errors in non-serial processes, are subject for future works.

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MARKET ORIENTATION AS A PREDICTOR FOR ENGINEERING AND REENGINEERING COMPANY

Ljiljana Pecić[1],
1 Visoka tehnička mašinska škola strukovnih studija Trstenik, ljiljana.pecic©vtmsts.edu.rs,

Abstract*: It is known that there is a huge percentage of companies that have dismissed benefits of TQM implementation. TQM is especially important for companies which come from underdeveloped countries and countries in transition. This paper is the result of long-term monitoring and it tries to prove the usefulness and necessity of using a new methodology of Company Reengineering (CR). The results showed that company may have certificated quality system, or achieved TQM or is on its way to achieve it, but if it does not have marketing oriented organizational culture, than it has to undergo the entire company reengineering using a new methodology.*

1. INTRODUCTION

The second industrial and the third technological revolutions, along with the widespread usage of computer applications in all fields of human activity (since the 1970s), brought about a sudden worldwide development which introduced entirely new behavior rules in all areas of human activity, including company operations. That change has caused the rapid growth of economic capacities, imposing a competitive spirit not only to companies but also to economies of different countries, regions and the whole world. The globalization imposed to all spheres of human life, in one way or another, has been forcing many countries, their economies and the companies operating in such environment to introduce dramatic and, to a huge extent, radical changes.

In developed countries, these changes are of primarily developing character. The radical breakthroughs which happen in their companies are related to their organizing. Proper terminology and specific methodological innovations for their implementation are given in a systemized form by the world organization for standardization and are imposed to other economies around the world. All this is supported by the series of international standards. As response to the above highlighted norms, in Japan, the most advanced industrial country in the world, total quality management philosophy occurred, known as TQM. Achieving TQM in all companies in the world is the most important imperative of organizational development nowadays.

Of course, all the above are, primarily, the characteristics of trends in the developed world economies. The economy of the early 1990s in those countries was characterized by the industry in undeveloped condition, with very low level of market economy (characterized by the existence of production and planning operations and consensus economics) and with political systems which were propagating stiffness and tightness in the lifestyle and behavior. Within these economies, business collaboration followed the principles of simple economics. When such an economy found itself in the process of changes imposed by the global world at the end of the 1980s, chaos and economic stagnation and decline significantly afflicted the companies operating within it. Now it became necessary to implement a variety of universal radical changes in ownership, programming, technology, organization, market and above all culture.

Serbia is one of the countries struck with the imposed transition process.

However, the question imposed then still holds: *according to which rules should the companies behave?*

2. NEW METHODOLOGY

Some researchers reported that TQM implementation had led to improvements in quality, productivity and competitiveness only in the range of 20 to 35 percent of the firms that have implemented it [1, 4]. Most often the reason for this situation points to the lack of organizational culture quality necessary for immediate acceptance of adequate changes. It is well known that TQM can have dramatic impact on an organizational culture [2,5]. TQM is a management approach where the application of practices such as teamwork, internal customer relationship and supplier partnership are tools for cultural transformation and involve major cultural change in the organization [3]). TQM programs have much more chances to succeed if prevailing organizational culture is compatible with the values and basic assumptions proposed by the TQM discipline [6]. The success of TQM as an organizational change will much depend on organizational culture [7].

It is well known that the companies in their business follow one of the orientations: product, sales or market. It is said that business process reengineering is a radical improvement of one or more processes, and it is a part of business process reengineering. The questions that still have not gained adequate answers are: *"What does reengineering of all processes in a company mean, what is the beginning of the realization of such reengineering, and why it should be done?"* The authors are of the opinion that there are three distinct demands for company reengineering:

- QMS is implemented and there are strives to achieve TQM, but the achieved effects are unsatisfactory, or even poor, which rises a need for implementation of radically new total process organization aiming at TQM,
- QMS is implemented and there are strives to achieve TQM, but the company is facing a great danger that can only be prevented by proper total transformation process, with a tendency of achieving TQM, and
- TQM is achieved but the company is facing a high business risk which can only be prevented by proper total process transformation with a tendency of exercising new TQM.

If the organizational culture in the company with an already organized process is at an adequate marketing quality level, then the company should arrange its organizational process using already known selective approach. However, if it is not, then the company should apply the proposed totalistic approach, referred to as company reengineering (CR).

The main factor for the successful implementation of engineering and reengineering, and successful TQM achievement, is the presence of innovative management in companies. Only innovative management in enterprises can achieve concrete innovative changes. Realization of innovative behavior in companies is possible only if its management, particularly strategic, exercises full innovation process and its reengineering.

As the final result of the persisting problems analysis, two procedures are established:

- The first one, authoritative for successful total process organization with a tendency to achieve TQM in predominantly undeveloped economies, especially in economies in transition, and
- The second one, for successful implementation of company reengineering, as a necessary and the most difficult form of radical transformation in all economic conditions.

Algorithms for performing both company engineering and company reengineering are given in further text as Algorithm 1 and Algorithm 2 and presented in Figure 1and Figure 2, respectively.

The proposed solutions take into account the specific conditions of enterprises' economies, and especially the conditions of underdeveloped economies, which are characterized by the following facts:

- Low financial solvency,
- Significant technological obsolescence,
- Unsatisfactory manifestation of market-oriented organizational culture
- Unsatisfactory level of work quality and behavior
- Social unwillingness to accept and interpret the essential norms and standards of behavior in developed economies, and
- Pressure from economically developed countries (to accept world globalization, with corresponding norms and standards).

The proposed methodological solutions take care that company engineering and reengineering must: be planned, have a long-term realization, start by introducing a new basic model, include complete workforce, and be managed and directed by an innovative management team.

3. CONCLUSION

The conducted study was done because there was a real need to find a solution for all those companies in the world whose business is not satisfactory. Achieving TQM is today`s business imperative because business excellence is realized through its implementation. During the last fifteen years process organization was implemented in all companies trying to achieve TQM. Companies from developed countries were leaders in these projects. Companies from undeveloped countries are trying to implement such changes using the same methodological solutions. However, the results are not so efficient, even for companies in developed countries. Business process reengineering, made to radically improve one or more processes in a company, provided benefits to small percentage of companies which started it.

Here presented methodology offers the solution for companies from all around the world. Business process reengineering is perhaps a solution for successful companies from developed countries, but the presented totalistic approach is much more suitable for all other companies. Such an approach, called company engineering, in its basis has the establishment of a new market-oriented organizational model and total process organization aimed at achieving TQM, based on incidentally achieved QMS. The crucial factor is whether to apply a selective or totalistic approach, and that decision depends on the level of marketing orientation of an organizational culture.

The level being acceptable, selective approach should be applied. Otherwise, a totalistic approach should be put in practice. Whenever the level of marketing orientation attains unsatisfactory level, company reengineering should be applied.

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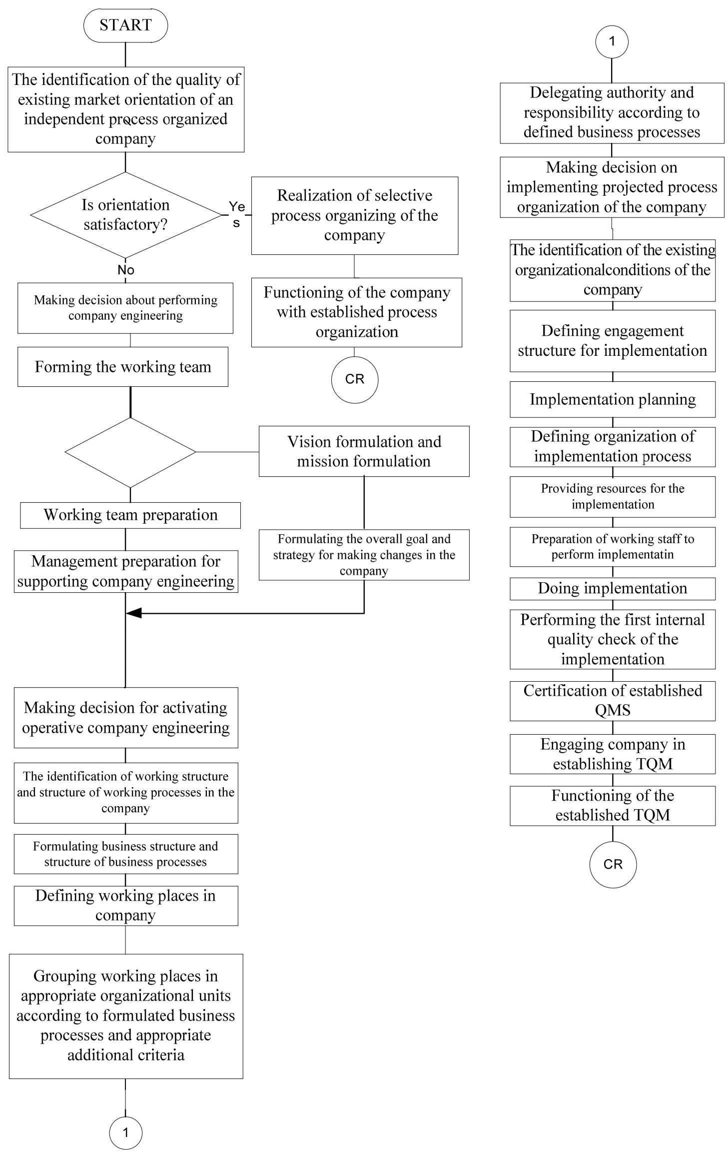

Figure 1: Algorithm for implementing engineering in the simple independent company

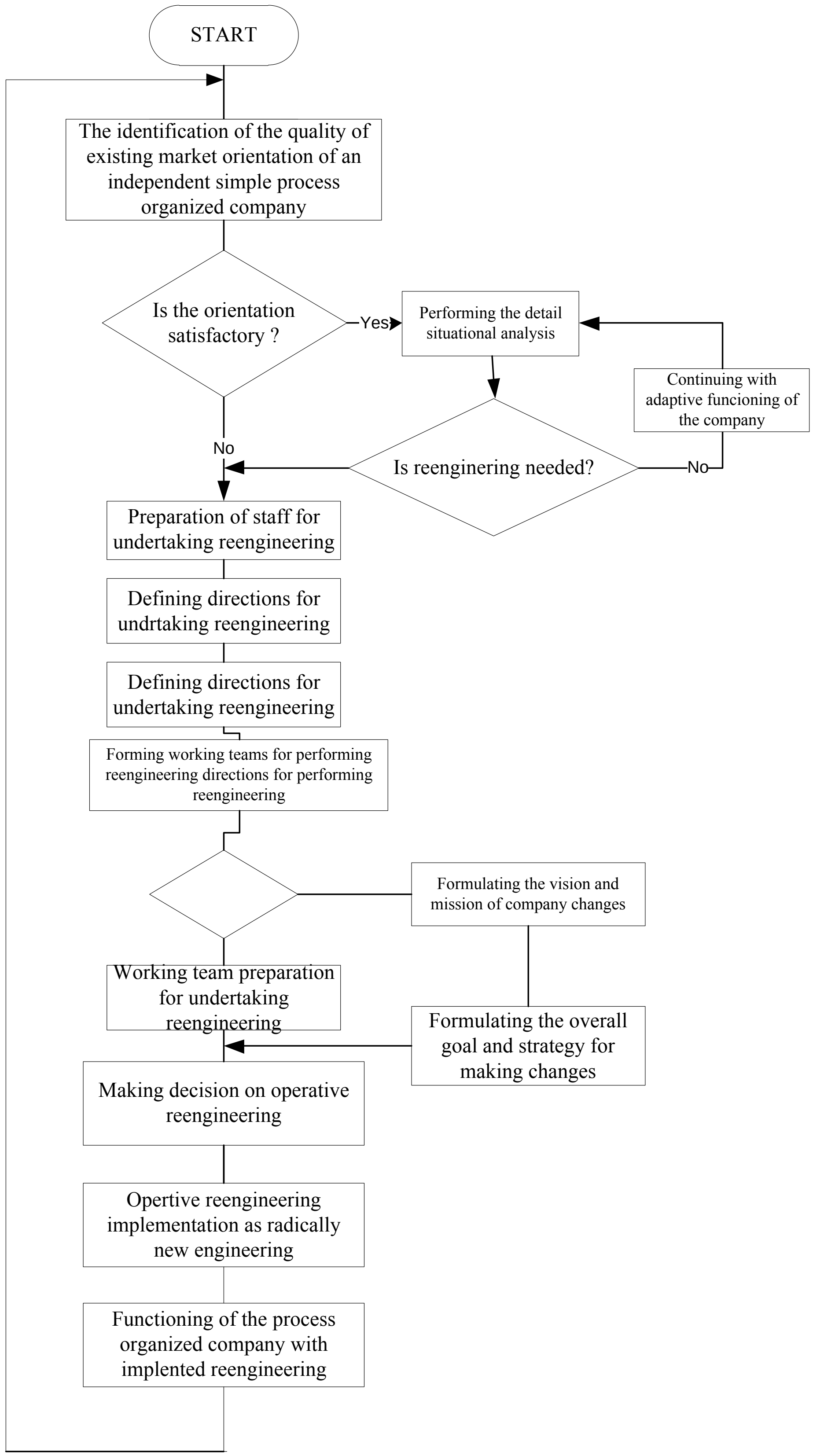

Figure 2: Algorithm for reengineering the simple independent company

Session

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THE FUZZY MODEL FOR EVALUATION WASTE IN PRODUCTION PROCESS OF RECYCLING DEVICE

Danijela Tadić[1], Slavko Arsovski[1], Aleksandar Tomović[2], Milan Pavlović[3]
[1]Faculty of Engineering, University of Kragujevac, Serbia
[2]Faculty of Mechanical Engineering, University of Belgrade, Serbia
[3]Technical Faculty "Mihailo Pupin", University of Novi Sad, Serbia

Abstract. *The aim of this paper is to explain a model for evaluating effects of different waste types which are formed in the production process into environment. The relative importances of identified waste types are different and are given by expert's assessment. Their assessments are described by linguistic expressions which are modelled by triangular fuzzy numbers. The aggregation of the individual opinions into group consensus is performed by using the fuzzy ordered weighted averaging operator. The elements of decision matrix can be calculated as product of the the aggregated relative importance of considered waste type and its value. The rank of identified waste types is given by PROMETHEE method. The effect of considered waste types into environment corresponding to the given rank. The proposed method is illustrated by example with real life data.*

Key words: *Environment, Waste, fuzzy group decision making, PROMETHEE.*

1. INTRODUCTION

Environment protection management is an area of industrial engineering that has been a very popular field of research in the terms of science and practice in last decade. Recycling management enable the development and sustainability of the company over time. According to evidence data, about 70% different waste types can be recycled. The solution of this problem can be found by applying recycling processes. It can be said that recycling processes have effect to economic, environment and energetic domains.

Recycling process can be defined as processing materials which can be used for production of different raw materials. The basic assumptions of recycling process management are: R- reduce, R- reuse, and recycle.

These are many waste types. In this paper, the focus of authors are waste which are created in the production process.

The evaluation of the effect to of the different waste types into environment can be solved by using Life Cycle Assessment (LCA) which is defined in the ISO 14040:2006, SRPS ISO 14040: 2008.

In [1] it is supposed that the considered problem can be stated as multi-criteria optimization task. In this paper PROMETHEE method [2]. There are six preference types which are defined in the PROMETHEE. Choosing preference types is based on experience and knowledge of decision makers [3].

Ranking factors which effect to environment is performed by using the PROMETHEE in ([4], [5]).

Comparing to papers which can be found in the literature, the proposed model has the some differences which can be denoted as advantages. By using LCA method, the wastes which formed in the production process are identified. The three environment elements are considered: ground, air and water. It is assumed that these elements have equal importance. Determining the relative importance of the identified wastes into environment elements is stated as fuzzy group decision making problem. The waste values are estimated by experts. Their estimates are based on the evidence data.

The paper is organized in the following: The short survey of the respecting literature is presented in Section 1. The problem statement is given in Section 2. Section 3 shows the proposed Algorithm. The proposed model is illustrated by real life data and presented in Section 4. The Conclusion is given in Section 5.

2. PROBLEM STATEMENT

The production process of recycling device can be decomposed into sub-processes. There are many kinds of waste which can be ensured in considered business process. The list of ensured waste can be defined. Each waste type has an effect into elements of environment (wather, air, ground).

The aim of this paper can be defined as determining waste type which has an highest effect to environment.

In general, waste types can be presented by set $I = \{1,...,i,...,I\}$. The total number of considered waste kinds and the total number of environment elements is denoted as I, and J, respectively. The environment is presented by set $J = \{1,...,j,...,J\}$. The i and j, respectively is index for waste type i, i=1,..,I, and environment element j, j=1,..,J, respectively. The relative importance of waste type i, i=1,..,I into environment element j, j=1,..,J is different.

The management team (quality manager, environment manager, production manager) make estimates of the relative importance of treated uncertainties. The management team uses linguistic expressions instead of precise numbers. It is close to the human thinking. The fuzzy rating of the relative importance of each considered uncertainties at the level each decision maker e, e=1,..,E are modelled by triangular fuzzy numbers (TFNs), $\widetilde{W}_{ij}^{e} = (x;\, l_{ij}^{e}, m_{ij}^{e}, u_{ij}^{e})$, with the lower and upper bounds l_i^e, u_i^e and modal value m_i^e, respectively. These TFNs are:

very low importance - $\tilde{R}_1 = (x;0,0,0.2)$

low importance - $\tilde{R}_2 = (x;0.1,0.3,0.5)$

moderate importance - $\tilde{R}_3 = (x;0.2,0.5,0.8)$

high importance - $\tilde{R}_4 = (x;0.5,0.7,1)$ and

very high importance - $\tilde{R}_5 = (x;0.8,1,1)$.

As mentioned, the production manager groups have unequal importance, so the aggregated values of the relative importance of waste types, and aggregated values of the relative importance of calculated by using the fuzzy ordered weighted averaging operator (FOWA) which is explained in [6]. The FOWA operator is an extension of the ordered weighted averaging (OWA) operator. The relative importance of quality manager, environment manager and production managers are 0.27, 0.48, and 0.25, respectively. By using the moment method [7], the representative scalars w_{ij}, respectively, are given.

The weighted values of waste type at the level of each environment element is calculated as product the aggregated relative importance and assessed value for each environment element j, j=1,..,J. The normalization of elements of decision matrix are given by using the vector normalization procedure [8].

3.0 THE PROPOSED ALGORITHM

The modified PROMETHEE method can be realized by using the following steps:

Step 1. Fuzzy rating of the relative importance of each waste type for each environment element is performed by each decision maker, $\widetilde{W}_{ij}^{e}$, i=1,..,I; j=1,..,J;e=1,…,E

Step 2. Determine to the aggregated value of the relative importance $\widetilde{W}_{ij}$:

$W_{i,j}$ = FOWA ($\widetilde{W}_{ij}^{e}$)

Step 3. Determine the representative scalar, W_{ij} of TFNs $\widetilde{W}_{ij}$, i=1,..,I; j=1,..,J

Step 4. Determine to value of each waste type, i=1,..,I for each environment element j, j=1,..,J, $v_{i,j.}$

Step 5. Construct to the decision matrix D:

$$D = \left[d_{ij}\right]_{IxJ}$$

where:

$d_{i\,j} = W_{ij} \cdot v_{ij}$ is weighted value of waste type I, i=1,..,I for environment element j, j=1,.,J.

Step 6. The normalization of elements of the decision matrix is given by vector normalization procedure:

$r_{i,j} = \frac{d_{i,j}}{\sqrt{(\sum_{i=1}^{r} d_{i,j}^{2})}}$, i=1,…,I; j=1,..,J

Step 7. The preference index of each waste type I, i=1,.,I for each environment element j, j=1,.,J is defined as:

- Positive flow:

  $\emptyset_j^{+}(a_i) = \sum_{m=1}^{I} \Pi(a_{i,}a_m)$

- Negative flow:

  $\emptyset_j^{-}(a_i) = \sum_{m=1}^{I} \Pi(a_{i,}a_m)$

Step 8. Determine the overall preference flow:

$\emptyset_j(a_i) = \emptyset_j^{+}(a_i) - \emptyset_j^{-}(a_i)$, j = 1,....., J

Step 9. Rank of considered waste types is determined with respects to all environment elements and their weights.

4.0 ILLUSTRATIVE EXAMPLE

In this Section, the proposed Algorithm is illustrated by real-life data.

The indetified waste type are: oil (i=1), dizel (i=2), organic waste (i=3), synthetic waste (i=4), metal wate (i=5), plastic waste (i=6), rubber waste (i=7) and cleaners (i=8).

Respecting to literature data, it is assumed that unit value of the metal waste is 0.8, the placstic waste is 0.06, rubber waste is 0.04, and other waste types is 0.1.

By using the proposed Algorithm (Step 1) the relative importance og each waste type i, i=1,..,I for each environment element j, j=1,..,J are assessed and shown in Table 1.

Table 1. Fuzzy rating of the relative importance of each waste type for each environment element

k=1			k=2			k=3		
Q	E	P	Q	E	P	Q	E	P
$\widetilde{R_3}$	$\widetilde{R_2}$	$\widetilde{R_2}$	$\widetilde{R_4}$	$\widetilde{R_3}$	$\widetilde{R_1}$	$\widetilde{R_2}$	$\widetilde{R_1}$	$\widetilde{R_1}$
$\widetilde{R_4}$	$\widetilde{R_4}$	$\widetilde{R_1}$	$\widetilde{R_5}$	$\widetilde{R_5}$	$\widetilde{R_3}$	$\widetilde{R_3}$	$\widetilde{R_3}$	$\widetilde{R_1}$
$\widetilde{R_2}$	$\widetilde{R_2}$	$\widetilde{R_1}$	$\widetilde{R_3}$	$\widetilde{R_1}$	$\widetilde{R_1}$	$\widetilde{R_1}$	$\widetilde{R_1}$	$\widetilde{R_1}$
$\widetilde{R_3}$	$\widetilde{R_4}$	$\widetilde{R_4}$	$\widetilde{R_4}$	$\widetilde{R_4}$	$\widetilde{R_3}$	$\widetilde{R_2}$	$\widetilde{R_3}$	$\widetilde{R_3}$
$\widetilde{R_2}$	$\widetilde{R_3}$	$\widetilde{R_4}$	$\widetilde{R_1}$	$\widetilde{R_1}$	$\widetilde{R_3}$	$\widetilde{R_2}$	$\widetilde{R_4}$	$\widetilde{R_5}$
$\widetilde{R_3}$	$\widetilde{R_4}$	$\widetilde{R_4}$	$\widetilde{R_2}$	$\widetilde{R_3}$	$\widetilde{R_3}$	$\widetilde{R_1}$	$\widetilde{R_1}$	$\widetilde{R_2}$
$\widetilde{R_4}$	$\widetilde{R_5}$	$\widetilde{R_3}$	$\widetilde{R_1}$	$\widetilde{R_2}$	$\widetilde{R_1}$	$\widetilde{R_3}$	$\widetilde{R_4}$	$\widetilde{R_3}$
$\widetilde{R_3}$	$\widetilde{R_2}$	$\widetilde{R_2}$	$\widetilde{R_5}$	$\widetilde{R_4}$	$\widetilde{R_4}$	$\widetilde{R_4}$	$\widetilde{R_3}$	$\widetilde{R_3}$

The aggregated values of the realtive importnace of treated importance are given by the proposed Algorithm (Step 2 to Step 3). The proposed procedure is illustrated further. Consider the gumeni otpad (i=7). The relative importance of this easte type is assessment by management team. The aggregated value of the treated waste type is:

$\widetilde{W_{71}} = 0.27.\widetilde{R_4} + 0.48.\widetilde{R_5} + 0.25.\widetilde{R_3}$=(x; 0.569, 0.794, 0.950)
such as $W_{71} = 0.782$

By appying the proposed Algorithm (Step 4 to Step 5) decision matrix is constructed.

Table 2 The weighted decision matrix

0.0354	0.0429	0.0081
0.0525	0.0750	0.0375
0.0225	0	0
0.0886	0.065	0.0446
0.3968	0.100	0.5288
0.0388	0.0268	0.0045
0.0318	0.0058	0.0197
0.0354	0.0781	0.0365

The normalized decision matrix is calculated and shown in Table 3 (by analogy Step 6 of the proposed Algorithm).

Table 3 The normalized decision matrix

0.0849	0.2539	0.0152
0.1261	0.4439	0.0703
0.0541	0	0
0.2139	0.3847	0.0836
0.9523	0.5919	0.9908
0.0931	0.1586	0.0084
0.0667	0.0343	0.0369
0.0854	0.4622	0.0683

The preference index for each environment element j, j=1,..,3 is calculated by using the proposed Algorithm (Step 7):

Table 3 The preference index for k=1

									$\emptyset_j^-(a_i)$
	0	1	0	0	0	0	0	0	**1**
	1	0	1	0	0	1	1	1	**5**
	0	0	0	0	0	0	0	0	**0**
	1	1	1	0	0	1	1	1	**6**
	1	1	1	1	0	0	0	0	**4**
	1	0	1	0	0	0	1	1	**4**
	0	0	1	0	0	0	0	0	**1**
	0	0	1	0	0	0	1	0	**2**
$\emptyset_j^+(a_i)$	**3**	**3**	**6**	**1**	**0**	**2**	**4**	**3**	

Table 4 The preference index for k=2

									$\emptyset_j^-(a_i)$
	0	0	1	0	0	1	1	0	**3**
	1	0	1	1	0	0	0	0	**3**
	0	0	0	0	0	0	0	0	**0**
	1	0	1	0	0	1	1	0	**4**
	1	1	1	1	0	1	1	1	**7**
	0	0	1	0	0	0	1	0	**2**
	0	0	1	0	0	0	0	0	**1**
	1	1	1	1	0	1	1	0	**6**
$\emptyset_j^+(a_i)$	**4**	**2**	**7**	**3**	**0**	**4**	**5**	**1**	

Table 5 The preference index for k=3

									$\emptyset_j^-(a_i)$
	0	0	1	0	0	1	0	0	**2**
	1	0	1	0	0	1	1	1	**5**
	0	0	0	0	0	0	0	0	**0**
	1	1	1	0	0	1	1	1	**6**
	1	1	1	1	0	1	1	1	**7**
	0	0	1	0	0	0	0	0	**1**
	1	0	1	0	0	1	0	0	**3**
	1	0	1	0	0	1	1	0	**4**
$\emptyset_j^+(a_i)$	**5**	**2**	**7**	**1**	**0**	**6**	**4**	**3**	

By using the proposed Algorithm (Step 8 to Step 9) the overall preference index and rank of the considered waste is determined and presented in Table 6.

Table 6 The rank of the treated waste in production process

	$\emptyset^+$ -$\emptyset^-$	Rank
i=1	12-6=6	**6**
i=2	7-13=-6	**3**
i=3	20-0=20	**8**
i=4	5-16=-11	**2**
i=5	0-17=-17	**1**
i=6	12-7=5	**5**
i=7	13-5=8	**7**
i=8	7-12=-5	**4**

According to the obtained results it can be said that the highest effect to the environment has the waste which is denoted as metal wate (i=5). It can be concluded that recycling technologies of metal waste should be improved.

5. CONCLUSION

Based on the results of good practice of developed countries is known that well organized and existing of recycling processes have high influence on realization of state development strategy. One of the management problems of recycling domain is environmental protection. The environment elements can be ground, air and water. It is assumed that these elements have equal relative importance. The assessment of waste types into environment may be introduced through identification of waste type, assessment their priorities. The solution of considered problem is obtained in exact way because the solution is less burdened by the subjective judgments of decision makers.

All uncertainties in relative importance of waste types are described by predefined linguistic expressions. Decision makers present their opinion by using linguistic expression in more precise way than by using precise numbers. Linguistic variables are modeled by TFNs which offer a good compromise between its computational ability and accuracy of the results. The aggregation opinions of decision makers into group consensus is performed by FOWA operator. The values of identified waste types are assessed by evidence data.

The rank of the identified waste types with respect to all environment elements is given by applying PROMETHEE method. The highest effect to the environment has waste type which is placed into at the first place in the rank. According to obtained results, the improvement strategies of environmental protection can be defined (one of requirement ISO 9001:2008, and ISO 144000).

Besides the advantages, the proposed model has certain constraints, for instance the number of waste types, available of evidence data, change of number of waste types and/or environment elements, change legal regulations, etc.

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THE EVALUATION AND IMPROVEMENT PERFORMANCES OF MARKETING PROCESS

Danijela Tadić[1], Snežana Nestić[1], Miladin Stefanović[1]
[1]Faculty of Engineering, University of Kragujevac, Serbia

Abstract: *The aim of this paper is to explain a model for evaluating performance of marketing process in production enterprises. These production enterprises operate in an uncertain and variable environment. Key performance indicators (KPIs) of marketing process are identified by management team. The relative importance of KPIs and their values is assessed by management team. They used linguistics expressions which are modelled by triangular fuzzy numbers. Improvement strategy is based on results which are obtained by applying Genetic algorithm.*
Keywords: *marketing process, evaluation of KPIs, fuzzy sets, Genetic algorithm*

1. INTRODUCTION

The different changes in the business world, for instance, competitive pressures, force industrial organizations to demand from strategic managers the continuous improvement of business processes. It is presented one of requirements ISO 9000:2008. The considered problem has become a topic of research for both industry and academia in the last decades. The most important prerequisite for defining an adequate improvement quality strategy is a clear understanding of business process quality [1].

The defining of business processes is based on mission statement, critical success factors (CSFs) could be identified – what the organization must accomplish to achieve the mission, by examination and categorization of the impact [2]. The defining of key performance indicators (KPIs) is based on the selected CSFs, which need to be clear, simple and easy to comprehend. Proper selection of KPIs is essential for effective performance measurement because too many KPIs can cause an unnecessary waste of time and money.

It can be mentioned that performance measurements can be objective and subjective. The objective performance measurements are based on independently observable facts and are easily quantifiable. The subjective performance measurement is complex and often difficult. Almost all authors of the presented papers suggest a framework which includes qualitative and quantitative KPIs.

The qualitative KPIs are described by linguistic variables. Modelling of linguistic variables can be performed by using the theory of fuzzy sets because [3]: (1) the fuzzy sets theory resembles human reasoning in its use of approximate information and uncertainty to generate decisions, and (2) fuzzy sets theory could be used as an appropriate and efficient approach in modelling linguistic expressions.

Different methods for evaluation of KPIs are developed in the literature. Those methods are developed on a different mathematical and logical framework, so that between these methods there is no consensus, indicating the difficulty of this research field [4].

The main aim of this research is to develop an assessment method that can be used to evaluate marketing process and identify management initiatives priorities for improvement in production enterprises. In these eneterprises marketing cost are very high [5]. In the literature, there are no papers in which the considered problem is solved. There are many reasons. It is necessary to make a difference between long-time and short-time effects of marketing initiatives, there are difficulties in measuring brand, very hifg importance of financial measure which are defined by strategic management team.

The paper is organized in the following way. Section 2 reviews a short overview of related research. The proposed algorithm is given in Section 4. Conclusions are presented in Section 5.

2. LITERATURE REVIEW

One of the most important requests of the standard ISO 9001:2008 can be defined as introducing a management review for measurement and analysis and improving KPIs of business objectives.

In the literature and practice, there is no systematic grouping of the business process KPIs. It is realistic to assume that identification of KPIs depends on the size of the enterprise, as well as the type of activity and business sector where the enterprise belongs. Coccoa and Alberti [6] suggest that KPIs can be collected according to best practices.

In the literature, there are many proposed methods for the measurement of KPIs. Some of them are presented in Nudurupati *et al* [7]. For instance, in Coccoa and Alberti [6], a new self-assessment tool of KPIs for SMEs is proposed. In this, a model maturity scale with multiple descriptions is proposed and used. In [8] the authors used a fuzzy linguistic scale for the describing of government performance measurement. The linguistic scale was used to convert the subjective assessment of managers into an information entity. Hakimollahi *et al* [9] developed the performance measurement approach based on Balanced Score-card (BSC) [10] with a fuzzy interference IF-THEN rules. The judgments of experts are based on knowledge and experience.

Neely *et al* [11] suggested that performance measurement could be defined as the process of quantification of efficiency and effectiveness of action.

In many papers, the measurement of KPIs is stated as a multi-criteria decision making problem ([12], [13]). Evaluation of the relative importance of KPIs and their preference are obtained by using an interview method. A questionnaire is distributed among managers of the treated industrial companies. The overall priority is given using the fuzzy Analytic Hierarchy Process (FAHP). Evaluation and ranking of business objectives for four BSC perspectives is performed by applying FAHP [13].

In the literature, there are many papers in which different measurement methods for marketing process are developed ([14], [15], [16], [17]). It can be mentioned that there are differences between measurement methods of KPIs production and service enterprises ([18], [19]). Ambler and Puntoni [20] suggest a framework for measurement KPIs of marketing process. The obtained results must at least provide development a new perspectives in treated domain. In [21] a new organizational model for marketing process KPIs information handling is proposed. They investigated the effects of processing conditions on the satisfaction measurement system.

With respect to the recommendation of ISO 9001:2008 that each enterprise should develop an approach to improvement of processes, the issue of assessment of affectivity of KPIs and business objective effectiveness of KPIs could be stated as an important issue.

By comparing papers which propose a model for determining the effectiveness of business processes and KPIs, certain differences could be noted, which are further described. This analysis, at the same time, shows the advantages of the proposed model.

In this paper, KPIs are defined for each business sub-process. Experts define the list of possible KPIs; this is determined by literature data, results of good practice, and experts' knowledge of the importance of KPIs for the production enterprises. The presented model is novel because it combines determination of the relative importance of the identified KPIs for each business sub-process and their current values using the fuzzy approach. All existing uncertainties are described by linguistic expressions which are modelled by triangular fuzzy numbers (TFNs). The determining of vector weights of the identified KPIs is stated as fuzzy group decision making problem [22]. The aggregation opinions of decision makers into a group consensus can be performed by applying different methods. In this paper, the fuzzy ordered weighted averaging (FOWA) operator is used [23]. In this paper, an effort is given to observe simultaneously both crisp and uncertain KPIs in the problem of evaluation of KPIs.

3. THE PROPOSED FUZZY MODEL FOR MEASUREMENT OF KPIs OF MARKETING PROCESS

In process approach, the marketing process can be decomposed into sub-processes. Formaly, these sub-processes can be presented by set indices $\mathrm{K} = \{1, .., \mathrm{k}, .., \mathrm{K}\}$. The total number of sub-processes is denoted as K and k, k=1,..,K is index of sub-process. These sub-processes are: planning of sales and marketing (k=1), promotion and propoganda (k=2), research market (k=3), arranging sales (k=4), the realization of contracts with customers and monitoring implementation (k=5), and resolving complaints from customers (k=6). KPIs of the sub-processes are presented by set indices $P_k = \{1, .., \mathrm{p}, .., \mathrm{P_k}\}$. The total number of KPIs of the sub-process k, k=1,..,K is denoted as $\mathrm{P_k}$ and p, p=1,.., $\mathrm{P_k}$ is index of KPI p of the sub-process k, k=1,..,K. The KPIs of the sub-process planning of sales and marketing (k=1) are: implementation of the plan of sales which is expressed in quantity (p=1), implementation of the plan of sales which is expressed in money (p=2), implementation of the marketing plan (p=3). The KPIs of the sub-process promotion and propoganda (k=2) are: success (p=1), and changing the current revenues compared to income before the promotional period (p=2). The KPIs of the sub-process research market (k=3) are: market positioning (p=1), timeliness of getting information (p=2), completeness of information (p=3), and usability obtained information (p=4). The KPIs of the sub-process arranging sales (k=4) are: percentage implemented offer (p=1) and time (p=2). The KPIs of the sub-process the realization of contracts with customers and monitoring

implementation (k=5) are: realization (p=1), delay (p=2) and success (p=3). The KPIs of the sub-process resolving complaints from customers (k=6) are: customer satisfaction (p=1) and complaints (p=2). The relative importnace of KPIs are assessed by management team at the level of each enterprise. It can be assumed that management team make decision by consensus. Formaly, considered enterprises are presented by set indices $E = \{1,..,e,..,E\}$. The total number of considered production enterprises is denoted as E and e, e=1,..,E is index of enterprise.
We calculate the overall weighted coefficients of: an enterprise, $r_e, e = 1,.., E$, sub processes with respect to all considered enterprises, $r_p, p = 1,.., P$ and KPIs with respect to all enterprises, $r_{kp}, k = 1,.., K_p; p = 1,.., P$. These values are given in terms of maximization function of the ranks' sum, S_{total} and minimization function of the ranks' variance of the corresponding variables, Var. At first place in the rank is the company which is associated with the highest value r_e , and it is labelled as e^* and at last place in the rank is the SME which is associated with the lowest values $r_e, e = 1,.., E$. In a similar way, the rank of sub processes of the production process and rank of KPIs are determined.
Determining the optimal strategy for improving marketing process quality in any enterprise. The considered enterprise, e, $e = 1,.., E; e \neq e^*$ is selected randomly.
In this case, the optimal increase of KPI values is obtained from the condition of the minimum proposed function f. The variables of function f are the sum of KPIs' ranks for the SME, e^* which is placed at first place in the rank, S_{max} , $S_{max} = \sum_{p=1}^{P}\sum_{k=1}^{K_p} w_p w_{kp} \cdot r_{kp}^{e^*}$ and the sum of KPIs' ranks of a randomly selected SME, S' , $S' = \sum_{p=1}^{P}\sum_{k=1}^{K_p} w_p w_{kp} \cdot r_{kp}^{e}$ the parameter α and α_{kp} which are referred to as the total increase of the selected KPIs, i.e. the increase for KPI k, $k = 1,.., K_p$ of the randomly selected enterprise.
The optimal increase of KPI values is obtained from the condition of the minimum proposed function f:

$$\min(f) = \min\left[S' + \alpha \cdot \left(S_{max} - S'\right)\right] - \sum_{k=1}^{K_p} \alpha_{kp} \cdot S'$$

The marketing process quality can be improved if appropriate management initiatives that lead to an increase in the value of one or more KPIs of the treated marketing process are applied. In practice, KPIs whose values should be increased are selected according to the stakeholder requirements. Each solution achieved in an exact manner is less influenced by subjective attitudes of decision makers, so it is more precise. With respect to this fact, we can conclude that decision makers could develop an appropriate and reliable improvement strategy for any enterprise type.

4. CONCLUSION

Improvement of the marketing process can be realized through measurement of their KPIs, improvement of personal motivation, checking the data collected and realization of appropriate preventive measures which led to improvement of marketing process.
The main contribution of this paper is the introduction of a model for assessment of marketing process effectiveness in production enterprises which exist in uncertain environment. The relative importance of KPIs of identified sub-processes of the considered business process, as well as determining their values is performed by using linguistic expressions. These linguistic variables are modelled by using the fuzzy sets theory. By using genetic algorithm (GA), improvements of KPIs are determined.
This paper contributes to both practice and research. As a contribution to real-life practice, the method could be very useful for: (1) management teams of manufacturing SMEs to increase the quality of products and efficiency of their businesses, (2) customers, and (3) other stakeholders.
The proposed method is flexible: (1) changes in the number and/or kind of KPIs, (2) changes in their relative importance, and (3) can be easily extended to the analysis of other management decision problems in different research areas.
The general limitations of the model are scoped to: (1) the need for well-structured sub-processes and and (2) the need for well-structured KPIs of identified sub-processes. It need may be fulfilled by implementation of a Quality management system according to ISO 9001:2008.
Future research should cover analysis of different KPIs of marketing process in different enterprise types. This should enable knowledge transfer amongst enterprises that belong to the same industry sector and as a final consequence improve sustainable development.

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COST ANALYSIS OF SHELL AND TUBE HEAT EXCHANGERS WITH CONCENTRIC HELICAL TUBE COILS

Marko S. Jarić[1*], Mirko M. Dobrnjac[2], Nikola J. Budimir[1], Tamara S. Bajc[3]

[1] Innovation Center of the Faculty of Mechanical Engineering, University of Belgrade, Kraljice Marije 16, 11000 Belgrade, Serbia

[2]Faculty of Mechanical Engineering, University of Banja Luka, Vojvode Stepe Stepanovića 71, 78000, Banja Luka, Bosnia and Hercegovina

[3] Faculty of Mechanical Engineering, University of Belgrade, Kraljice Marije 16, 11000 Belgrade, Serbia

[*]Corresponding author: mjaric81@gmail.com

Abstract: *The paper deals with the manufacturing costs of shell and tube heat exchangers with concentric helical tube coils. The most common correlations for calculating prices of shell and tube heat exchangers found in open literature were tested using the market data for a comparison and they have shown significant deviations. A new correlation for estimating prices of heat exchangers with concentric helical tubes (when the shell is made of carbon steel and the helical tube of copper) was determined in the following form:*

$$C_{in} = 614 \cdot S_{hts}^{0.627}$$

Key words: *heat exchanger, correlation, manufacturing costs, helical tube*

1 INTRODUCTION

Heat exchangers with helical tubes are often encountered in chemical and petrochemical industries, HVAC systems, thermal, environmental and many other engineering applications. They can be used as heaters, coolers, condensers and evaporators, and their design is largely restricted to non-fouling fluids [1,2]. In comparison with straight-tube heat exchangers, heat transfer rate of helically coiled heat exchangers is significantly greater because of the secondary flow pattern in planes normal to the main flow [3,4]. Basically, helical coil heat exchangers are a compact shell and tube apparatuses, consisting of several layers of coiled tubes within a closed shell. There is a number of types of these apparatuses and in the present study heat exchangers with concentric helical tubes (HECHT) are to be investigated. Tube bundle of HECHT consist of a number of tubes wound helically around a central supporting tube and placed in a cylindrical shell. Rows of tubes can be wound in the same direction (Fig. 1) or in the opposite directions (Fig. 2).

Between the tube coils the wire inserts are placed in order to prevent the collision of tubes [1,5,6]. Despite the decades of application of the heat exchangers with helical tube coils in the industry, the problems related to their economic costs have not been fully explored.

Taking this into consideration, the primary objective of this paper was to determine the manufacturing costs of shell and tube heat exchangers with concentric helical tubes. These costs in general case include the costs of materials for apparatus, energy, labor, and other costs.

2 CALCULATION PRICE OF HEAT EXCHANGERS

Only several correlations for estimating the cost of shell and tube heat exchangers can be found in literature. They are based on knowledge of the design of the apparatus, the operating pressure, the heat transfer surface, the material the apparatus is made of, etc. The most often cited correlations are listed in Table 1, where they are not given in its original form, but are adjusted in order for the price to be expressed in an appropriate manner (in this case EUR2014 month September).

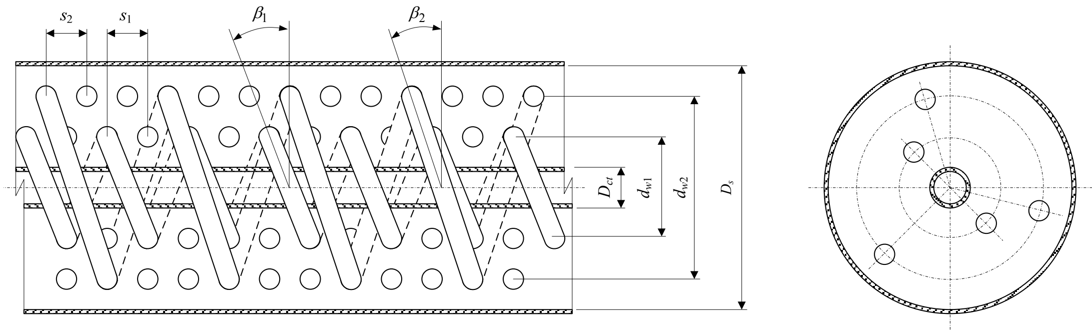

Figure 1 HECHT with tubes wound in the same direction.

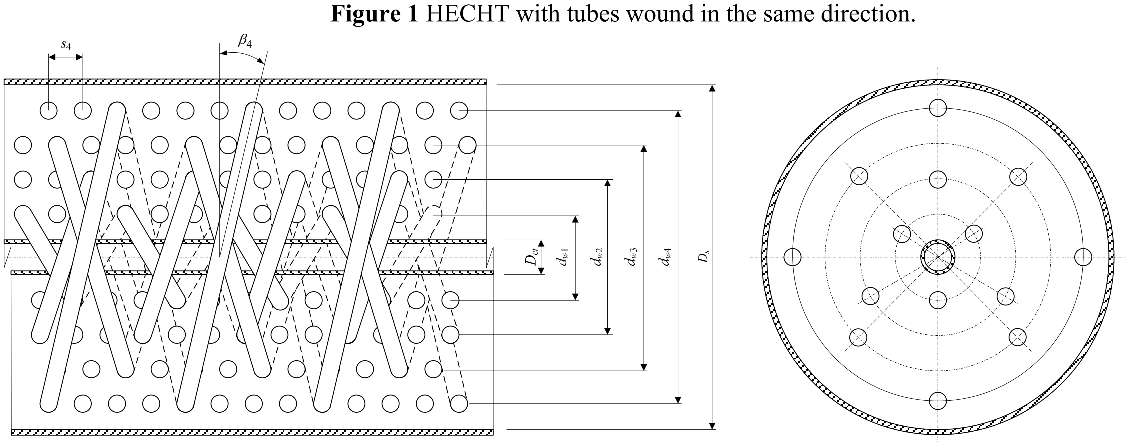

Figure 2 HECHT with tubes wound in the opposite direction.

Table 1 Correlations for estimation price of shell and tube heat exchangers by various authors

No.	Material (Shell-Tube)	Temp. (°C)	Pressure (bar)	S_{hts} range (m^2)	Correlation	Ref.	Eq.
1	Carbon steel- Carbon steel	-	-	-	$C_{in} = 6325 + 326 \cdot S_{hts}^{0.80}$	[8]	(2)
2	Carbon steel -Stainless steel	-	-	-	$C_{in} = 7695 + 370 \cdot S_{hts}^{0.85}$	[8]	(3)
3	Stainless steel - Stainless steel	-	-	-	$C_{in} = 9035 + 293 \cdot S_{hts}^{0.91}$	[8]	(4)
4	Carbon steel -Titanium	-	-	-	$C_{in} = 12649 + 623 \cdot S_{hts}^{0.92}$	[8]	(5)
5	Titanium - Titanium	-	-	-	$C_{in} = 15811 + 632 \cdot S_{hts}^{0.93}$	[8]	(6)
6	-	-	-	$0.5 \div 0.27$	$C_{in} = 970 \cdot S_{hts}^{0.432}$	[9]	(7)
7	Carbon steel - Carbon steel	-	$20 \div 30$	$10 \div 600$	$C_{in} = 1499 \cdot S_{hts}^{0.64}$	[10]	(8)
8	Carbon steel - Brass	-	$20 \div 30$	$10 \div 600$	$C_{in} = 1368 \cdot S_{hts}^{0.71}$	[10]	(9)
9	Carbon steel - Stainless steel	-	$20 \div 30$	$10 \div 600$	$C_{in} = 1394 \cdot S_{hts}^{0.86}$	[10]	(10)
10	Stainless steel -Stainless steel	-	$20 \div 30$	$10 \div 600$	$C_{in} = 2006 \cdot S_{hts}^{0.82}$	[10]	(11)
11	Carbon steel - Carbon steel	≤ 350	≤ 10.5	$9 \div 6500$	$C_{in} = 9096 + 120 \cdot S_{hts}$	[11]	(12)
12	Stainless steel - Titanium	-	-	-	$C_{in} = 32956 + 4011 \cdot S_{hts}^{0.81}$	[12]	(13)
13	Carbon steel - Carbon steel	≤ 300	≤ 50	-	$C_{in} = 3406 \cdot S_{hts}^{0.68}$	[13]	(14)
14	Carbon steel - Aluminium	≤ 300	≤ 50	-	$C_{in} = 4428 \cdot S_{hts}^{0.68}$	[13]	(15)
15	Carbon steel -Monel	≤ 300	≤ 50	-	$C_{in} = 7115 \cdot S_{hts}^{0.68}$	[13]	(16)
16	Carbon steel – Stainless steel	≤ 300	≤ 50	-	$C_{in} = 5791 \cdot S_{hts}^{0.68}$	[13]	(17)
17	Stainless steel - Stainless steel	≤ 300	≤ 50	-	$C_{in} = 9878 \cdot S_{hts}^{0.68}$	[13]	(18)

18	Carbon steel - Carbon steel	-	-	$9 \div 90$	$C_{in} = 2095 \cdot S_{hts}^{0.551}$	[14]	(19)
19	Admiralty	-	-	$9 \div 90$	$C_{in} = 1522 \cdot S_{hts}^{0.679}$	[14]	(20)
20	Copper–brass	-	-	$9 \div 90$	$C_{in} = 1844 \cdot S_{hts}^{0.679}$	[14]	(21)
21	Carbon steel- Copper	$0 \div 200$	$2 \div 30$	$2.5 \div 38$	$C_{in} = 749 + 332 \cdot S_{hts}$	[15]	(22)

Table 2 Year built of apparatus

No.	S_{hts}, m^2	Year built	Cost of apparatus in year built	Cost of apparatus (EUR_{2014})
1	0.5	2013	500	525
2	1	2014	600	614
3	1.5	2011	850	823
4	2	2012	1100	1083
5	2.5	2009	1190	1381
6	3	2010	1275	1221
7	4	2011	1360	1316
8	5	2012	1550	1526
9	6	2013	1650	1731
10	7	2012	1750	1723
11	8	2010	1880	1800
12	9	2012	2180	2146
13	10	2011	2150	2080
14	12	2010	2520	2413
15	15	2013	2850	2989
16	18	2011	3420	3308
17	20	2011	3800	3676
18	22	2010	4180	4002
19	25	2010	4750	4548
20	30	2012	5700	5610
21	35	2010	6650	6367
22	40	2012	7600	7480
23	44	2013	8250	8652
24	47	2013	9030	9470

Prices of apparatuses have to be corrected also from the year in which they were manufactured (Table 2) in the year for which the analysis is done. The simplest method, which is used to correct the price, takes into account the increasing costs due to market trends and the cost is given by next equation:

$$C_A/I_A = C_B/I_B \qquad (1)$$

where

- C_A, EUR, price of apparatus at the moment A,
- C_B, EUR, price of apparatus at the moment B,
- I_A, index of price at the moment A,
- I_B, index of price at the moment B [5,7].

3 ANALYSIS OF MANUFACTURING COSTS OF HEAT EXCHANGERS WITH CONCENTRIC HELICAL TUBE COILS

For the heat exchangers with a concentric helical tube coils, the correlation for the assessment of investment costs is not encountered in the literature. Therefore, the goal of this analysis was to determine deviations that appear during the use of the existing correlations.

Deviation in prices calculated using the correlation 2 $\div$ 22 and the actual price of apparatuses (data obtained from the manufacturers on territory Bosnia and Hercegovina, Serbia and Croatia) is expressed using statistical indicators: correlation ratio (CR) and the root-mean square deviation (RMSD), which are also shown in Table 3.

The analysis proved from these correlations show significant deviations and that they cannot be successfully used to describe the manufacturing costs for the mentioned type of shell and tube heat exchangers (a heat exchanger with concentric helical tube coils, where the apparatus shell is made of carbon steel and the heat exchanger's tubes are made of copper).

Table 3 Statistical parameters of literature correlations

No.	Correlation/EUR	*CR*	*RMSD*	Eq.
1	$C_{in} = 6325 + 326 \cdot S_{hts}^{0.80}$	0	438.76	(2)
2	$C_{in} = 7695 + 370 \cdot S_{hts}^{0.85}$	0	551.75	(3)
3	$C_{in} = 9035 + 293 \cdot S_{hts}^{0.91}$	0	641.66	(4)
4	$C_{in} = 12649 + 623 \cdot S_{hts}^{0.92}$	0	979.37	(5)
5	$C_{in} = 15811 + 632 \cdot S_{hts}^{0.93}$	0	1214.7	(6)
6	$C_{in} = 970 \cdot S_{hts}^{0.432}$	0.8284	29.02	(7)
7	$C_{in} = 1499 \cdot S_{hts}^{0.64}$	0	159.53	(8)
8	$C_{in} = 1368 \cdot S_{hts}^{0.71}$	0	177.64	(9)
9	$C_{in} = 1394 \cdot S_{hts}^{0.86}$	0	310.93	(10)
10	$C_{in} = 2006 \cdot S_{hts}^{0.82}$	0	431.06	(11)
11	$C_{in} = 9096 + 120 \cdot S_{hts}$	0	616.41	(12)
12	$C_{in} = 32956 + 4011 \cdot S_{hts}^{0.81}$	0	3088.83	(13)
13	$C_{in} = 3406 \cdot S_{hts}^{0.68}$	0	541.19	(14)
14	$C_{in} = 4428 \cdot S_{hts}^{0.68}$	0	733.03	(15)
15	$C_{in} = 7115 \cdot S_{hts}^{0.68}$	0	1237.52	(16)
16	$C_{in} = 5791 \cdot S_{hts}^{0.68}$	0	988.93	(17)
17	$C_{in} = 9878 \cdot S_{hts}^{0.68}$	0	1756.32	(18)
18	$C_{in} = 2095 \cdot S_{hts}^{0.551}$	0	201.48	(19)
19	$C_{in} = 1522 \cdot S_{hts}^{0.679}$	0	187.23	(20)
20	$C_{in} = 1844 \cdot S_{hts}^{0.679}$	0	247.38	(21)
21	$C_{in} = 749 + 332 \cdot S_{hts}$	0	79.17	(22)

Therefore, on the basis of the data given in Table 2 (for 2014 year price), a new correlation was found in form (Figure 3):

$$C_{in} = 614 \cdot S_{hts}^{0.627} \qquad (2)$$

for range 0.5 m^2<S_{hts}<47 m^2, 4<p<25 bar, 10<T<180 ºC.

Its statistical parameters are CR=0.9497 and RMSD=15.94%. In the above equations ($2 \div 22$) the value of heat transfer surface (S_{hts}) was expressed taking into account the outside surface of helical tube coils.

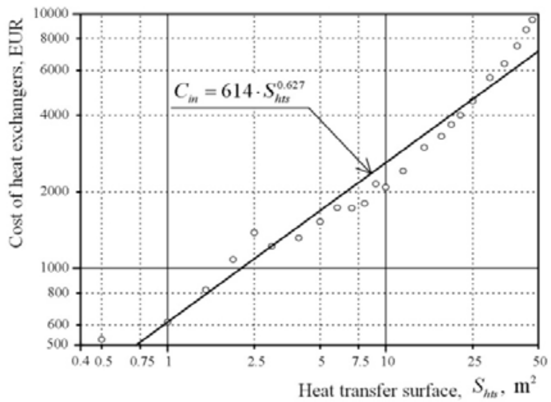

Figure 3 Manufacturing costs for apparatus versus to heat transfer surface

The new correlation for determining the price of shell and tube heat exchangers with concentric helical tube coils (when the shell is made of carbon steel and the tube is made of copper) has the following form

$$C_{in} = 614 \cdot S_{hts}^{0.627} \qquad (3)$$

for range 2.50<S_{hts}<38 m^2, 4<p<25 bar, and 10<T<180 ºC. Statistical parameters of this equation are, CR=0.9497 and RMSD = 15.94.

4 CONCLUSION

The paper presents the main types and manufacturing costs for shell and tube heat exchangers with concentric helical tube coils. The cost analysis was conducted using the actual price (data obtained from the manufacturer) of apparatus with helical tube coils on territory Bosnia and Hercegovina, Serbia and Croatia.

After examining the correlations currently found in the existing body of literature on investment costs of shell and tube heat exchangers, it was concluded that a new correlation needs to be found.

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Nomenclature

C_A, EUR price of apparatus at the moment A,
C_B, EUR price of apparatus at the moment B,
C_{in}, EUR, investment cost of heat exchanger (price of manufactured apparatus),
D_{ct}, mm, diameter of, carrier tube,
D_s, mm, internal diameter of heat exchanger,
d_{w1}, mm diameter of helical tube 1,
d_{w2}, mm diameter of helical tube 2,
I_A, index of price at the moment A,
I_B, index of price at the moment B,
p, bar, operating pressure of heat exchanger,
s_1, mm, pitch of helical tube coils 1,
s_2, mm, pitch of helical tube coils 2,
S_{hts}, m^2, heat transfer surface.

Greek letters

β_1 , angle of helical tube coils for diameter d_{w1},
β_2 , angle of helical tube coils for diameter d_{w2},

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CONCEPTUALIZATION OF COMMON PARAMETERS WHICH ARE REQUIRED FOR TECHNICAL-TECHNOLOGICAL ANALYSIS OF INVESTMENTS

Andrea Ivanišević[1], Branislav Marić[2], Alpar Lošonc[3]
Ph. D, University of Novi Sad, Trg Doditeja Obradovica 6, Serbia, ([1]andreai@uns.ac.rs, [2]bmaric@uns.ac.rs, [3]alpar@uns.ac.rs)

Abstract. *Investments, as important factor of development of every country, represent a complex category of different professions. The basis of every investment is the technical-technological element which needs to be presented and studied in an adequate professional way so that it can, in the economic part of the study, imply costs and benefits.*
Having worked on the projections and evaluation of investment sudies for many years, the authors concluded that projectors for the technical-technological part of the investment studies project the concerned matter differently which, in spite of the specificities of each branch of economy or service, still has some identical and common elements of the contents.
Having the Terms of Reference as the starting point, the common elements of technical-technological analysis for the designing and exploitation phases were identified and collected in this paper, thus offering some guidelines for future projectors. This paper is the result of a conducted research and empiric analysis, thus it can be used as the scientific basis to all projectors in the future period when an influx of foreign investments in Serbia is expected.
Key words: *Investments, technical-technological element, financial resources*

1. INTRODUCTION

The concept of investment in contemporary professional practice and literature is usually considered from two aspects. In our opinion, the first aspect is related to the definition according to which the investments represent the investing of money and other financial resources in present which effects, such as new usability, are recognized in the future. The second aspect includes the concept of investing in securities (or capital) today and its effects will be produced in future. Almost identical understanding of the process makes the investing a universal process which is differentiated based on the understanding of this type of very important man's activity.

In their several year long experience in this field, authors encountered numerous problems regarding the „basis“ for every economic investment, and that is the problem of presentation of common elements which depict the characteristics of investment in technical-technological sense.

Thus, a question is raised about common technical and technological elements which can present the production of textile, tobacco, metal, leather, shoes, etc. Naturally, this includes commerce, agriculture, services and other businesses. Answer to the above question should be searched for in the analysis of general production characteristics in an industrial company and the analysis of general case of development of industrial companies.

2. BASIC POSTULATES OF TECHNOLOGICAL PROCESSES

Defined assortment of products and possible placement are the basis for projection of production technology. The technology is the one which practically determines all essential elements of future investment. There are two types of future investments:

- new construction or
- reconstruction.

In this presentation, new construction, as a more complex case, was taken as an example for the analyses below.

Terms of Reference defines the following:

1. General information about the investor and investment
    - name of the investor
    - location of the investor
    - name and location of investment
    - period of construction, etc.
2. Objectives of the investment regarding:

- the production program for final products
- the distribution centers depending on the market
- the production program for assemblies, sub-assemblies and parts that constitute a product
- the production program for spare parts
- quality system
- threshold price and desirable price of final product
- structure of the staff, etc.

3. Documentation for construction
   - valid standards and norms
   - bill of material
   - changes made to documentation, etc.
4. Important terms
   - date of beginning and completion of elaborate study
   - dynamics of the realization of investment
   - dynamics of the exploitation of investment
5. Number of work days and hours per year based on which effective capacity can be calculated

$$T = m * n * s * \eta$$

where:

m – number of work days
s – number of shifts
n- number of work hours
η – time utilization rate

6. Specification of resources available for the investment
   - covered surfaces
   - open-air surfaces
   - equipment, devices, installations and tools
   - staff engaged (their number and qualifications)
7. Requirements and liabilities relating to future development
   - product alterations
   - changes of types and levels of technology
   - changes of the infrastructure
   - changes of the staffing structure
   - liabilities regarding the ecology and preservation, etc.
8. Prices and conversion
   - time and procedure of conversion
   - referential time of preparation of investment program
9. Dynamics of the realization of project and investment
   - time limits and exploitation period
10. Laws, standards, regulations and instructions
    - review of all related laws, standards, norms, and regulations that an investment needs to comply to.

Having the Terms of Reference as its starting point, the technical-technological analysis needs to define:

1. Description of technological process
2. Preparation of technological production processes
3. Preparation of basic normatives: material, tool, time
4. Determining (calculating) the number of units of equipment
5. Determining (calculating) number of staff
6. Determining the storage capacity
7. Defining necessary means of transportation and palletization
8. Defining business and plant inventory
9. Specification of nevessary power and fluids
10. Plan of acquiring „knowledge and right“
11. Defining all other factors relevant for the techno-process and implications it may have

3. MAIN ELEMENTS RELATED TO CONSTRUCTION OF INVESTMENT BUILDINGS

Main information about construction and realization of an investment can be practically taken from the estimated value which is generally formed as follows (table no. 1).
From the aspect of methodology, design and structure of table no. 1 cover the case of reconstruction as well, since the conventions for preparation of investment studies allow input of past costs and development factors to new investment (Marić, 2013.).

Table 1. Table explanation (above the table)

No.	**Technical structure of investment**	**Present condition**	**New investment**	**Total**
1.	Land			
2.	Construction works			
3.	Equipment - foreign - domestic			
4.	Infrastructure			
5.	Material rights			
6.	Start-up cost			
7.	Staff training			
8.	Other			

4. CUMULATIVE – COMMON ELEMENTS OF TECHNICS AND TECHNOLOGY OF INDUSTRIAL (AND OTHER) COMPANIES

Taking into consideration the fact that lifespan of every investment consists of construction period and period of exploitation, the presented elements of technological production processes, that is, the elements of construction and erection of industrial buildings, can be considered as minimum information needed for the presentation of technical-technological analysis of every investment program which later, in the financial analysis, shows costs and expenses.

Construction period	Exploitation period
1.Structure of investment in land (amount)	
2. Structure of investment in buildings (amount)	
3. Structure of investment in equipment (amount)	
4. Structure of investment in infrastructure (amount)	
5. Structure and amount of investment in material rights	
6. Start-up costs (amount)	
7. Staff training (amount)	
8. Other investment (amount)	
	9. Description of technological process
	10.Preparation of technological processes
	11. Overview of necessary equipment
	12. Overview of needed staff
	13. Overview of necessary storage and transportation means
	14. Overview of business and plant inventory
	15. Investment in ecology and safety at work
	16. Overview of power consumption
	17. Other

5. CONCLUSION

In their multiannual experience in the field of investment projections, the authors recognized numerous problems, and the aspect of tcehnical-technological analysis is presented in this paper. Strong interest in common elements of investment and future business resulted in the idea to identify and present general elements which are common for making projections about construction and businesss operation of every investment building in the fields of economy and services. The presented model identifies and describes 17 parameters used for present and future investment projections.

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USE OF SOLID RECOVERED FUEL (SRF) IN CEMENT INDUSTRY – ECONOMIC AND ENVIRONMENTAL IMPLICATIONS

N. Dondur[1], A. Jovovic[1], V. Spasojević-Brkić[1], D. Radić[1], M. Obradović[1], D. Todorovic[1], S.Josipović[1], M. Stanojevic[1]
[1]Faculty of Mechanical Engineering, University of Belgrade, Serbia

Abstract: *In the paper we have analysed whether and to what extent co-incineration of secondary fuels in cement manufacturing is cost-effective. Techno-economic assessment shows that combined combustion of solid recovered fuel and traditional fossil fuel (petroleum coke) is economically viable to the extent of 20:80 per cent. The paper also concluded that the impact of the plants on the quality of air would be negligible.*
Key words: *solid recovered fuel, environment, economic, risk*

1. INTRODUCTION

In order to reduce energy dependence on conventional fossil fuels and negative effects on the environment, cement industry is increasingly turning toward alternative fuels. Cement manufacturing is highly energy-intensive, with energy resources typically accounting for 30-40% of the product price. Traditionally, the primary fuel is coal, though other fuels such as petroleum coke, natural gas and oil are also used. Besides these fuels, various types of wastes can also be used as fuels. Solid Recovered Fuel (SRF) is mechanically fragmented solid secondary raw materials, i.e. waste having the use value for energy generation (not eligible for recycling) and is qualified, by its nature, as non-hazardous waste. Use of waste materials as alternative fuels in cement industry started in the 1970s and since then the number of cement plants worldwide using alternative fuels and raw materials has steadily increased. In order to lower the costs of energy resources, cement plants in the European Union follow a long-established practice that the primary fuel (commonly coal) is replaced by secondary fuels. The most frequent secondary fuels include waste or recycled materials which have high heating value and which are convenient for burning in cement kilns. High temperatures in a cement kiln destroy these materials in the environment-friendly and energy-efficient manner. A large number of countries are replacing the primary fuels with secondary fuels even up to 50% of the specific heat needed for the clinker making process. Use of secondary fuels primarily depends on the availability of that type of fuel. Therefore, it is necessary to conduct a techno-economic analysis that will show whether and to what extent co-incineration of secondary fuels in cement manufacturing is cost-effective [5].

2. TECHNOLOGICAL PROCESS

The cement manufacturing process includes the following technological steps: exploitation and preparation of raw materials (limestone, marl and clay); grinding, transportation and storage of raw materials; production and storage of raw meal; fuel storage, transportation and preparation; clinker production, transportation and storage; cement production, transportation and storage; cement packing and palletising, shipping. Raw meal is produced by grinding raw materials in the raw material grinding mill. The components include: a mix of marl and limestone, pure limestone, clay, pyrite burning and bauxite. The core and dominant component is a mix of limestone and marl. Other components are used for correcting the contents of the necessary oxides in the raw meal. Function of the raw mill is to dry and grind the raw mix. The raw materials are dried in the mill drying chamber where these materials are also partly crushed by rotation movement causing friction. Drying is done by bringing hot gases from the rotary kiln or from the rotary kiln which is used when the rotary kiln is not working or not producing sufficient quantity of hot gases. In the mill raw materials are crushed by means of the diameter 20-90mm grinding balls until the desired fineness is achieved. The ground raw materials are sent by air flow through the pipeline into the separator – grit separator. In the separator itself bigger particles of the raw meal are separated. Thus separated bigger particles go, by free fall, to the air slide which returns them to the mill for regrinding. Fine particles of the raw meal go

through the pipeline to two cyclones. From the cyclone the ground materials are pneumatically transported to the silos for homogenization while one part of the air flow is injected through an appropriate pipe into the cooling tower and further to the electrostatic precipitator and the other part of the air flow is reversed, through a pipeline, to recirculate through the mill, pipeline, separator and cyclones. Since the temperature of gases entering the electrostatic precipitator is high, the plant for cooling of gases is used – cooling tower. The cooling tower also operates as a cyclone and therefore part of raw meal falls on the transport system through which it is brought back into the process. Smaller particles of the raw meal are drawn from the cooling tower, by ventilator, into the electrostatic precipitator. After separation of the raw meal particles, these particles are taken from the electrodes (by means of the shakers) through the screw conveyor to the T-section and further to the airlift. The raw meal is then transported pneumatically from the airlift through the pipeline to the homogenization silos. In the homogenization silos raw meal is finally mixed by compressed air and chemical components are blended. Homogenized raw meal is brought through the silos discharge device into the raw meal silos into which the air is injected so that the raw meal stays loose. From these silos, through the silos discharge devices, the raw meal is transported further into the rotary kiln.
Technological basis of the cement clinker manufacturing process is the rotary kiln with four-stage cyclone heat exchanger (pre-heater) with satellite cooler and burner, using the dry process technology. (Figure 1.)

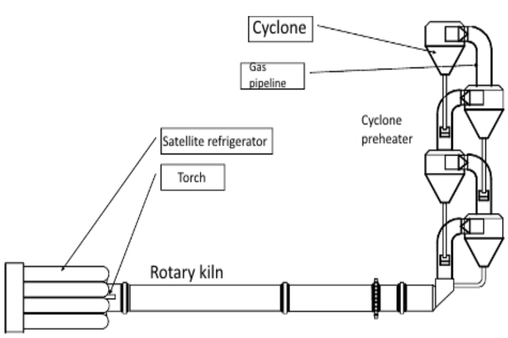

Figure 1. Schematic diagram of a rotary kiln and four-stage cyclone pre-heater

Fuel oil, petroleum coke or coal is used as fuel for the rotary kiln. However, to be used as fuels for the rotary kiln, these fuels need to be prepared before use and therefore the new solid fuel drying and grinding plant was designed. Clinker, as a main semi-manufactured product in the cement manufacturing process, is made by burning raw meal in the rotary kiln. The main process conditions in the rotary kiln are as follows: raw mix is kept for long time, oxygen-rich environment (O2), temperature of the raw mix is up to 1500 ºC and temperature of the gases up to 2000 ºC, temperature of the flame at the top of the burner is over 2000 ºC, which causes intensive degradation of lime (CaCO3) to calcium oxide, known as quicklime or burnt lime (CaO) and carbon dioxide CO2 at temperatures below 800 ºC. The main component in the cement making process is clinker, with the use of the following additives: gypsum (necessary to control the setting time of the cement), slag, fly ash and lime. However, as the clinker is the basis for manufacturing cement, cement quality depends on the clinker quality, percentage and fineness of grind.

2.1. Used energy and possibility of using SRF

In the cement plant in which economic justification of the use of the solid recovered fuel produced from waste (SRF), petroleum coke, coal and fuel oil are used as main fuels for the rotary kiln. In 2010 the share of coal was 2.5% and of petroleum coke 95.7%, whereas in 2011 the share of coal was 68.6% and petroleum coke 29.5% respectively. In the 2009-2011 period consumption of petroleum coke ranged from 41389 to 11065 tons. Consumption of coal in 2011 was 34725 tons. According to the Project, it is planned to use solid recovered fuel which can be found on the market and which meets appropriate quality standards [1] The planned maximum volume of the use of solid recovered fuel is 25,000 tons per year (capacity of 48 tons per day, that is, 2 tons per hour, with the maximum level of substitution of the main fossil fuels of 24 %).
SRF is most frequently produced in the plants (in the vicinity of municipal waste landfills) where after separating the recyclable fractions of waste, the remaining residue is fragmented, dried, stabilised and packed [6]. SRF consists of fuel segments of waste: paper, fabric, light fractions of artificial materials, wood, rope, yarns, etc.

3. IMPACT ON THE ENVIRONMENT BY USING SRF

In the observed Cement Plant, pollutants discharged into the air, primarily solid particles generated in the course of the manufacturing process (crushing and grinding of the raw mix, technological process in the rotary kiln, transport, storage and grinding of the cement clinker, cement packaging and transport, storage and grinding of the solid fuels, etc.) as well as gas components (from fuel burned and technological gases) are generated.
Experiences from other (similar) cement plants where solid recovered fuel is already used as alternative fuel show no increase in the gas and solid particle emissions above Emission Limit Value (ELV) nor threat that transport and/or burning of this material will deteriorate the quality of air in the immediate environment and beyond.

Manipulating the SRF in the warehouse, dosage and transport will not cause any deterioration of the air quality in the wider area of the cement plant complex.

As the fuel combustion gas products which are dosed on the side of the main burner spend considerable time in the rotary kiln, there is no possibility that some component (particularly not an organic component) or fuel combustion product is not fully decomposed and converted into the simplest oxides. To that end, the calculation of the SRF co-combustion in the cement kiln was made, as follows:

- the SRF flow of 3,000 kg/h is adopted,
- operation of the kiln with fossil fuel as well as with the mix fossil fuel +SRF (co-combustion)
- for the SRF which meets requirements of the technical standards, as well as for the operation of the kiln with and without SRF, the emission factors are adopted, based on the EU, EPA, Solid Recovered Fuels, Contribution to BREF "Waste Treatment", European Recovered Fuel Organisation, Thomas Glorius, Joop van Tubergen, Institute and Chair of Processing and Recycling of Solid Waste, RWTH Aachen, EUROPEAN COMMISSION - DIRECTORATE GENERAL ENVIRONMENT REFUSE DERIVED FUEL, CURRENT PRACTICE AND PERSPECTIVES (B4-3040/2000/306517/MAR/E3) FINAL REPORT.

Flue gas flows from the process of co-incineration of SRF in the cement kiln, obtained in the calculation, are shown in Table 1, whereas Table 2 shows data on the rotary kiln processes.

Table 1. Flue gases flows in cement kiln

Flue gases	Values	Units
Flows on 10% O_2	145000	Nm^3/h
Total flows	145000	Nm^3/h
SRF flue gases flows	25500	Nm^3/h
Flue gases flows from other fuels	119500	Nm^3/h

Table 2. Flue gases flows in rotary kiln

Flows	Values	Units
SRF	3000	kg/h
Clinker	66660	kg/h
SRF/Clinker	0,05	kg SRF/kg klink.
Petroleum coke (wet)	7044	kg/h
Petroleum coke (dry)	6725	kg/h

Table 3. shows values of flue gases flows components obtained by calculation.

Table 3. Calculated emission values of the components

Components	Concentration of SRF in 10% O_2, calculated [mg/Nm^3]	Concentration without SRF in 10% O_2, measured [mg/Nm^3][1]	Total concentration, [mg/Nm^3]	Flow [kg/h]	GVE [mg/Nm^3]
PM	14	1,23	3,476	0,5039	30
NO_x	262	744,66	659,78	95,668	800
SO_x	4	0	0,7034	0,102	50
CO	53	75,33	71,403	10,353	500
TOC	10	6	6,703	0,972	10
PCDD	0,000000068	$3{,}5\cdot10^{-9}$	$1{,}484\cdot10^{-8}$	$2{,}152\cdot10^{-9}$	0,0000001

1 – existing emissions

In order to assess the impact of the use of SRF on the air quality, a model of dispersion of pollutants (NO_2, SO_2, dust, CO) from the main emitters (stack of the kiln, raw mill, cement mill and solid fuel mill).Within the assessment of the impact of the cement plant on the environment (Environmental Impact Assessment), the standard model EPA (U.S. Environmental Protection Agency) AERMOD was used. Models for the needs of this study covered a modelling domain of 20×20 km with the cement plant in the centre. By applying the AERMOD, a 3D model of the cement plant was made (Figure 2.), covering only those facilities which are relevant for dispersion modelling..

Figure 3. shows the results of dispersion modelling of total dust from three main cement plant emitters with the use of SRF. The maximum obtained value for the averaging over one-year period is 0.13403 $\mu g/m^3$, and this value is recorded on the slopes of the hill, located approx. 1 km south of the Cement Plant. Considering the maximum allowable value for this pollutant component of 70 $\mu g/m^3$. [2], it can be concluded that, considering this pollutant, the impact of the plants on the quality of air would be negligible.

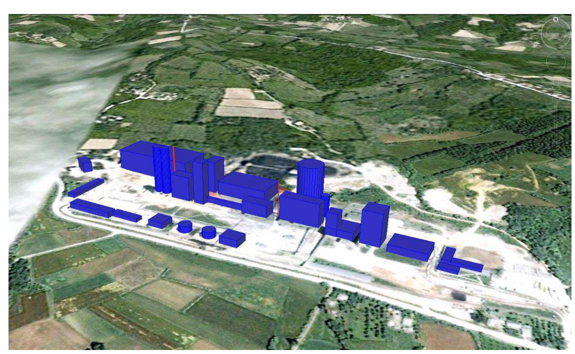

Figure 2. 3D model of cement plant

Taking into account all the results obtained through the dispersion modelling of the pollutants from the SRF co-incineration process in the cement plant, a conclusion can be drawn that the impact on the overall quality of air will be negligible. Results of the air pollution dispersion model show that the concentration of particles in the air in the broader area surrounding the cement plant will remain below the defined maximum allowable values.

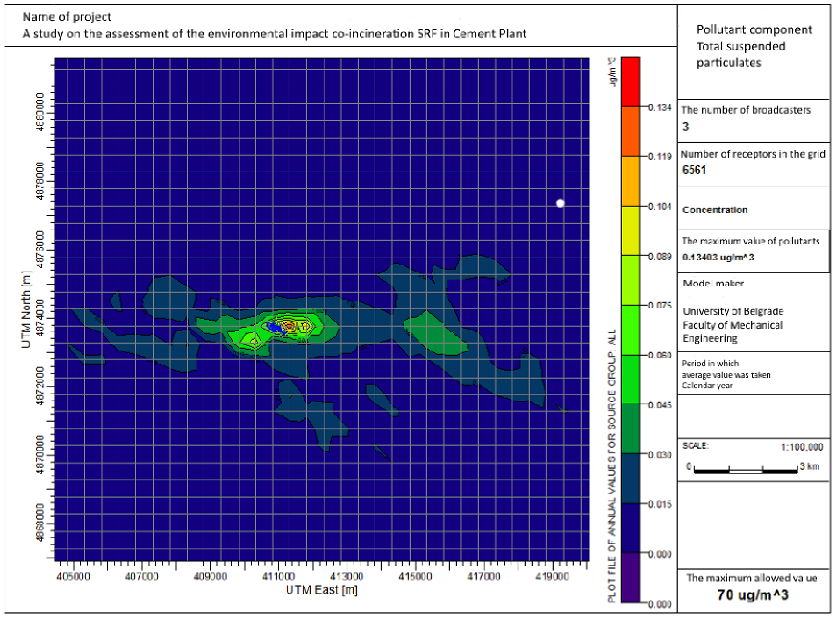

Figure 3. Results of the dispersion modelling of total dust from three main cement plant emitters with the use of SRF

Therefore, no cumulative impact of the emission of pollutants on the existing quality of air should be expected. The impact of the Cement Plant from the aspect of emissions into the air will remain at the present level. Health hazards to the exposed population due to this process can be considered negligible. Partial substitution of the main fuel with alternative SRF will not cause the appearance of new types of wastewaters and waste or increase in the quantities of the existing ones. An increase in noise levels due to the transport and delivery of SRF to the location of the Cement Plant will be negligible. The use of alternative fuels will not cause any new effects that could produce, together with the existing impacts of the Cement Plant, any new cumulative effects on the environment.

Althouth it is assessed that additional emissions due to the use of SRF will be extremely limited and will not cause an increase of the present effects on the quality of air in the surrounding of the cemenet plant, the manufacturing process and emissions from the plants will be monitored in the same manner as so far. Given the fact that the use of SRF will not lead to a change in quantities and quality of wastewaters or cause generation of additional quantities of waste, monitoring of the environmental impact defined by environmental impacta assessment study includes primarily monitoring of the air quality impact and refers to the emissions of pollutants from the raw mill and rotary kiln emitters and air quality at the measuring points in the wider zone of the cement plant.

4. ECONOMIC ASSESSMENT

4.1. Methodology

In order to identify the net economic effects of the substitution of the portion of fossil fuels by solid fuel generated from municipal waste, the authors applied the standard approach of comparing the situation "With" Project, that is, if the substitution is made and the situation "Without" Project, that is, if the cement plant continues to use exclusively fossil fuel as a heat energy source in the rotary kiln. The situation "With" Project means that investment (for technical adaptations) is made without production losses and that after project implementation the volume of production will not change in the further exploitation life of the cement plant. "With" Project situation implies an increase of the operating costs (maintenance and insurance of newly-installed equipment and additional consumption of electricity), but also reduction of the heating energy costs due to the substitution of part of more expensive fossil fuel (petroleum coke). "Without" Project situation means unchanged revenues and costs in the planned exploitation life of the cement plant. The criteria for the evaluation of the repair justification are defined according to the standard approach of comparing financial and economic costs and benefits. [4]. For evaluation of the financial cost-effectiveness of the Project the authors used the dynamic approach of the Discounted Cash Flows for "With" and "Without" Project situations. This analysis is meant to show whether the project on partial substitution of main fossil fuels with solid fuels generated from municipal waste increases or reduces the cement plan resources over the entire exploitation period. In order to assess project cost-effectiveness in the overall exploitation period the authors developed a table of "With" and "Without" Project financial flows. The "With" Project financial flow gives a dynamic overview of annual revenues from cement sale and transport, on the one side, and the overview of all financial outflows, including investment and operating expenses without depreciation and corporate profit tax, on the other side. The "Without" Project financial flow gives a dynamic overview of annual revenues from cement sale and transport, on the one side, and a dynamic overview of financial outflows excluding depreciation and corporate profit tax. To define the net financial effect of the combined combustion project over the entire economic life it is necessary to establish the difference between the "With" and "Without" Project cash flows. The net difference between these flows represents an annual financial effect of the project on combined combustion of SRF and of the main fossil fuels. The net present value of the Project is a discounted sum of these differences, whereas the internal rate of return (IRR) is an average rate of profitability of the invested funds. The Project's net present value is positive and multiply exceeds the initial investment costs. Discounted value of the net profit at the rate of 5% is EUR 1,574,296, which is twice as much as the initial investment. According to this criterion for evaluation of investment justification, the Project is acceptable. Apart from the positive net present value, the Project also achieves a positive internal rate of return of 27.5%. Payback period is 4.5 years, which is acceptable for projects in the cement manufacturing industry. Investment in the project of co-combustion of fossil fuels and municipal waste includes the effects and costs beyond the company which are relevant for the overall social and economic development. As given in the preliminary design, the project of construction of the plants for combined combustion should also have, besides saving of fossil fuels, positive environmental implications. Namely, treatment of portion of municipal waste as a potential heating fuel in the cement industry brings useful environmental effect for the overall economy. Burning plastic, fabrics, cardboard, paper or rubber in the rotary kiln at extremely high temperatures is a preferred option of non-recyclable municipal waste management. Although purchase or manufacturing of the solid recovered fuel is an economic cost for the investor from the aspect of the overall economy, portion of the municipal waste generated into solid recovered fuel represents an indirect economic benefit. These positive environmental effects are included into the cost-benefit methodological framework and monetarily valued in an indirect way. Based on the assessed local cost of the solid municipal waste treatment at landfills (5-10 euros per ton), costs of the manufacturing SRF from non-recyclable portion of the solid municipal waste (15–20 euros per ton), required quantities of the non-systematised solid municipal waste for manufacturing a ton of SRF (3 tons) and annual consumption of SRF (12,750 tons per year), the authors calculated the monetary equivalent of positive environmental effect of the project on introducing co-combustion in the cement plant in the amount of EUR 51,000 p.a. $(7.5 \cdot 3-17.5) \cdot 12750$. Within the assessment of the economic justification of the project for construction of the co-combustion plant, the authors developed an economic flow, showing all flows of real resources, including investment, operating costs without transfer payments, real savings in the consumption of heating energy, but also positive environmental effect achieved through solid municipal waste management. The economic net present value of the Project is EUR 2,054,443 and the economic internal rate of return is 33%.

4.2. Sensitivity and risk analysis

Sensitivity analysis is the first phase in the assessment of the investment project risks. Calculating the values of parameters for the project assessment starts with the most likely input values. [3]. Price and quantity of the used SRF, price and quantity of the used petroleum coke, the rate of substitution of petroleum coke with solid recovered fuel produced from waste, price and quantity of electricity, prices of other solid and liquid fuels, value of investment are the parameters that can be changed over the co-combustion implementation and exploitation. Change in the values of these parameters certainly affects the values of relevant parameters for the evaluation of the project justification. Sensitivity analysis is performed by changing one input parameter by certain percentage while keeping other input parameters constant. Therefore, this is a statistical approach that does not include simultaneous changes of input parameters. Selection of critical variables is performed based on the try and error approach. Namely, after an input value is changed by certain percentage, change in the level of evaluation parameters is observed (NPV, IRR and payback period of a given investment). The aim of the uncertainty analysis and identifying the most critical items of the project is to find out at which items and by which percentage change of the value of that item the critical (last acceptable) values of outputs can be most rapidly achieved and/or by which percentage certain item should be increased or decreased so that the NPV is zero or IRR is equal to the discount rate. In the sensitivity analysis the percentage change of the value of an input parameter of the

Project which equalizes the net present value to zero and IRR to the discount rate is called the switching value. Table 4. shows varying of the prices of solid recovered fuels, price of petroleum coke, volume of investment and rate of substitution of petroleum coke with solid recovered fuels. Prices and investment vary in the range ±10%, whereas the rate of substitution of petroleum coke with SRF, except the base case 20:80 is also tested for the case 10:90.

Table 4. Sensitivity Analysis

Variable	Changes in (%)	NPV (€)	IRR (%)	Payback (Years)
SRF price	0%	1574296	27,5	4,36
	-10%	1934406	31,9%	4,02
	10%	1214185	23,0%	5,69
Switching values (%)	43,7%	0	5%	/
	Changes in (%)	NPV (€)	IRR (%)	Payback (Years)
Fossil fuels price	0%	1574296	27,5	4,36
	-10%	4095070	56,6%	2,51
	10%	-946479	-5,9%	/
Switching values (%)	6,5%	0	5%	/
	Changes in (%)	NPV (€)	IRR (%)	Payback (Years)
Investment costs	0%	1574296	27,5	4,36
	-10%	1652942	30,7%	4,01
	10%	1495649	24,8%	5,21
Switching values (%)	290%	0	5%	/
Rate of technical substitution (SRF:fossil fuels)	SFR:FF	NPV (€)	IRR (%)	Payback (Years)
	20:80	1574296	27,5	4,36
	10:90	223387	8,9%	9,81

Sensitivity analysis shows that the Project's most critical input parameter is the price of petroleum coke. If the price of petroleum coke is increased by 6.5% (from 105 to 112 euros per ton), the project will not earn profit and the payback period of the investment funds exceeds the projected exploitation period of the Project. Co-combustion Project is not particularly sensitive to the change of SRF price. The net present value is zero and the internal rate of return is the discount rate (5%) only if the price of solid recovered fuel is increased from EUR 30 to EUR 43 per ton (44%). Change of the investment costs does not have notable influence over the Project performance. The Project is commercially unjustified only if the investment costs are tripled. Change of the rate of technical substitution of petroleum coke with SRF significantly influences the Project performance. Namely, if the rate of substitution is reduced from 20:80 to 10:90, the discounted net profit of the Project (NPV) falls by 86% and the average annual profitability (IRR) by 67%. To assess risk of a specific component of the Project, that component must be not only sensitive, but also highly uncertain. Risk assessment is measurement (quantification) of uncertainty. Therefore, for the assessment of the Project's risks, critical components of the Project must be defined. For each critical component of the Project probability of event must be calculated because such probabilities also define probability of outputs of the project model analysis. Risk analysis or quantitative assessment of uncertainty thus goes one step beyond the sensitivity analysis by defining weights to the critical variables of the model (price of petroleum coke and SRF), that is, probability at which given value of those variables will occur. Once the distribution of these weights and/or probability for the selected critical variables (based on the sample or otherwise) is determined, it is necessary to define the technique that will reliably transfer the impact of these variables thus (stochastically) determined to the model results. In this case, the term "reliably" means that the occurrence of the critical variable by the selected (determined) distribution of probability is transferred to the result of the model (NPV or IRR). In the risk analysis for the Project on Co-Combustion of SRF and Petroleum Coke in the cement plant the price of solid recovered fuel was modelled by triangular probability distribution and the price of petroleum coke by log-normal distribution. Figures 4. and 5. give the overview of the obtained results of the NPV and IRR simulation (Latin Hypercube Sampling method).

Results of the risk assessment show that the expected value of the internal rate of return (IRR) is 25.49% with probability of about 25%. Simulation results show that with 90% probability the internal rate of return of the Co-Combustion Project will range from 1.0% to 46%. Probability of the negative internal rate is about 10%. With adopted probabilities (by appropriate statistical reliability tests) for the prices of SRF and petroleum coke, the profitability of the Project is significantly above the relevant cost of capital (interest rate).

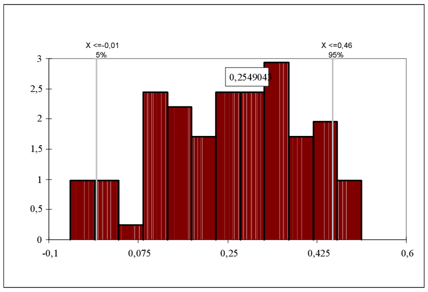

Figure 4. Probability distribution for IRR (%)

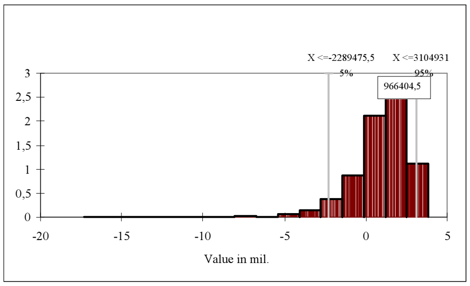

Figure 5. Probability distribution for NPV

5. CONCLUSIONS

Sensitivity and risk analyses have identified critical input economic parameters and quantified their importance on the performance (results) of the Co-Combustion Project in the Cement Plant. Sensitivity analysis has identified, through a try and error method, the most critical input economic and technical parameters. Minor changes of the price of petroleum coke, price of SRF, volume of investment and the rate of technical substitution of petroleum coke with SRF cause dramatic changes of the Project performance. Given the Terms of Reference, special attention is given to the energy sources. Petroleum coke, that is, the prices of petroleum coke and its combination with SRF, remains the most critical economic parameter. A slight increase in the price of petroleum coke (6.5%) brings the Project to the verge of acceptability (total net profit is equal to zero). Given the relatively lower importance of SRF in the overall energy consumption, an increase of the SRF price is not so dramatic from the aspect of the total performance of the Project. In the basic combination of the combined combustion (20:80), the price of SRF needs to go up by 43.7% for the Project to be at the verge of acceptability. The rate of technical substitution, that is, its change is of crucial importance for the Project performance. If it is assumed that the prices of petroleum coke and SRF are not changed, which is the basic assumption in the sensitivity analysis, a decrease of the substitution rate from 0.25 to 0.11 leads to a dramatic reduction in the net present value and internal rate of return. Namely, if SRF and petroleum coke are technically (energy-based) combined at the rate 10:90, the net present value is still positive, internal rate of return is slightly above the discount rate and the payback period is about 10 years. Given the positive effect size, the volume of investment is a less critical variable. Of course, it does not mean that it is irrelevant how much and when will be spent for the Project implementation, but it gives a possibility for building and purchasing more comfortably and at higher prices the necessary mechanical and electrical equipment. The total price of the Project may even be increased by three times and the investment would be at the verge of justification.

In the probabilistic risk assessment two input parameters were assessed: price of petroleum coke and price of SRF. These are the two variables whose variances affect the Project performance. Although important, the volume of investment and rate of technical substitution of petroleum coke with SRF were not tested through the probability assessment because the investor may directly influence these parameters. Namely, though the volume of investment can also be affected by external factors (change of purchase prices in the course of the construction), it is still a foreseeable parameter and potential uncertainty lasts only in the first two years, until the completion of the construction works and purchase of mechanical and electrical equipment. The risk of the Project was assessed through the probability assessment of the SRF and petroleum coke price variances. With probability of loss (negative net present value) of 20% and negative internal rate of return of 10% the Project on the construction of the plants for the use of solid recovered fuel (SRF) for combined combustion with the main fossil fuel can be classified into the group of projects with acceptable (low) level or investment risk.

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ENVIRONMENTAL PROTECTION AND ENERGY EFFICIENCY CONCEPT IN FIVE STAR HOTELS IN MACEDONIA

Biljana Petrevska[1], Vlatko Cingoski[2]
[1]Faculty of Tourism and Business Logistics, "Goce Delcev" University - Stip, Macedonia
[2]Faculty of Electrical Engineering, "Goce Delcev" University - Stip, Macedonia

Abstract. The paper assesses the application of the concept of environmental protection and energy efficiency in hotel industry, by elaborating the case of Macedonia. It investigates the extent of environmental protection practices in terms of current level of involvement. For that purpose, the research was consisted of an online survey conducted among managers of five star hotels. The results point that large number of hotels lack policies and practices related to environmental protection and energy efficiency. Finally, the paper allows increased understanding of the way hotel industry in Macedonia operates when referring environmental protection issue, and identifies challenges the hotels are faced with in their attempt to decrease operating costs towards energy efficiency. At the same time, the research poses new challenges that urgently need to be brought to hotel management and tourism development planning.

Key words: Environmental protection; Energy efficiency; Five star hotels; Macedonia.

1. INTRODUCTION

Hotels are one of the most energy intensive facilities with correspondingly high energy costs. They are ranked among top five in terms of energy consumption in the tertiary building sector (minor only to food services and sales, health care and certain types of offices) (Hotel Energy Solutions, 2011). So, there is an inevitable relationship between hotel industry development and environmental and energy efficiency impacts. The main intention of the management is to focus its activities in the line of reducing operating costs by introducing new sources of energy that a priory preserves the environment by creating an eco-friendly establishment. Due to the fact that clean and well preserved environment is one of the main preconditions for high quality service generally in the hospitality-oriented facility, one may conclude the dependent nature of the hotel development.

This study is designed to provide information on the nature and the extent how the hotel industry meets the environmental and energy efficiency issues, due to fact that this is relatively unexplored topic in Macedonia. The research topics are: (i) to determine the extent of environmental protection practices in the hotels in Macedonia; (ii) to assess the current level of the involvement of Macedonian hotels in applying environmental protection practices; and (iii) to pose valuable findings to hotel management for cutting the operational costs based on saving energy.

In order to meet the three-fold objectives, the paper covers several sections. After the introductory part, Section 2 provides a brief overview on literature addressing environmental performance and benefits for hotel industry. Section 3 encompasses the methodology and research framework. Section 4 presents the main analysis, discussion and findings, while the future challenges and recommendations are noted in the last section. Generally, the contribution of this paper lies in the fact that it enriches poorly developed academician work in Macedonia addressing this issue.

2. LITERATURE REVIEW

There is a large body of literature arguing the necessity of always having in mind the environments, thus introducing environmental protection programs in hotel activities in terms of reducing energy consumption, recycling, composting food scraps etc. (Bowe, 2005; Bruns, 2000; Chen, Legrand, & Sloan, 2005; Dodd, Hoover, & Revilla, 2001; Karagiorgas et al, 2006). Furthermore, many academics note that hotels have noticed the benefits from improving environmental performance generally by reducing the operational costs (Forbes, 2001; Kirk, 1998) and sustaining competitive advantage, increased demand for eco-friendly hotels etc. (Bohdanowicz, 2005a, b; Le et al., 2006; Vazques, Santos, & Alvarez, 2001).

Additionally, various regulations serve as primary instruments of action for hotels in the line of fulfilling obligatory regulations for health and safety, environmental taxes, building standards etc. This leads to necessity of developing industry benchmarking (Kozak, 2004; Pyo, 2001; Wöber, 2001).

3. METHODOLOGY

The study took qualitative and quantitative methods. The qualitative approach included literature review on main publications of interest addressing application of environmental protection programs and hotel energy efficiency in other countries. Furthermore, a number of publications of interest were carefully followed, along with websites for updates on environmental initiatives.

The quantitative approach covered data obtained from an online survey. The data were collected via questionnaires administered to managers of five star hotels in Macedonia. To determine the sampling frame, a list of five star hotels was provided by the Sector of Tourism within the Ministry of Economy. Based on the list, a total of 16 five star hotels were identified. According to the bylaw on categorization of hotels in Macedonia, a five star hotel should have more than 20 rooms and at least 570 points obtained from minimum fulfillment of 120 criteria. These criteria encompass three main sections referring rooms (cleanness, public spots, parking etc.), furniture (sanitary comfort, sleeping comfort, equipment, entertainment, telecommunication etc.), services (room service, drinks and beverage, reception, additional services etc.), and free activities (additional equipment, spa and wellness facilities, animation, child care etc.). Yet, no criteria related to environmental protection activities are noted.

The questions were structured in four interrelated parts: Environmental policy, Environmental protection, Resources and Perception indicators. The questionnaire was consisted of two types of questions, whereas for the first section covering issues on Environmental two-choice questions were applied, while for other three sections a 5-point Likert scale (1=very low, 2=low, 3=medium, 4=strong, 5=very strong). The following scheme was applied when interpreting the mean range of results in the line of quantifying the factors impact: 1.00-1.80 (very low); 1.81-2.60 (low); 2.61-3.40 (medium); 3.41-4.20 (strong); and 4.21-5.00 (very strong).

No pilot study was performed due to financial constraints. The survey was conducted during May-June 2015 with a follow-up reminder to each non-respondent approximately each week. The response rate was 62.5% which is relatively high and untypical for online survey when usually the response rate is between 16-25% due to lack of personal contact and less binding (Bohdanowicz, 2005b; Jeong et al, 2003; Medina-Munoz & Garciá-Falcón, 2000). The statistical evaluation of obtained data was performed by SPSS program. Kayser-Meyer-Olkin measure (Kayser, 1974) and Bartlett's test (Bartlett, 1954) were applied.

4. FINDINGS AND DISCUSSION

The study found that generally, the surveyed five star hotels have almost the same attitudes toward questions although they differ in terms of working history, from relatively young hotels existing up to 5 years on tourism market, to well positioned hotels with over 15 years of working experience. It is hard to determine precise number of employees in the surveyed hotels since some of them have up to 50 employees, but some have even more than 100 employees. So, we have generalized the responses towards application of environmental protection activities and energy saving concept.

The reliability of the survey instrument is satisfactory since the Cronbach's α is relatively high (0.7759). The Kayser-Meyer-Olkin measure of sampling adequacy is 0.675 and the Bartlett's test of Sphericity is significant at 0.000. Table 1 poses summarized results from the survey addressing the sections Environmental protection, Resources and Perception. The results from the questions covering the section on Environment policy are interpreted in only descriptive manner. Namely, it is found that 70-80% of surveyed hotels hold a Certificate for energy efficiency, prepare written plans for environmental protection and have an employee responsible for activities related to environmental protection. Although this is in favor of supporting the European environmental impact assessment regulation yet, there is a certain risk in the interpretation of these findings. Namely, the possession of such documents may reflect only the appearance of social responsibility of the hoteliers and still to have doubts in the environmental protection concept. In this line is the understanding for the questions related to the term "personnel for environmental protection' which might be understood as a 'personnel in charge for cleaning the environment' which in most cases is a job of the housekeeping staff. Half respondents stated to have Eco certificate, Eco label, prepare reports on environmental protection and provide info to guests related to environment protection. Despite the high level of existence of environmental concern and policy, yet only one of the surveyed hotels have received an award related to environmental protection. This strongly supports the general finding concerning environmental policy in Macedonia that still needs to be done.

The questions related to Environmental protection actually addressed the indicators for interventions and knowledge. It was found that five star hotels do not have any interest in environmental education by providing extremely limited or no staff environmental training at all, thus this has low impact. Half managers stated to have considerable amount of environmental pollution around the hotel, but they performed many interventions to prevent it. So, this is the only factor that had strong influence when assessing the extent of activities related to environmental protection. On the other hand, the hotel managers reported to have adequate knowledge on ISO 14000 (environmental protection standard) resulting with medium impact. Consequently, we found this group of question completely congruent with previously interpreted results where it was found limited environmental awareness and concern.

Third section of questions addressed resources in the line of assessing the nature of energy use and resource conservation. Due to fact that the use of energy is a cost factor, it was expected that hotels takes measures to reduce and replace it with renewable sources of energy. The findings are alarming since they point to extremely limited use of geothermal energy, biofuel and photocell lighting. Moreover, the treatment of the waste water and 'smart rooms' have no meaning in terms of energy efficiency. The energy saving light bulbs were found as a resource with medium impact, along with the minimal usage of solar energy and the dimming system. On the other hand, hotels pay large attention to use energy saving systems that control every appliance in the room and key-card control system that provides no power unless the room key is inserted. This is being assessed as strong factor. Guest demands for linen and towel changes are seriously taken into consideration being assessed as very strong factor of influence along with central cooling/heating system.

The summarized results (Table 1) confirm the findings as in Cunningham (2005), Erdogan & Baris (2007), Mbaiwa (2003) as well as Trung and Kumar (2005) that although being aware of importance of the environmental protection, yet its stewardship is not a top priority. This is most probably because Macedonian hotels are driven by increasing the number of tourists regardless the environmental concerns and with little or no environmentally friendly practices. Consequently, the five star hoteliers in Macedonia are less concerned about environmental protection per se, except for economic and legal interest. Macedonia faced many economic and socio-political problems after its independence in 1991, so environmental issues have only just recently come to attention. This is completely opposite to other countries, like the Scandinavian where environmental protection is of high quality and importance and has long received political and financial support at local and national level.

The presented findings in Table 1 indicate that increase of costs is the most powerful limiting factor for applying the concept of energy efficiency, while the lack of subsidies has the lowest impact. Although the sample was consisted of five star hotels which should have advanced knowledge in different fields, yet the hotel management is not well informed about the energy efficiency concept, thus evaluating it as an indicator with medium impact. In this line, the respondents have intermediate interest in this concept, and the technical limitations of hotel facility are perceived as a factor with medium influence.

Table 1. Summary of findings

Type of indicator	Mean	Std.
ENVIRONMENTAL PROTECTION		
Employees training	2.40	2.826
Hotel's surrounding pollution	2.80	3.912
Prevention interventions	**3.33**	4.183
ISO 14000	2.80	2.966
RESOURCES		
Solar	2.90	5.357
Geothermal	1.33	0.577
Biofuel	1.22	1.826
Photocell lighting	1.22	3.536
Use of treated water	1.40	2.082
Energy saving light bulbs	2.90	7.274
Smart rooms	1.60	2.630
Dimming system	2.90	4.919
Key-card control	**4.10**	10.145
Demand for linen and towel changes	**4.90**	28.991
Central control cooling/heating	**4.50**	17.578
PERCEPTION (limiting factors)		
Not informed	2.80	2.236
Not interested	2.80	2.881
Costs increase	**3.40**	3.416
Technical limits	2.89	2.380
Lack of subsidies	2.67	3.266

5. CONCLUSION, RECOMMENDATIONS AND FUTURE WORK

Hotels consume substantial quantity of energy, water and other non-durable products, thus provoking substantial environmental impacts. On the other hand, they rely on clean nature and unpolluted environment as a core value for hotel industry. Tourists more often abandon tourism destinations in poor environmental condition and trace for hotels with eco label, eco certificate and certificate for energy efficiency. Consequently, hotel industry is becoming increasingly environmentally responsible by taking care of energy efficiency.

The study found that Macedonian five star hotels are aware of the negative influences on the natural surrounding that arise due to their specific function. They are also aware that hotels may benefit from environmental pro-activeness, which is important for the performance and development of tourism. Yet, their top managements are lacking interest in the energy efficiency concept blaming the increased costs for its successful implementation. This implies that environmental concerns and the willingness to act are strongly dependent on the hotel manager's knowledge. Furthermore, the restricted financial resources and high operation costs due to low and limited application of renewable resources, generally reduces the hotels to be more active in environmental issues.

Based on surveys findings, the paper recommends that managers of the five star hotels in Macedonia should be focused on shifting professional ethics, developing and exerting wide range of environmental protection programs and activities in the first line by introducing renewable sources of energy which will result in reducing energy consumption. Finally, the paper urges need for applying environmental protection as well as the energy efficient concept and more frequent penalizing of environmentally unsound concepts practiced in hotels in Macedonia. Instead of being focused on quick economic benefits, the five star hotels should induce more pro-environmental attitudes among managers.

During the research, several limitations occurred which might be addressed in some future work. Namely, although the presented data is reliable, it is difficult to establish to what extent it is representative of the overall hotel industry in Macedonia. Therefore the study may be enhanced by extending the sample by including four and three star hotels in Macedonia, as well as to spread the target location within other countries. On the other hand, it must be taken into consideration that the goal of the study was to identify indicators that can be overcome by hoteliers requiring minimum information input which is easily available.

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THE ROLE OF PRIVATE SECTOR IN INDUSTRIES BASED ON IRON AND STEEL PRODUCTS A CASE STUDY: STEEL ANGLES & FLATS FACTORY

Jamal Mohamed Ben Sasi[1] , Ramadan Ahmed Abugeddida[1]
[1]Faculty of Engineering , Misurata University, Libya

Abstract. Iron and steel industry of the modern industries that met with great demand during the past few years to become the most advanced industrial countries are looking serious and down the monopoly of the industry's products. The private sector plays an important role in achieving economic development and advancing the technical development in different countries, where a large proportion of industrial projects and services, and thus contribute to the creation of employment opportunities for large numbers of the workforce and reduce the increasing rates of unemployment. This paper represents one of the attempts to explain the importance of the private sector in general in the economic life and its place in social life, as well as how to activate the role of the private sector in economic development, and in particular the experience of the private sector in the development of one of the local factories based on products of Libyan Iron and Steel Co., Misurata - Libya, which represents a model for local complementary industries for the production of iron angles and flats. Ensure on the important of privatization and customization, where many studies indicated to adopt some of the countries in the world promote the development of the private sector and give it more support in terms of finance and tax treatment, and touched the search to the contribution of the private sector in the development, implementation and funding criteria for national skills for the purpose of training and rehabilitation. As limiting the administrative problems and obstacles, technical and marketing of the plant referred to previously and the mechanism used to address them, and the extent of support and overcome the legal and administrative procedures as well as financial by the relevant authorities. Finally, conclusions.

Keywords: privatization, industry, steel.

INTRODUCTION

In recent years the economic development projects and social development are a major shift in the degree of economic change and sustained quick growth to human capital will lead the development processes. This means the economic progress cannot be achieved without the availability of qualified manpower and specialized workers. They can carry out the planning and implementation of development programs of economic system. The sectors of economic development need engineers, technologists and technicians, that they have the necessary setup required education, training and experience in various areas of development [1]

The development of small enterprises tries to encourage the residence of the most important part of economic processes in social and developing countries. Also it is .essential to increase the capacity of production, contribute in solving the problems and unemployment. Therefore, many countries has increased the interest rate in projects, provided assistance in various methods and in accordance with available possibilities [2]

The private sector includes economic activities based on private property ownership, whether individual or collective ownership. Considering that the private sector is a key partner to the public sector in achieving the development process. The Arab Organization for Industrial Development and Mining permits organization within the new orientations to be involved in all phases of the organization's activity.[3] Based on the above, the paper focused on the obstacles faced in the private sector management, and precisely related to the industrial, economic problems and limit technical development.

OBJECTIVE OF THE PAPER

- Clarify the experience of the private sector in the development of one of the local factories based on the products of Libyan Iron and Steel

Company(LISCO), which represents a model of steel angles and flats industry.

- Detect the most important problems of the private sector, and delay its development, especially the economical, technical and industrial constraints.
- Find out solutions and suggestions, providing some of the procedures and mechanisms to clear up the most important obstacles that effect on the private sector management.

PRIVATIZATION

Acquires of privatization or customization of the most interesting countries in the world, whether developed all of which gives economic labels in English or French for privatization. There is no concept of the word privatization, which varies from one place to another and from one country to another. It is the philosophy of modern economic related strategy, which can convert a large number of economic, service and social sectors from the public sector to the private sector. Privatization is usually as a tool to activate the improvement economical comprehensive program with several axes pointed at improving economic conditions in any country. The importance of The small enterprises (SMEs) and their role in national economic development is to support of the national economy , support the development of the economy , increase the production, provide economic success, and the important highpoints of economic as the following [4]:

- Generate income for the owners of these establishments.
- Provide employment opportunities for labor and thus work to reduce unemployment and shortage rates.
- Production of goods and export opportunities leading to access to foreign exchange.
- Create value-added products and national capital.
- Give opportunities for other investments of facilities.
- Establish infrastructures for the national economy in the face of obstacles and negative effects such as inflation.
- The small enterprises provide economic system and social stability.
- These facilities play a role in raising the people's participation in the national economy.
- The provision of opportunities for citizens to get income helps citizens in access to food, health, education services, to eliminate the displaced groups, so create a more stable society.

GENERAL CHARACTERISTICS OF SMALL PROJECTS AND ENTERPRISES

In spite of relative small size of small projects, they have certain characteristics different from the rest of other projects; we can mention some of them:

- Direct supervision by the owner of the project: As the project management which done by the owner personally. Therefore, the project management and flexible decisions both of them can be ensured the success of the project.
- Easy to adjust the needed production: Where customer favorites are taken into account, characterized by rapidly changing in production line and taking into considerations the needs of the market.
- Accuracy and good quality of the production due to the approval of specialization in the production of certain products, which means higher skill factor, and increase productivity.
- Can be established in small spaces due to lack of production facilities.
- The Contribution of raising the standard of existing and meet the basic needs of various sectors of culture.
- The degree of risk in the small projects is not high .

THE ROLE OF SMALL PROJECTS IN CREATING JOBS FOR LIBYANS

The importance of small projects in Libya as it provides fertile ground to encourage domestic savings, where these projects are characterized by low capital required for investment when compared to large projects, and they are often used domestic savings, and usually have an administration structure is simple, including accounting methods , and arises from the literal roots. It is not necessarily to use complex technologies and machinery, making it more attractive to small savers who do not tend to forms of participation that deprive them of direct supervision and management of their investments. And what could be the most prominent of these projects contribute to the development programs in Libya, is that they all can contribute to the way in reforming and restructuring the financing industry to provide significant employment opportunities and variety to the Libyans and the mobilization of individual savings and achieving justice in spatial development**.**

PROMOTION AND DEVELOPMENT OF THE PRIVATE SECTOR

Some countries of the world decided to fix the knowledge of promoting and developing the private sector, where we find that China has adopted general guidelines to encourage, support and guide the development of the private sector in economic terms. Also that it should make all efforts to create a healthy environment for the economic development of the private sector. This should accelerate the changes that should be made, including simple of restrictions on the private sector to reach its products to the market, give more support in terms of finance tax treatment, improved social services and government in this sector. [5]

List of proposed of research and development that are showed to organization of the private sector:

NO	Proposed	Urgent	Later On	Description
First: Technical Development				
1	Development of raw material			
2	Parts imported manufacturing			
3	Improve the quality of the product			
4	Reduce the cost of production and operation			
5	Develop the shape of the product catalog			
6	Develop alternatives for the product			
7	Design system for the maintenance of operating devices			
8	Training systems for engineers and technicians			
9	Operating systems development mechanism (operating automation)			
10	Diagnose problems with operation and production			
Second: Administration Development				
11	Automating administration			
12	Administrative staff training			
13	Programs are designed to measure achievement of human powers			
14	Feasibility studies for operation and production			
15	Feasibility studies of manpower			
16	Programs are designed to follow the development of profitability			
17	Design and preparation of programs Advertising			
18	Design marketing plans			
Third: The other problems faced the organization				
No.	Type of problem			Description of the problem

THE MODEL FOR THE PRIVATE SECTOR (STEEL ANGLES & FLATS FACTORY)

The Factory is located in Misurata city in the industrial region. It is considered the basis of other factories in dependent industries on the products of Libyan Iron and Steel Company.

The factory system consisted of many units which can be categorized as follows:

A. Manufacturing and production system.

B. Backup systems, which contribute to help the manufacturing and production system. They are as follows:

- Quality control system in a product for inspection and testing of the final product.
- Materials management system and storage, which contributes to the processing of raw materials, the final product and the best system for storage.

C. Support systems: They are as follows:

1. The energy grid system, which provides the factory with the electric power needed. It contains the following:

• Electrical convertor, kv 1000kv, 11 / v380, v220.

• Power generator of 1000 kw.

2. Maintenance workshops, which include all of the machinery maintenance workshops, turning and welding operations.

3. The water system, which provide the plant with cooling water.

4. Fire safety system, included specific gas cylinders.

5. Personnel, services, and transportation management system.

Production systems and accessories of the steel factory included the following data:

- Flowchart system functional units, as shown in Figure (1).
- Locations map of functional units as shown in Figure (2).
- The organization structure of the steel factory as shown in figure (3).
- Technical specifications of the products of steel factory as shown in table (1).

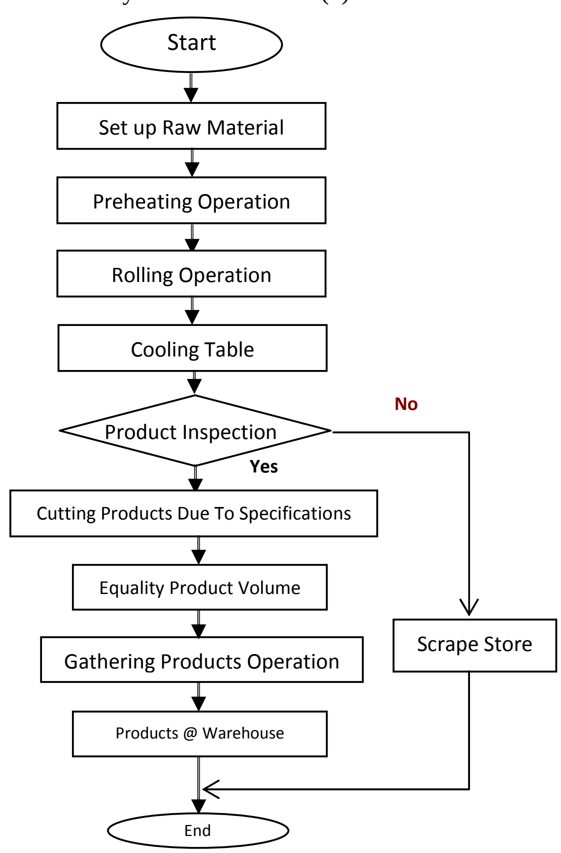


Figure (1) Flowchart system of functional units

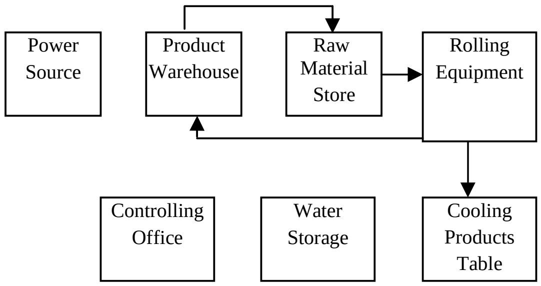


Figure (2) Locations map of functional components

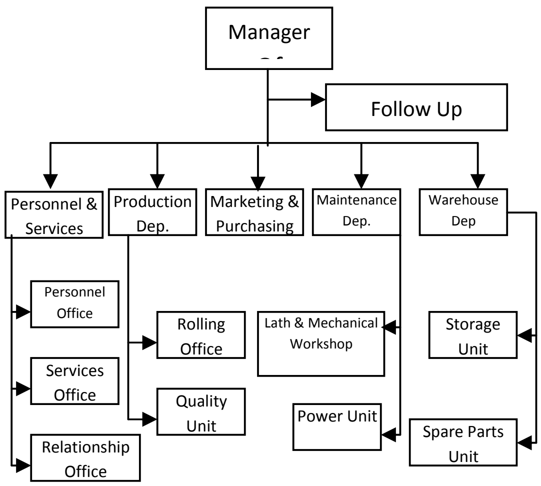
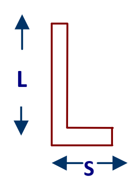
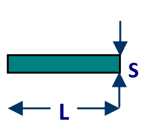


Figure (3) The organizational structure of the steel factory

Table (1) Technical specifications of the products of the factory

WEIGHT KG	Length meter	S mm	L mm	Description
6.66	6	3	25	**Angles** 
8.16	6	3	30	
10.68	6	4	30	
9.6	6	3	35	
12.54	6	4	35	
11.04	6	3	40	
14.52	6	4	40	
16.44	6	4	45	
20.28	6	5	45	
18.78	6	4	50	
22.62	6	5	50	
1.7	6	3	12	**Flats** 
2.83	6	3	20	
3.77	6	4	20	
5.65	6	4	30	
7.07	6	5	30	
7.54	6	4	40	
9.42	6	5	40	
11.78	6	5	50	
14.13	6	6	50	

PROBLEMS AND CHALLENGES FACING THE PRODUCTION IN STEEL ANGLES & FLATS FACTORY

- Irregular flow of electrical power for the plant, due to frequent power outages from the source.
- Lack of water services, causing an increase in production costs.
  - Lack of integrated industrial zone infrastructure, paving of roads and other related services.
  - Difficult administrative work pertaining to the workforce, in terms of accommodation and renewal permit, legal and sudden changes related.
  - The probability of changing the industrial area, causing instability and not being able to try to work a strategic blueprint for the plant depends on it.

CONCLUSIONS

1. Better performance in the private sector will be gained.
2. Full support for the private sector by the government will improve the quality of the products.
3. Increased integration between the private and public sectors.
4. Motivation for employees will give them encouragement.
5. The quality of employees training will improve the final products.

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BUSINESS PROCESS REINGENEERING IN MERGED COMPANY

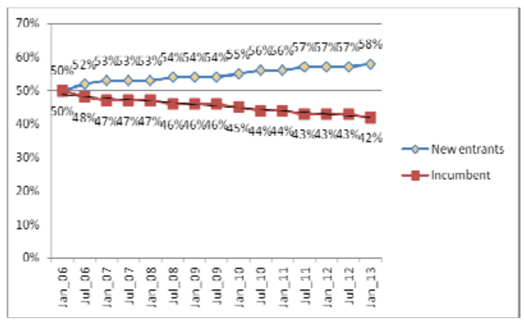
Frosina Geceva Kocova[1], Ljubomir Drakulevski[2]
[1]Makedonski Telekom AD Skopje, R.Macedonia,
[2]Ss Cyril and Methodius University in Skopje, Faculty of Economics, R.Macedonia

Abstract. *The global trend in telecommunication sector is focused on a strong push of the merger between telecommunication providers of fix network and services, mainly incumbent operators, and mobile network and service providers. The main driver for merging fix and mobile telecommunication businesses is a big market competition. Merger itself requires business process reengineering or at least process alignment. The adjustment of IT tools that are running behind the business processes is a real challenge. Business Process Management System can support faster merge of the companies from the business process point of view. The new business processes for the new company should be designed and be operational in a short period of time using a Business Process Management System (BPMS). The experience of implementation of the BPMS system in Makedonski Telekom and T Mobile Macedonia and implementation of the new processes tailored for the new company is a goal of this paper.*
Keywords: *Business Process; Reengineering; BPMS; R.Macedonia, Makedonski Telekom AD*

1. INTRODUCTION

The globalization of the economy and the liberalization of the telecommunication markets have formulated new conditions in this market segment which are characterized by instability and intensive competition. Competition is continuously increasing with respect to price, quality and selection, service and promptness of delivery. The competition is even more complex and severe considering the global trend of ceiling of the telecommunication market. Incumbent telecom operators all over the Europe share the same history of state ownership. They become privatized due to the European telecommunication market liberalization, losing monopoly position. New providers reshaped telecommunication market becoming a dominant player in this market segment.

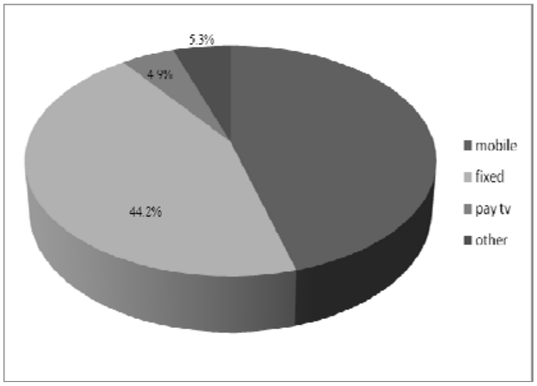
Market share trend in fix telecommunication market between incumbent and new entrants in EU in period 2006-2013 is presented in Fig 1.



Source: Communication Committee, Eurostat
Figure 1: Fixed broadband lines – operator market shares at EU level, 2006-2013

Convergence of the technologies, development of broadband services with introduction of VoIP (Voice over IP) and television services has changed the telecommunication market.
Introduction of mobile broadband services via 3G technology accelerate the competition in telecommunication market between the fix and mobile operators. The fix line services have a decreasing trend comparing the mobile services. Repositioning on the telecommunication market considering the decrease of the prices had impact on the revenue growth of telecom providers.
Average EU telecom revenue growth in period 2009-2010 is (-2.4)%, as presented in Figure 2.
Declining growth rates and core market shrinking are pushing telecom operators to make a strategy to survive on the market.
Merger and acquisition activity is on the rise in all industries, and seems to be the most popular strategy for survival of incumbent telecom operators.

M&A between incumbent telecom operators and mobile operators become mainstay in EU, but also in other countries.



Source: Communication Committee, Eurostat
Figure 2. Electronic communications sector revenues at EU level, 2010

There are four distinct types of acquisition present in the telecoms sector, defined in terms of two dimensions. The first is geographic scope, described as domestic mergers vs. cross border deals. The second is type of access-technology combination. The third is fusion of two mobile providers. The merge of fix line operator and mobile operator results in cross technology combination, as a fourth type of M&A and most dominant one.
Each type of merger is characterized by its own specific source of value generation and synergies, as well as challenges. Offering converged and bundled services for customers can make a competitive advantage for telecom providers.
The situation in Republic of Macedonia is very similar.
Incumbent telecommunication provider in fixed network, “Makedonski Telekom” AD participates in the total fix telecom’s market with 63.74%, competing with around 30 service providers [1]. The market share of “Makedonski Telekom”, as an incumbent, is bigger than EU average, but the revenue growth trend is negative.
In order to be more competitive on the market, the company decided to follow the merge strategy with T-Mobile, a daughter company, with 48.62% mobile communication market share.
The company’s merge as a process is very complex. No matter how the M&A will be implemented, the telecom providers should set up and follow a rigorous integration process.
Therefore in this paper only the impact of M&A on business processes is treated.

2. PROCESS MAP OF THE COMPANY

Company activities are organized in a business processes that are specific for each company. Design of the business processes and the correlation between the business processes reflect the management vision for the company strategy proceeding.
Business process management (BPM) has been referred to as a "holistic management" approach [2] to aligning an organization's business processes with the wants and needs of clients
The M&A is a management challenge for redesigning of the business processes and/or improvement of the business processes that will meet the expectations of the new company.
The business process redesign (Process Map) is treated in a few phases:

- Screening of AS-IS situation (business processes with relevant activities) in both companies.
- Identification of the existing processes that should be modified, improved and adjusted according to the needs of the new company.
- Identification of the new processes that need to be developed.
- Definition of New Process Map (definition and mapping of processes).
- Implementation of the processes.

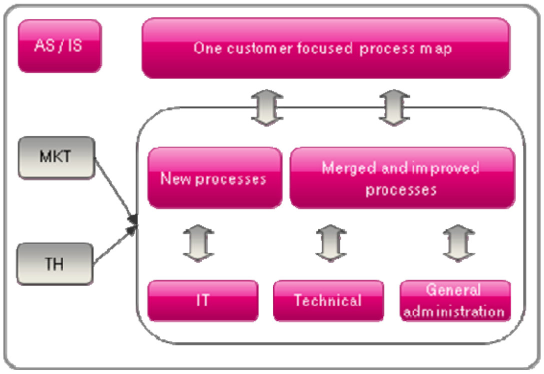


Figure 3. Transformation Process from AS IS into TO BE organization

An “AS IS” or baseline model gives an overall picture of how the process works, now. Any structural, organizational and technological weak points and bottlenecks can then be identified, along with possible improvements at the next stage.
Most of the G&A processes are identified for improvement and adjustment to the new company.
Based on the analysis of AS IS situation, the processes that need reengineering are identified.
Following criteria are considered as critical for process prioritization:

- Revenue impact.
- Cost savings.
- Time to market/ time efficiency/ customer satisfaction.

During the design of the new TO BE processes the following information are considered:

- The desired outcome of the process.
- The start and end points (customer need and customer need fulfillment).

- The activities that are performed.
- The order of activities.
- The people who perform the activities.
- The documents and forms used and exchanged between functions and from customers and suppliers.

When we talk for a customer need, the employees should be treated as internal customers. Their expectation of value added in TO BE processes is very important for easier acceptance of initiated changes in company.

The real challenge is adjustment and unification of the support processes (mainly G&A processes) considering the good practice from both companies.

The new Process Map which represents TO BE processes is customer focused as an important approach of the new merged company.

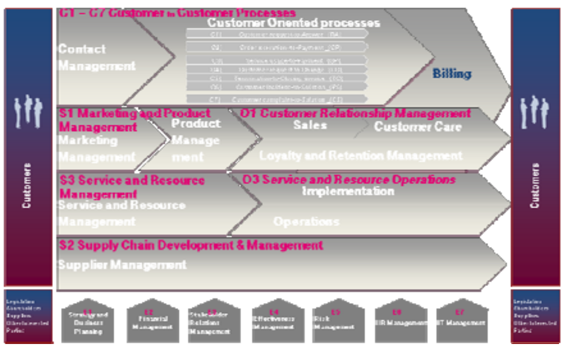


Figure 4. Business Process Map of merged company

Very important for process improvement and process reengineering are the IT tools that support the relevant business process. That means that any process development is connected with the development of IT tools. IT tools give the automatization to the process, increase the process flexibility, process effectiveness, supporting quicker and paperless transactions, removing physical and organizational boundaries.

The companies that have merged already use some IT tools for running their processes. Since the processes have to be improved or reengineered the review of all IT tools and relevant application needs revision as well with a decision on their further development or retirement.

Time needed for modification of current application and time needed for development of new applications has direct impact on the implementation of the new processes in the merged company.

3. BPMS PLATFORM

Business change is inevitable, and leading organizations will require the ability to dynamically make changes to business processes to maintain competitive advantage. Such dynamic process change might be enabled automatically by allowing technology to change the process based on rules and parameters, or by using deeper analytics and information about events to provide real-time situation awareness. These capabilities can enable the people who are involved in the process (and business process owners who are responsible for process performance) to enact process change, tailoring their responses appropriately to emerging business threats and opportunities.

The initial situation related to the Workflows in both companies is described with the next figure.

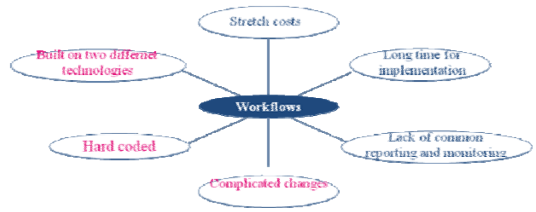


Figure 5. Existing situation of Workflows before merge decision

The Business Process Management System (BPMS) supports faster implementation of the business processes of the new merged company. The development and implementation of business processes on BPM Platform follows few steps presented in Fig.6.

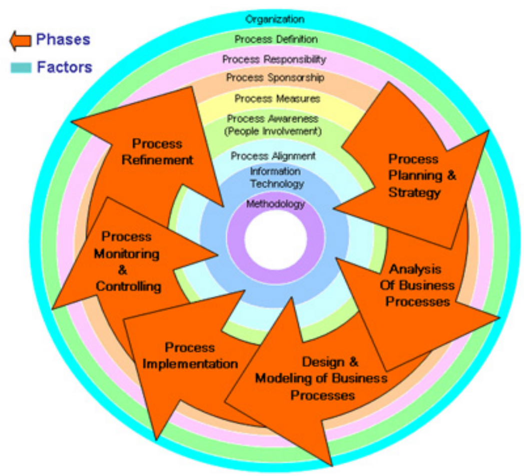


Figure 6. Business Process Management Framework

The BPMS is a technology that supports business process management (BPM), a management discipline that treats processes as assets that directly contribute to enterprise performance by driving operational excellence and agility.

Strategic Objectives for implementation of BPM Platform

- Accurate and faster processing of business critical activities.
- Reduce overall IT costs.
- Reduce duplications.
- Increase visibility into operational efficiencies and bottlenecks.
- Reduce business risks.

- Easier process changes in case of reorganizations, and/or acquisitions.

Operational Objectives refers on the increased flexibility, efficiency and fast respond for new business process implementation or modification of the existing represented by following parameters:

- Time for implementation of the new business process.
- Time for modification of the existing business process.
- Time for correction of the operational business process.

The configuration of BPMS that will meet the strategic and operational objective should consist of the following modules:

- Design Environment.
- Business Process Engine.
- Business Rules Engine.
- Form Management.
- Business Activity Monitoring (BAM) System.
- Management and Administration.

The BPMS needs to be designed from the ground up to be deployed on top of Service Oriented Architecture (SOA).

BPMS solution should provide possibility for integration with various databases (e.g. MS SQL, Oracle) in order to facilitate access to the relevant applications' data. Integration with other systems (like SAP, Customer Care etc.) that are deployed is expected as well.

Modern generation of intelligent BPMSs have added enhanced support for human collaboration, integration with social media, mobile access to processes, more analytics and real-time decision management.

4. CONCLUSION

The selected platform that has met the technical requirements is APPIAN BPMS.

Part of the workflows for the new reengineered business processes are implemented by usage of Appian as a BPMS.

In the first phase of company preparation for a planned merge (about a 2 years period), workflows for the following business processes are implemented considering harmonization and/or approval phase:

HR processes (vacation, training, business trip, selection and recruitment); Contract; Business Case; Project Document approval; Tendering process; Request for Procurement; Consent; Product Tariffs; Individual Case Pricing; Complains handling; Regulations; Budget Transfer. The version for mobile devices is also implemented supporting mobile devices like iPhone, iPad, BlackBerry, and Android operating systems.

The mobile application enables users to monitor general or targeted events, to collaborate on goals, to take direct action on task, and to stay abreast of key activities. The users gain mobile access to task and event notifications, mobile-enabled forms, one-click mobile approvals, up-to-date business information, and ad-hoc collaboration. The social Tempo interface also allows users to discuss about core business activities, systems and events.

Expectations of the common BPM Platform for easier reorganization of the new company and giving an added value are fulfilled trough:

- Faster deployment of new business processes that support the needs of new company (around 1 month),
- Collaboration between employees as internal users of BPMS straighten the new corporate culture and better usage of HR resources
- Increasing the flexibility of the company as a respond to the changes in business environment considering clear distinction of roles and responsibilities
- Monitoring, controlling and reporting of business processes considering the analysis of KPI (target KPI per process are achieved)
- Established traceability, history and control over business processes

IT technology seems to be a one of the most important driver and prerequisite for successful company M&A activities.

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PRODUCT LIFE-CYCLE MANAGEMENT DATA INTEGRATION FOR THE OVERHAUL OF RAILWAY BRAKING DEVICES

Branislav Stevanov[1], Nemanja Sremčev[1], Đorđe Lazarević[1], Danijela Gračanin[1]
[1]Department for Industrial Engineering and Management, Faculty of Technical Sciences, University of Novi Sad, Serbia

Abstract. *The railway braking devices are going through different phases of their product lifecycle, from production and exploitation through the overhaul and finally to the disposal. Overhaul of railway braking devices presents the phase where all information is integrated. Data integration for an overhaul of the railway braking devices presents a complex matter, because it involves different file formats created by various participants in different phases of the product life-cycle. The key point is to organize all the created data in one place so that all process participants can access it. This paper presents a possible solution for managing and integrating all important data for the railway braking devices during all phases of the products lifecycle.*

Key words: *railway braking device; overhaul; data integration; product lifecycle management.*

1. INTRODUCTION

Railway braking devices present an important safety component of the trains. Its overhaul consists of several phases such as visual inspection of the device, its disassembly and replacement of worn or damaged parts, its assembly and testing. Overhaul process for railway braking devices involves many participants such as production companies, railway companies and overhaul service companies. Every participant generates certain data which is relevant to the successful operation of the braking device. Also every participant operates from different location and the trains itself are operating in railway transport. The data involves bill of materials data, CAD drawings data, exploitation information, defect information, lists of parts for overhaul, overhaul work orders and schedules, testing results information and etc. To successfully manage all the necessary information a product life-cycle management (PLM) approach can be used. It is important to identify what are the PLM phases for railway braking devices and to identify all information flows in every phase and between phases. Then the information can be managed through the appropriate PLM software through the application of item revision system and defined workflow processes.

This paper is organized as follows. Second section presents overview of exploitation and overhaul of railway braking devices and how are these processes observed through the application of product lifecycle management approach. Third section presents a case study with a proposed PLM solution for the presented problem. Fourth section presents conclusions and future work and the last section presents literature references.

2. LITERATURE REVIEW

Product lifecycle management approach

The products change through its life-cycle and also change all the data that is tied to product. The generated product data is can exist in more than one copies and they are often incosistent in the terms of its contents. The problem of data integration and management is the core feature of the PLM approach. PLM approach tries to solve problems concerning data access and availability, data archiving, copying and confidetiality, and data exchange [6].

The product life-cycle management presents the approach which has evolved from the enterprise need for data management through the various information systems (such as material requirements planning (MRP), enterprise resource planning (ERP), customer relationship management (CRM) and supply chain management (SCM)) and from the data creation in different product life-cycle phases [5]. PLM approach enables better collaboration between all the participants in the supply chain, like suppliers, industrial companies and customers. PLM approach is based on the product data management, with products drawings (CAD data) and products bills of materials (BOM's) as basic data. PLM manages data through processes. One of fundamental processes of PLM data management is the engineering change process as described in [7]. Based on this process every changes tied to the product can be traced through items and its revisions, and also the responsible persons can be identified quickly.

Lifecycle of the railway braking devices

Since the railway transport has significant impact in national and international transport of goods it is vital that it operates successfully and safely. Most of the trains operate with the pneumatic brakes [10].

The performance of the railway braking devices used on trains is subject to many influences caused by its exploitation use and conditions. Previous research on the subject of railway braking includes the exploitation characteristics [9], failure analysis [2], materials appliance and environmental issues [1], testing and simulation of the braking systems [3].

Life-cycle management of the railway braking devices has been covered poorly in the literature and in scientific research. Most authors observed only certain aspects or certain life-cycle phases, and mostly the life-cycle assesment has been done for the whole trains like heavy metro trains [4]. It would be interesting to investigate how the railway braking devices change through its lifecycle and how to manage all the informations which are generated in each lifecycle phase. As identified in [8], lifecycle phases of railway braking devices include:

- production phase,
- first exploitation phase,
- overhaul and exploitation phases,
- disposal phase.

The overhaul and exploitation phases repeat as long as the braking device can operate, until it is ready for the product disposal phase.

The case study presented in the next section uses the engineering change process as a basis for the product lifecycle management. The case study shows a possible solution of how the braking devices data could be managed by using the PLM software through the identified life-cycle phases. Overhaul process decisions are simulated with PLM software.

3. CASE STUDY

Overhaul process

The case study describes the overhaul process for the railway braking devices at the overhaul service company in Serbia. The overhaul process of the braking devices consists of four main activities:

- Reception and visual inspection of the braking device,
- Disassembly of the braking device and defect detection,
- Parts preparation and assembly,
- Braking device inspection and functional testing.

Reception and visual inspection of the braking device is the first activity where the customer brings the braking device and the braking technician specialist inspects it. After the visual inspection is done, braking specialist makes the record of receipt and visual review.

Second activity is the braking device cleaning and disassembly. Technical documentation for the overhaul process is used for this activity. It presents the manual for the overhaul process of the braking device. For the railway braking device there are two types of parts which can be replaced:

- Type of parts which are replaced every time the braking devices goes to overhaul (rubber parts),
- Type of parts which are replaced only when needed that is only when they are damaged (metal parts).

Braking devise specialist makes the document of the noted defects and the spare parts list. The work order for the overhaul of the braking device is issued.

After the spare parts are retrieved from the warehouse, the assembly of the braking device can start. The assembled braking device is sent to testing. Inspection and functional testing is done on the testing table. The braking device is tested with different levels of working pressures within the controlled environment. Test results are printed in the form of functional testing diagram and in the form of the inspection protocol which serves like a table for inputting actual parameters.

Braking device data has been inputted into PLM software. The PLM software enables defining the braking device as an item, enables the overhaul process creation, and enables the PLM phases changed through the item revisions.

PLM software process

In the PLM software solution (Siemens Teamcenter®), folders are consisted of items, and every item has its revisions, which are consisted of any kinds of datasets. In this example, the monitoring of the life-cycle phases for the braking device and the execution of each phase is shown (Figure 1). When the braking device of a certain serial number is commissioned, the monitoring of its lifecycle can start. First item revision (A;1-Production), which contains important documents for that phase (bill of materials, drawings, etc.) is created, and it represents the first PLM phase of the braking device life-cycle. When the first exploitation phase starts, the revision of the first item revision (A;1) is executed, and the new revision is created (B;1-First exploitation). The new revision represents the second lifecycle phase of braking devices. During the implementation of revision, administrator chooses which documents will be copied from the previous revision and which will not, and adds new, specific documents for that new PLM phase. This process is repeated through all phases (production, first exploitation, overhaul, exploitation, overhaul and disposal).

The overhaul is the third life-cycle phase and its item (C;1-Overhaul) is also obtained with the revision of the item from the previous phase (B;1). After five years of use, every braking device needs to be serviced. The overhaul process for the railway braking device is created and conducted through the PLM software. In the PLM software this process has seven activities (reception and visual inspection; disassembly of the braking device and defect detection; part preparation and assembly; inspection and functional testing; review; status adding; notification) which are shown in Figure 2. Each of activities is done of one or more workers, and only the last activity is carried out automatically on the basis of results from previous stages. If all the activities are completed successfully, a flag appears next to the item revision (C;1), which symbolizes that the activities execution was successful, and therefore the process of overhaul is completed (Figure 3). After the overhaul, the braking device goes to reuse, therefore the forth revision is done, and the item revision (D;1-Exploitation) is created. The processes of the overhaul and the exploitation are repeated until it is decided that device has to be withdrawn from use. The fifth phase is the overhaul, the sixth phase is the disposal, and for each of them is made one item revision (E;1 and F;1), with the relevant documents within them. If the braking device is ready for disposal, then in the previous overhaul phase it is not overhauled and tested. In this way, very quickly and at any moment it is possible to see in which phase is a specific device and to see the whole product history, with the required supporting documents. Also, the problem of avoidance of the responsibility by workers is eliminated, because it is possible to see when was each phase performed and by whom.

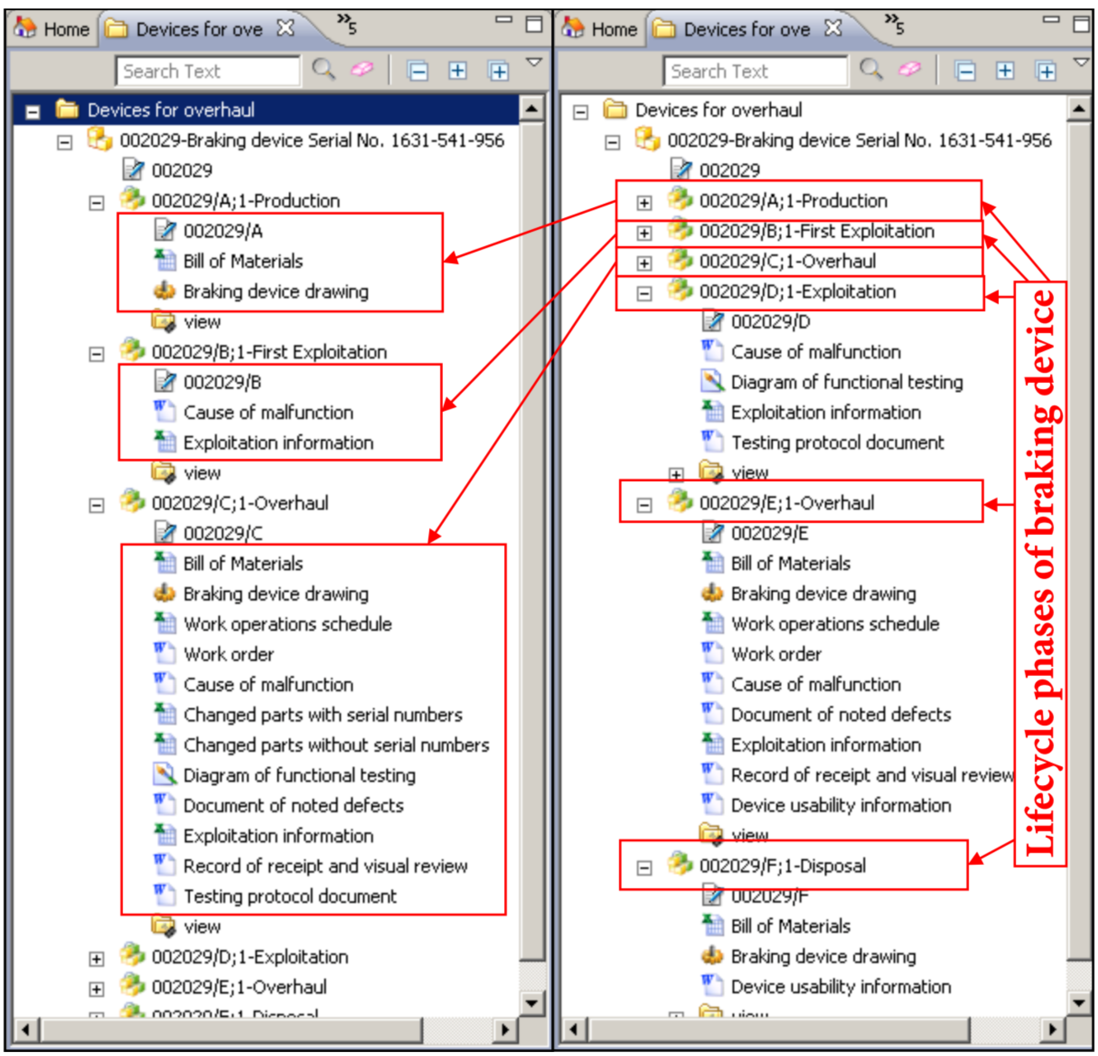

Figure 1. *Lifecycle phases of braking device conducted in PLM software*

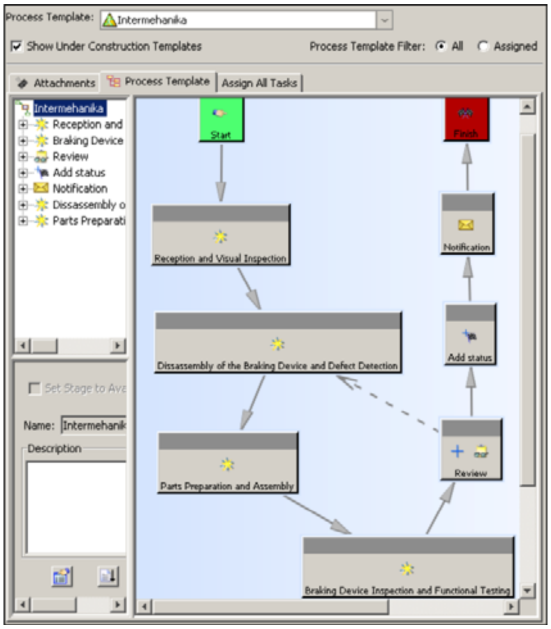

Figure 2. Overhaul process for the braking device

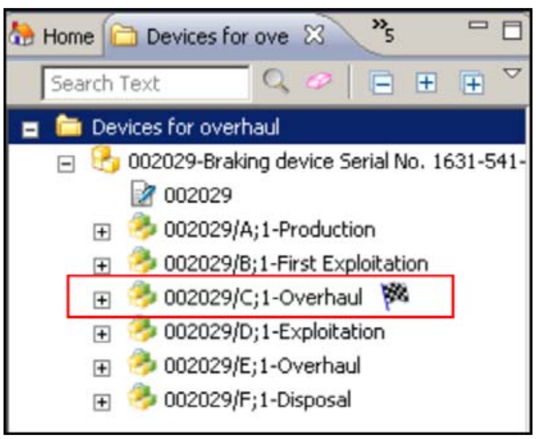

Figure 3. Successfully completed the overhaul process

4. CONCLUSION

The paper presents engineering change process on the example of the railway braking devices. All the life-cycle phases of braking devices and its data management through PLM software were presented. Future work will include the investigation of the possibilities of further integration of the PLM software with existing software in the enterprise and with the supply chain participants.

5. ACKNOWLEDGEMENT

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ROLE OF HUMAN CAPITAL IN ENGINEERING

Leposava Grubić-Nešić[1], Slavica Mitrović[1], Vladimir Ivanković[1]
[1]Faculty of Technical Sciences, University of Novi Sad, Serbia

Abstract. *In the turbulent environment, in which we live, the changes are inevitable and commonplace. Technological development, information technology era, as well as uncompromising competition are conditions that exist in organizations today. Those organizations, as well as their employees, primarily engineers who are unwilling to change will not long be able to survive in the market. Big changes are happening in all industries, and all that affect changes in the nature of the job, which requires changing patterns of behavior of employees in the industry and a change of their competencies. Human resources is a category of strategic importance for any modern business system in the contemporary business development, because it directly affects business results: increases revenues, reduces operating costs, increases market share, as well as reduces the absence of employees and their fluctuations, diminishes accidents on work, decreases job dissatisfaction, conflict and lack of work acceptance.*

Key words: *Human capital, engineering, business competences.*

1.INTRODUCTION

Modern business conditions, characterized by significant technological change, require increasing attention on the development of humanity and human capital. Human capital consists of many dimensions, which have been explored by a large number of researchers. The research of human capital association with work performance clearly shows a link between human capital and organizational performance. Human capital was often observed in the level of education of the respondents, and a connection is established with increasing economic indicators [2, 20, 3, 10]. Results indirectly show that in situations where one aspect of human capital, such as knowledge, is increased, magnification of other aspects of human capital, such as willingness to change can be expected. The concept of HC has becomethoroughly integrated into theoretical and empirical studies in economics and other social sciences, during the past decades. Being linked with outcomes, HC has been considered as a significant driver of performance, at both macroeconomic and microeconomic levels.

However, it is even more relevant that HC has been considered as an important source of innovation and strategic renewal [4, 5, 18].

In this modern business environment, customer needs are changing on daily basis, with competition becoming more global, and technology advancing at an incredible rate. To maintain competitiveness in such a challenging environment, companies need efficient management engineers who understand the ways of doing business.

Industrial engineering and engineering management as scientific disciplines emerged a century ago are strongly progressing nowadays. They are multidisciplinary by nature, their knowledge being applied in all business areas [14]. Industrial engineering has emerged much earlier than engineering management .

In such a dynamic environment, management engineers are required to be knowledgeable and skilful in the fields of organization and management, marketing and commercial, economic and financial and managerial and control functions, and be resolute in implementing the principles of engineering management [15]. Management engineers should also possess specific technical and engineering knowledge and experience, which makes them responsible for results of the work unit, department or sector they are managing. In modern business conditions, the work of management engineers also refers to functions related to the coordination of any movement of materials, products and goods in physical, informational and organizational sense. Thus, the task of management engineers is to integrate all components (activities) of engineering management, i.e. planning the activities, providing customer services, organizing logistic communication, managing the inventory,

transportation and storage, controlling business processes, etc. Engineering management also confirms the fact that "man is the most important factor when it comes to integrating all elements of the industrial system." Accepting the concept of modern engineering management, in addition to other benefits, the company (industrial system) can be able to reach its basic market objective, i.e. providing customers or consumers with high-quality services while minimizing the overall costs and making profit at the same time.
The objective of this article is to consider the role of human capital in engineering, with the special emphasis on willingness to change and innovation.

2. COMPETENCIES OF HUMAN RESOURCES

Human capital can be defined as the knowledge, qualifications, ability, experience, capabilities, skills, education, creativity, innovativeness, motivation, communication, flexibility, tolerance, teamwork capacity, learning capacity, commitment, personal characteristics and competence of employees, which assumes adequate application of all potentials and enables employees to execute their tasks and fulfill the expectations of customers, consequently creating certain value for the employer [11, 16]. Human capital can improve the organization's ability to sense changes in critical environmental variables that require changes in the organization's activities. Organizations in the new economy are facing turbulent environments and strong competition and because the environments within which organizations exist are becoming increasingly complex and dynamic, the need for the development of alternative mechanisms for monitoring the environment becomes more important.
The role, the character of work and the tasks of modern management engineers are highly complex. Management engineers are planning, organizing, directing and managing people, teams, money, technology, facilities and other resources with the aim of achieving the business objectives of the industrial system [7]. To ensure the short term operation of the industrial system, they are focused on resolving the problems and conflicts. As a rule of thumb, management engineers, instead of pursuing strictly technical jobs, are rather concerned with human resources. Their task is to decide how a specific unit or sector can contribute to the achievement of objectives of the industrial system, and then to distribute the resources that implement the decisions.
High levels of human capital increase the organization's monitoring capability by decentralizing the monitoring to meet the complexity of the environment. No longer is the monitoring only carried out by a centralized department, but additional information can be gained by employees who are closer to the actual stakeholder groups. Although top management has the responsibility for setting the strategic direction of the organization, the many submits engage in developing the strategies and tactics necessary to function effectively in their particular environments.
From the standpoint of the individual and the psychological dispositions of readiness to change, we distinguish the following aspects:the existence of emotional attitude toward change, voluntary or motivational potential to achieve change, the existence of a positive attitude and thinking about change and aspects of behavior towards realizing the changes [9]. Changes in people are the most difficult to define because they are associated with a range of external and internal influences, that are not visible in all situations[17].Willingness to change is the basis to sustainable development [8].
On which level of development can we count on the need for change? Is human being able to assess its own tardiness on time? When and under which conditions adaptation is enough, and when the organization has to initiate and implement changes?
Competencies represent a basic unit of human resource development and the language of communication in organizations in the part related to the performance, efficiency and effectiveness. Understanding the competences and their proper observation in the work environment, identifying as well as defining is the fundamental process in human resources development. Guidelines for the use of the ISO 10015 standard defines competence as the application of knowledge, skills and behaviors that result in performance.We can conclude that competences are the knowledge, skills and attitudes that create our behavior in the workplace. There are three aspects of competencies that we take into account: cognitive (knowledge), functional (skills) and social (behavior). Competencies identified at least two types of competences: behavioral and tehnical.Tehnical competencies define the knowledge and skills so that employees can perform their work roles in an efficient and effective manner[1].
As a result of automation and the beginning of mass production, during the industrial revolution, the separation of technical and non-technical competencies took place. Today, when we are in the second industrial revolution, we move away from mass production chain, so that the division of labor into smaller tasks is no longer an adequate way for work organization.
Characteristics of the second industrial revolution, which have high implications for staff competencies, as Mansfield states, reflected in [13]:

- The use of modern technology that requires employees who are organized and have specific thinking skills: to plan, make decisions, solve problems;
- rapid changes in product development as a response to consumer demand;

- high demands for quality and products that are adaptable to the individual requirements of customers;
- new forms of organizational design, where there is no need for multiple hierarchical structure;
- modified management and control systems, where it is essential that people may lead themselves through the process of work.

Today, in order to be successful in their professions, employees need to have more than technical competences, because experience has shown that only training for technical competence can not respond to the above mentioned needs and changes in the workplace demands.

The crucial skills required by the job in the modern organization is focused at the use of numbers, communication, problem solving, decision making and learning abilities. The function of this type of competencies provide horizontal and vertical mobility within organizations, and for those who are looking for a job ensure flexibility and adaptability in the labor market.

Woodruff [21] states that competent people are those who reach and / or exceed the impact that is expected of them. A special contribution to defining behavioral competencies, which are based on behavior, gave Klemp and Boyatzis who consider that the competence is a primary characteristic of an individual that results in superior performance at the job [12], while Boyatzis [6]. considers that competence is the primary individual characteristics and states that it can be: a motive, characteristic, skill, aspect of our own self-image or social role, or body of knowledge that is used [19]. Great influence on competence have the organizational context. According to Whiddett and Hollyford [19]., organizational context provides the parameters for individual behavior. The organizational context includes the value of the organization and its culture, mission, vision and other elements of the business system.

For an organization to effectively and efficiently apply the concept of competence, develop and implement a framework of competencies, and successfully guided the behavior of its employees to achieve results, it is necessary that behavioral competencies are associated with the values and mission of the organization, which ensures that an organization not only stated its commitment to the values but also integrates the behavior required to achieve results in organizations. A study conducted in Poland in 2009 revealed that the group of competencies, which largely determines the employability of people (team work, motivation and communication), can be just as important or even more important than technical skills (World Bank Group, 2012 specified in the IFC Job Study, 2013). Companies and policy makers have begun to recognize that technical skills are not the only ones which need to be developed. It takes a strong focus on core competencies and related groups of skills in the future, in order to create efficient generation of workers in the coming decades.

The key competences are formed as response to changes in the economy and the labor market, in the 20th century. Taking into consideration the consequences of economic change that have taken place over the past few decades, labor roles have become broader [13] and employers required employees with additional skills and competencies.

The crucial competences are all skills that are not specifically designated as technical. Key competences represent a transferable, multifunctional set of knowledge, skills and attitudes necessary for every individual to personal fulfillment and development, participation in social life and employment. This set of knowledge, skills and attitudes should be developed at the end of compulsory education or training, and should serve as a basis for further learning in the process of lifelong learning.

3. CONCLUSIONS

Thus, modern industrial systems are becoming increasingly complex. Engineers profession in modern business conditions presupposes knowledge about effective communication, working in teams, making quality decisions as well as a range of skills that implies soft skills. Incrementin human capital, which occurs as a consequence of the development of skills and abilities of individuals and teams, would contribute in maximizing the quality of work. Training engineers in the direction of soft skills enlargement involves developing personal and social competencies that are a prerequisite for the implementation and development of professional knowledge.

Competence is a proven ability to use knowledge, skills, personal and / or methodological abilities in various business situations. It does not mean that a competent person is also qualified person, but a qualified person should be competent.

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ENERGY AND ECONOMIC ANALYSIS OF USING DIFFERENT FUELS FOR HOUSEHOLD HEATING IN SERBIA

Tamara Golubović[1], Nebojša Manić[1], Nikola Dondur[1]
[1]Faculty of Mechanical Engineering, University of Belgrade, Serbia

Abstract. *The objective of this study was to create a techno-economic model which purpose would be to perform a techno-economic analysis of the different types of fuels which can be used for heating households in Serbia. Model gives two types of results: the year-by-year cash flow table and comparison diagrams of total costs for different fuels per annual heat consumption (GJ). By comparing total costs for the same heating system but different object size it can be concluded that bigger heating area has lower total costs per GJ and also heating system with boiler has lower values of total costs per GJ then systems with stove(s) for same object size.*

Key words: *Production management, ABC method..*

1. INTRODUCTION

Households in Serbia traditionally utilize solid fuel for producing heat in usually outdated combustion appliances. Also Serbia energy market is specific, in terms of fuel price calculations according to mass (for example coal) or volume (wood) instead of energy content. Furthermore as a country with large areas of agricultural and forested lands, Serbia has strong potential for the production of biomass. Biomass sources represent 63% of the total renewable energy sources (RES). Forests cover about 30% of the territory and approximately 55% is rural area [5]. Unfortunately Serbia households don't use all the benefits of utilization of modern solid biofuels from domestic producer. Based on year 2011 approximately 95% of pellet production in Serbia is exported in Italy and Slovenia, as significant countries for export of this type of products [4]. There are many reasons for poor utilization of solid biofuels in Serbia, especially in households. First, investment costs are relatively high for installation of new types of modern combustion appliances which can be used for new types of fuels. Second, consumer awareness of something new which is not traditional is full of skepticism and fears. Finally, availability of fuel and appliances in Serbian market is not satisfactory, so the consumers have buying more available goods. Standards for quality of solid biofuels and standard for test methods for combustion appliances have been recently adopted in Serbia, toward protecting customers of low quality fuel. However these standards are still not applied in practice.

Therefore, the objective of this study was to create a techno-economic model which purpose would be to perform a techno-economic analysis of the different types of fuels which can be used for heating process in Serbia. Model included evaluation of investment, operational and maintenance costs and considered eight types of fuel (Beech wood, coal "Banovici", briquet, coal "suseni Vreoci", coal "Kolubara", wood pelet, heating oil, natural gas) and was based on real prices from Serbian market in 2015. All the presented data should be used for defining economic aspects for promotion of renewable energy sources in Serbia and to show how households in long term could make savings in segment of producing energy for heating. Techno-economic model gives two types of results that can be beneficial for users, that is the year-by-year cash flow table and comparison diagrams of total costs for different fuels per annual heat consumption (GJ).

2. METHODOLOGY

2.1 Techno-economic analysis

Techno-economic model of different heating systems includes various parameters related to technology and Serbian market and as a result gives the year-by-year cash flow table and basic profitability measure, that is Net Present Value (NPV) [2]. In this study NPV can indicate if the selected heating system and type of fuel with all needed or existed equipment included, is profitable in a long term. How well this type of analysis will perform in a sense of giving correct and realistic output is directly related to how precise and realistic input is given. This is why adequate determination and prediction of every single input parameter is crucial for model to work properly. Input of techno-economic model of different heating systems includes investment and operating costs, that is, costs of heat supply equipment, additional equipment, equipment installation costs, annual cost of fuel and maintenance and repair costs. Correct estimation of these data was important challenge in this research.

2.2 Establishment of techno-economic model

For eight different types of fuels, namely Beech wood, coal "Banovici", briquet, coal "Vreoci", coal "Kolubara", wood pelet, heating oil and natural gas, following data was defined in order to estimate the heating value of those fuels: upper heating value H_u, moisture content W, ash content A and hydrogen content H. Types of fuels were selected considering two matters. Firstly, which types of fuels are traditionally used in Serbia for heating of households and secondly, which perspective types of fuels have production potential in Serbia.
Data were taken from [3], where they were given as a results of experimental tests.
According to these data, lower heating value H_l was calculated, using following equation [6]:

$$H_l = H_u - 25 * (9 * H + W)$$

Further, on the basis of data about object isolation (which are defined by user), value of required heat power by square meter of heated object was determined.
If object isolation is good, then specific heat flow q equals to 0.08kW/m^2, while if the isolation is poor it equals to 0.135kW/m^2. These values are taken from [7].
Calculated specific heat flow together with the size of object a (which is defined by user) gives required boiler heat output to heat considered household. Following equation is used:

$$P_{req} = a * q$$

According to type of combustion appliance (boiler or stove), using [7], total efficiency η is defined as following. Energy efficiency of boiler η_b is defined according to type of fuel, power of boiler and type of regulation. For solid fuel and boiler up to 50kW with manual regulation, value of 0.68 was taken. For pellet, value of 0.75 was taken from the manufacturer specifications. For heating oil and boiler up to 50kW, value of 0.82 was taken as the middle of given span. For natural gas and boiler up to 100kW with natural draft, value of 0.84 was taken. Energy efficiency of stove η_s was adopted as 0,70 according to stove producer declaration, technical reports of stove testing and literature sources [1].
Ratio of required boiler heat output and total efficiency gives required total amount of energy obtained from fuel:

$$P_f = \frac{P_{req}}{\eta}$$

Ratio of P_{req} and η gives specific fuel consumption m_f:

$$m_f = \frac{P_f}{H_l * a}$$

Taking into account that power plants in Belgrade provide heating from 6 am to 10 pm, sixteen hours are adopted as time of heating t_h.
Using this time, specific amount of fuel m was calculated as follows:

$$m = m_f * t_h$$

Next, total amount of fuel that is spent on defined size of object (in m^2) is calculated with equation:

$$m_a = m * a$$

According to established prices of fuels (FP) and defined number of heating days as 175, annual fuel cost is calculated as:

$$C = FP * m_a * 175$$

Fuel price is determined according to current prices on the Serbian market. Number of heating days is determined as 175 since heating season in Belgrade lasts from 15th of October to 15th of April.
Finally, fuel price per energy unit (per GJ) C_e is calculated with equation:

$$C_e = \frac{C}{H_l * 0.000001}$$

Fuel prices per GJ are used to form comparison diagrams of total costs for different fuels per annual heat consumption.
Within investment costs two possibilities were considered: heating systems with boiler for hot water production and additional equipment for this type of systems (heat panels - radiators, pipes, pumps, etc.) and heating system with stove. When entering the data, user can specify whether within the existing object (household) there are radiators with additional equipment and whether there is a chimney or not. According to these specifications and all other input, investment table is formed. All of the costs are defined for every type of fuel and are shown separately for the boiler and the stove.
Operation costs include annual fuel cost and maintenance costs. Maintenance costs are determined as 3% of equipment costs [8].

2.3 Cash flow table and comparison diagrams

In order to obtain NPV, discounted cash flow analysis is conducted. Discounted cash flow analysis is a method of valuing a project, company, or asset using the concepts of the time value of money. All future cash flows are estimated and discounted by using six percent discount rate. In order to obtain compassion diagrams, it was necessary to express fuel price per energy unit, that is, per GJ. Pervious chapter gives methodology for this. Consequently, all the costs need to be expressed per GJ as well and doing so requires them to be equally distributed in each year. In economic tables this is accomplished with processes of discounting and capitalization [2]. Operation costs take place in each year, but they are of different values, because of inflation. Therefore, calculating equal values in each year involves two steps. First, the present value of operational costs is calculated. Next, that present value is translated into equal values over the 15 years as in the case with investment cost, using PMT function. Now, there are equally distributed investment as well as operational costs in each year and they can be divided with annual consumption of energy (in GJ) in order to be used to form comparison diagrams, together with fuel price per energy unit.

3. DISCUSSION AND RESULTS

Resulting Techno-economic model of different heating systems is in form of excel file with 10 working sheets. First sheet, that is, input sheet, contains drop down menus or type in cells where user within a few steps specifies following information: type of fuel, isolation of object, combustion appliance and size of the house in square meter. According to these data all other required calculations are conducted as described in method section and shown. Interface is user friendly, which means it is very simple to use and to quickly obtain desired results.

Techno-economic model gives two types of results

1) The year-by-year cash flow table.

2) Comparison diagrams of total costs for different fuels per annual heat consumption (GJ).

The year-by-year cash flow table is formed for the specific case defined by user. Diagrams can be utilized by user for specific household in order to compare total cost of heating (investment and operation costs) for different types of fuels. In this way, taking into account availability of fuel as well, it is possible to choose the most cost-effective heating system. For illustration tree diagrams are given. Figure 1 shows investment and operation costs for different types of fuels, stove as combustion appliance, good object isolation, 50m^2, no radiator and existing chimney. Figure 2 shows costs for the same parameters except size of the object, which is 100m^2 in this case. Figure 3 shows costs when boiler is used in 100m^2 object and all other parameters are the same as in the cases before. Finally figure 4 shows costs for boiler and object size of 200m^2.

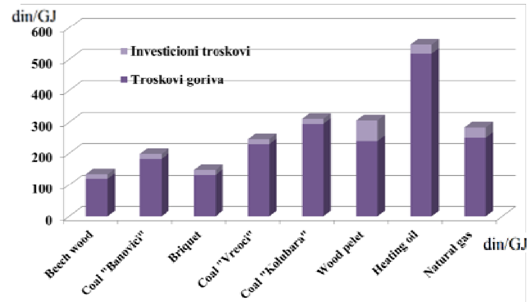

Figure 1 Investment and operation costs for stove and 50m^2

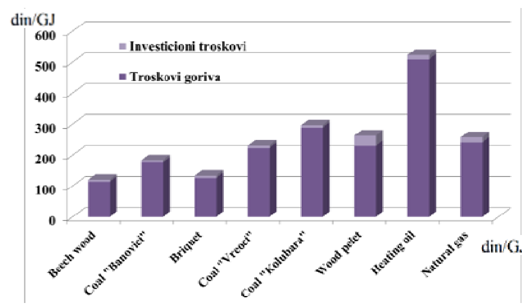

Figure 2 Investment and operation costs for stove and 100m^2

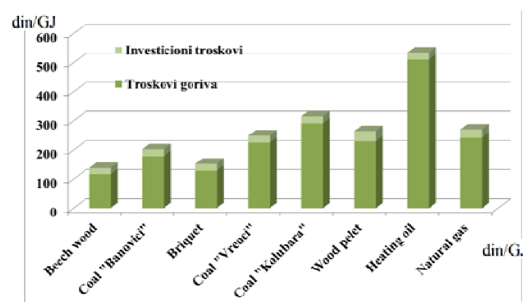

Figure 3 Investment and operation costs for boiler and 100m^2

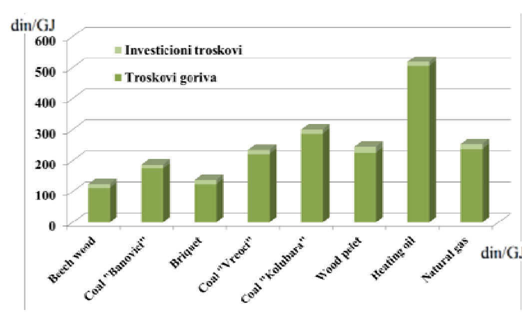

Figure 4 Investment and operation costs for boiler and 200m^2

4. CONCLUSIONS

According to previous presented methodology of techno economic analysis, established techno economic model through software developed in MS

Excell and obtained results for adopted cases which are presented in this paper, following conclusions are made:

- Techno economic analysis for using different fuels for heat production in households in Serbia can be carried out by developed techno economic model software through calculation of total costs per GJ of heat (investment + operational) for different types of fuel commonly used in Serbia households.
- According to results of techno economic model for all discussed cases the lowest costs for heat production in Serbian households are heat systems which used beech wood and wood briquette (more than 100 din/GJ) and the highest cost is the systems with heating oil (more than 500 din/GJ).
- Comparing total costs for the same heating system but different object size (Figures 1 and 2) can be concluded that bigger heating area has lower total costs per GJ and also heating system with boiler which produces hot water for central heating system has lower values of total costs per GJ then systems with stove(s) for same object size (Figures 2 and 4).

Future work on this model will include sensitivity analysis for discussed cases, price adaption for fuels and heating equipment according to market trends and incorporation of cost-benefit comparison for full techno-economic assessment adapt for this region.

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MANAGEMENT FOR COMPANIES WITH MULTIPLE LOCATIONS ACCORDING TO EXCEPTIONS

Petar Kefer[1], Dragan D. Milanovic[2], Mirjana Misita[2], Dragan Lj. Milanovic[2]
[1]Omni Surfaces, Toronto, Canada
[2]Faculty of Mechanical Engineering, University of Belgrade, Serbia

Abstract: *In this work, the importance was given to suppliers and customers according to exceptions, based on established criteria, related to business performance for company Omni Surfaces. It was applied multicriteria ABC method, based on interviewing and collecting information from workers and managers of business units. Obtained results, differentiate some suppliers and customers, which are the key players for company business performance.*

Key words: *ABC Method, multicriteria, suppliers, customers.*

1. INTRODUCTION

Increased production complexity and business problems, brings beside all other consequences, significant increase of elements which represent structure of subsystems for one company. One of the key aspects that is facing new business environment is increased number of suppliers and customers. It is a fact that each supplier and customer doesn't have same impact when we take in consideration earlier established criteria. Because the focus is on the most important criteria which are in same way of importance different than others. This is the base concept and setting for management and coordination based on exception.

The scale of research problem is taking in consideration complexity, multiple location that company has, organizational units, sub models and quality control of the processes inside of them. Experimental part of research will be performed in the company Omni Surfaces, located in the North America, more accurate in 3 cities: Toronto (Ontario, Canada), Edmonton (Alberta, Canada), Houston (Texas USA). The sales volume of the business on annual level is close 200 containers and capacity utilization is close to 50%. Company generates profit each year what brings confidence for investors and company owners. After sales volume on annual basis of 200 containers, company is facing dealing with complexity that exceeds level of control for business owners. After detail analysis of all the problems which we established by strategy is coming to conclusion that is necessity to create formal structure, recognize best practices, processes, procedures and standards which needs to be documented in order to control business performance indicators, and that needs to be reviewed on regular basis.

Research started with collecting information, analyzing them and interpretation in order to find answers on questions and solve established problem. Defined problem was identifying model of integrated management for company with multiple locations in order to increase capacity, profit, control, competitive advantage, and decrease complexity and cost.

In order to develop model to manage company with multiple locations research was done first with theoreticalsettings of this problem. Based on theoretical settings, empirical experience of person who does research and experimental research in three company locations under the roof of Omni Surfaces will be designed integrated model. As part of Omni Surfaces there are three sub companies that we can see as profit centers:

-Organizational unit Omni Surfaces Edmonton
-Organizational unit Omni Surfaces Houston
-Organizational unit Omni Surfaces Toronto.

ABC method plays important role in this research more precisely in the process of classification and grouping elements that differentiate the most important things from base group of elements. Concept of ABC method is relatively simple. There is important probability betweenincreased number of elements, that just small number of elements will have important impact on certain criteria for example, price, weight,sq. footage and similar... That group of elements is most of the time in small

number around 20% - 30%from the total number and participation in entire value for example with 70%-80%. Second and third group of elements will be created with analogy of the first group.
Also it is important that included elements in business we can look with multiple criteria. Importance some of criteria independently we can differentiate, so we can select them as primary, secondary and tertiary. In that case, application of ABCmethod we need to implement independently for each of established criteria.. The most frequency of elements in the group, obviously placing apart based element of importance in the frame of sample based on established criteria.

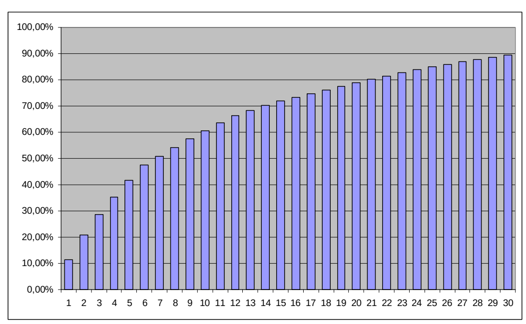
2. APPLICATION FOR MULTICRITERIA ABC METHOD IN RESEARCH

In this area of experimental research, information was collected and analyzed from management of subcompanies from multiple locations in relation with exception or ABC method. In order to see the problem for multiple standpoints, it was applied method of interviewing employees and managers for organizational units and business owners. This was important part, which was used to test established hypothesis. Results obtained with empirical research were statistically processed and in line with established research goals.
For each organizational unit that is Sub Company, the data was collected in 2012, for time between 03.01.2012. - 09.11.2012 about all suppliers, customers, revenue, expenses and obtained profit.
During the time that we looked in sub company Omni Surfaces Edmonton, it was processed 1,380 purchase orders between 56 different suppliers. In the table 1 there are suppliers sorted according to the number of deliveries in the time we looked, with that it is percentage and cumulative impact in total number of completed deliveries.

Table 1. Sorting suppliers according to number of deliveries

	Supplier	No. Deliveries	Percentage	Cumulative
1	Mineracao Guidoni LTDA	156	11,30%	11,30%
2	Apoena Logistica S/A - USD	130	9,42%	20,72%
3	Initial Inventory	108	7,83%	28,55%
4	Vickers Industrial Co.,LTD	93	6,74%	35,29%
5	Thor granitos e marmores ltda	89	6,45%	41,74%
6	World rocks - USD	81	5,87%	47,61%
7	Brasigran Brasileira De Granitos Ltda	46	3,33%	50,94%
8	Granos-Granitos S/A	45	3,26%	54,20%
9	BVL Granites	44	3,19%	57,39%
10	Fortuna Granitos Do Brasil LTDA	42	3,04%	60,43%
11	Omni Surfaces Corp. - Cad(Toronto)	42	3,04%	63,48%
12	GS Granite Limited	39	2,83%	66,30%
13	Antolini Luigi	29	2,10%	68,41%
14	Aro Granite International Inc	27	1,96%	70,36%
15	Bonotti-Stone-Trading - International	22	1,59%	71,96%
16	Levantina - The Natural Stone Company	20	1,45%	73,41%
17	Sincrest International PTE LTD	20	1,45%	74,86%
18	ItapoamaMineracao	19	1,38%	76,23%
19	Toledo MineracaoLtda - USD	19	1,38%	77,61%
20	FranchiumbertoMarmiSrl	18	1,30%	78,91%
21	JaciguaGranitos	18	1,30%	80,22%
22	Global Stone Source, INC	17	1,23%	81,45%
23	GramicGranitos E Marmores Ltda. - USD	17	1,23%	82,68%
24	Benicantilmarmoless.a (bemarsa) - Euro	16	1,16%	83,84%
25	Testi Do Brasil	15	1,09%	84,93%
26	International Product Supply Inc	14	1,01%	85,94%
27	Red Sea Mining Co. - USD	13	0,94%	86,88%
28	Bruno Lucchetti	12	0,87%	87,75%
29	Alliance Minerals North America LLC	11	0,80%	88,55%
30	Exotic granite & marble	11	0,80%	89,35%
...	...			
56	Nicola FontaniliS.r.l.	1	0,07%	100%

Information that are in the table #1, giving us opportunity to apply ABC method for selected suppliers. From information we can see that only 7 suppliers are involved in 50% of all purchase orders, 21 supplier we can see as A class in accordance with ABC method in which is necessary to pull away 80% all processed purchase orders, picture 1.



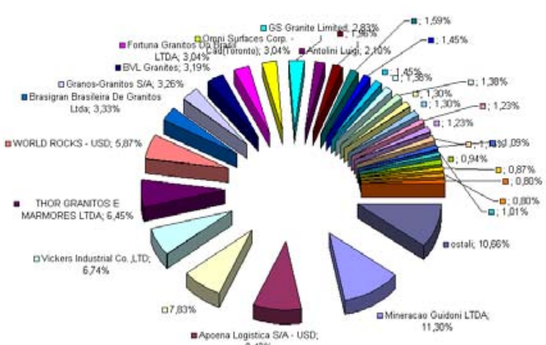
Picture 1. Histogram of supplier classification

With similar procedure for sub company Omni Surfaces Edmonton can be analyzed supplier structure for the time in period of 3.1.-9.11.2012 in which was processed 1.380 purchase orders. According to information related to complete deliveries there are 57 different customers who were placing orders and 20 customers contain 80% of all the orders what is important to take in consideration for future analysis in accordance with ABC Method for classification, table 2.

Table 2. Structure of customers

	Customer	No. Orders	Percentage	Cumulative
1	Universal Stone Fabricators Inc.	110	7,97%	7,97%
2	Gio Industries	91	6,59%	14,57%
3	World Stone Inc	90	6,52%	21,09%
4	Prairie Granite	69	5,00%	26,09%
5	CEI	68	4,93%	31,01%
6	Modern Granite	67	4,86%	35,87%
7	K&Js Custom	63	4,57%	40,43%
8	CNG Stone Products	62	4,49%	44,93%
9	Stoneworks Granite & Marble	51	3,70%	48,62%
10	Venato Stone	47	3,41%	52,03%
11	MGS Company	46	3,33%	55,36%
12	MichelAngelo	45	3,26%	58,62%
13	Atlas Granite Inc	44	3,19%	61,81%
14	Urban Granite Ltd	44	3,19%	65,00%
15	Fine Lines Tile And Stone	41	2,97%	67,97%
16	Classic Granite Works	39	2,83%	70,80%
17	Imperial Stone Inc	35	2,54%	73,33%
18	Aspen Granite	34	2,46%	75,80%
19	Reliable Granite	33	2,39%	78,19%
20	AllstoneInc	30	2,17%	80,36%
...	...	...	...	...
57	Universal Slate Inc	1	0,07%	100,00%

On picture 2, there is customer involvement presented in percentage as part of total number processed orders. Analyzing customers and suppliers in sub company Omni Surfaces Edmonton in comparison with total number of processed orders in deliveries, present frequency of customers and suppliers in total revenue for time we took in consideration. According to that in the coming text for application of multicriteria ABC analyze this criteria will be marked as frequency of showing.



Picture 2. Percentage of supplier participation

In summary all classified suppliers in comparison for three criteria connected for classification of suppliers based on multicrireia ABC method, are showed in table 3. Information in table 3 is in relation with three criteria connected with supplier classification in accordance with multicriteria ABC method and for criteria:

- Showing frequency
- Total revenue
- Profit

Table 3. All suppliers sorted based on three criteria

Rank	Suppliers sorted by criteria:		
	Frequency of occurrence	Revenue	Suppliers
1	MineracaoGuidoni LTDA	MineracaoGuidoni LTDA	MineracaoGuidoni LTDA
2	ApoenaLogistica S/A - USD	ApoenaLogistica S/A - USD	ApoenaLogistica S/A – USD
3	Initial Inventory	Thor Granitos E Marmores Ltda	Vickers Industrial Co., Ltd
4	Vickers Industrial Co., Ltd	Vickers Industrial Co., Ltd	Initial Inventory
5	Thor Granitos E Marmores Ltda	Initial Inventory	Thor Granitos E Marmores Ltda
6	World Rocks - Usd	Granos-Granitos S/A	Granos-Granitos S/A
7	BrasigranBrasileira De GranitosLtda	World Rocks - Usd	World Rocks – Usd
8	Granos-Granitos S/A	Fortuna Granitos Do Brasil LTDA	Fortuna Granitos Do Brasil LTDA
9	BVL Granites	BrasigranBrasileira De Granitos Ltda	BrasigranBrasileira De Granitos Ltda
10	Fortuna Granitos Do Brasil LTDA	Antolini Luigi	BVL Granites
11	Omni Surfaces Corp. – Cad (Toronto)	Omni Surfaces Corp. – Cad (Toronto)	Antolini Luigi
12	GS Granite Limited	BVL Granites	Levantina – The Natural Stone Company
13	Antolini Luigi	Levantina - The Natural Stone Company	Omni Surfaces Corp. – Cad (Toronto)
14	Aro Granite International Inc	GS Granite Limited	Testi Do Brasil
15	Bonotti Stone Trading International	Bonotti Stone Trading International	Global Stone Source, INC
16	Levantina - The Natural Stone Company	Testi Do Brasil	Franchiumberto MarmiSrl
17	Sincrest International PTE LTD	Global Stone Source, INC	Bonotti Stone Trading International
18	Itapoama Mineracao	Aro Granite International Inc	Nova Aurora Marmores E Granitos

			LTDA.
19	Toledo Mineracao Ltda - USD	Toledo Mineracao Ltda - USD	Fuji Marmores E Granitos S.A
20	Franchiumberto MarmiSrl	EXOTIC GRANITE & MARBLE	Aro Granite International Inc
21	Jacigua Granitos	Mineracao Guidoni LTDA	Granfuji Marmores E Granitos
...	...	...	...

Taking in consideration ranked suppliers that have majority impact on business performance we can conclude that they are suppliers who have higher frequency rank and impact on revenue. In a case when we have higher frequency showing in the scale of rank than in scale of total revenue, that means that for those suppliers we need to dedicate more time, open more purchase orders, mange more information, have more people to work and transportation. Suppliers who have higher frequency rank that is showing in comparison to participation in total revenue are:

- Initial Inventory,
- World Rocks – USD,
- BrasigranBrasileira De GranitosLtda,
- BVL Granites,
- Aro Granite International Inc, itd.

There are suppliers that have rank of participation in total revenue higher of rank that participate in total gross margin. In that case for this suppliers cost are higher because gross margin is smaller in comparison with other suppliers. Suppliers where is the rank of participation in total revenue higher from rank of participation in total gross margin are:

- Thor Granitos E Marmores LTDA,
- Antolini Luigi,
- Omni Surfaces Corp. - Cad(Toronto),
- Bonotti-Stone-Trading –International,
- Aro Granite International Inc.

There are also the cases where there is a rank of frequency where appearance of suppliers lower than participation in total revenue. Those suppliers need to be favorite, because they bring higher profitability for company in rationalization production and organizational activities. Suppliers where the frequency rank of appearance is lower from participation rank in gross revenue are:

- Thor Granitos E Marmores LTDA,
- Granos-Granitos S/A
- Antolini Luigi,
- Levantina - The Natural Stone Company, itd.

Suppliers where there is participation rank in total revenue lower thank participation rank in gross profit are:

- Vickers Industrial Co.,LTD ,
- Initial Inventory,
- BVL Granites,
- Levantina - The Natural Stone Company
- Testi Do Brasil,
- Global Stone Source, INC.

In these suppliers cost of transportation are minimal and company from this contracts have the highest productivity and profitability.

In summary all ranked suppliers in multicriterial optimization in comparison with frequency of appearance, participation in total revenue, participation in gross margin, there are presented in table 4.

Table 4. Summary of supplier rank based on three criteria

	Customer are ranked based on criteria:		
Rank	Frequency of appearance	Revenue	Gross Margin
1	Universal Stone Fabricators Inc	Gio Industries	Gio Industries
2	Gio Industries	Universal Stone Fabricators Inc	Universal Stone Fabricators Inc
3	World Stone Inc	World Stone Inc	World Stone Inc
4	Prairie Granite	Modern Granite	Modern Granite
5	CEI	K&Js Custom	MichelAngelo
6	Modern Granite	MichelAngelo	CNG Stone Products
7	K&Js Custom	CNG Stone Products	K&Js Custom
8	CNG Stone Products	Prairie Granite	Prairie Granite
9	Stoneworks Granite & Marble	MGS Company	CEI
10	Venato Stone	CEI	Classic Granite Works
11	MGS Company	Classic Granite Works	J&C Stone Cutters
12	MichelAngelo	Atlas Granite Inc	Atlas Granite Inc
13	Atlas Granite Inc	J&C Stone Cutters	Stoneworks Granite & Marble
14	Urban Granite Ltd	Stoneworks Granite & Marble	Venato Stone
15	Fine Lines Tile And Stone	Venato Stone	MGS Company
16	Classic Granite Works	Urban Granite Ltd	Urban Granite Ltd
17	Imperial Stone Inc	Aspen Granite	Aspen Granite
18	Aspen Granite	Ideal Tile	Ideal Tile
19	Reliable Granite	Fine Lines Tile And Stone	
20	AllstoneInc	AllstoneInc	
...			

The detail analysis of ranked customers who are part of majority participation in number of transactions and activities, they also have higher rank of participation in total revenue and those are:

- Prairie,
- CEI,
- Venato Stone,

- Stoneworks Granite & Marble

Customers where participation rank is higher is higher than participation rank in gross margin are:

- K&Js Custom,
- MGS Company.

Customers who have lower participation rank in total revenue from the participation rank in gross profit are:

- MichelAngelo,
- CNG Stone Products
- J&C Stone Cutters
- Stoneworks Granite & Marble
- Venato Stone.

3. CONCLUSION

With conducted research we obtained important results for the company management for Omni Surfaces, which can help to be more successful. The advantage of this classification, taking in consideration the most important elements based on samecriteria or the group of criteria is what will provide focus of attention for providing those elements in the right time. In that case we solve higher number of problems, and disregard the part of elements that doesn't have right relation on the impact.

The results of ABC method provide management, coordination based on exceptions, but it is important to say that looking on the big picture how to manage company is the most important. Ranking suppliers, customers, focus is on the most important, those who were based on some special importance are on the front of all the other.

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ORGANIZATIONAL PATHOLOGY

Janko M. Cvijanović[1], Jelena Lazić[1]
[1]Economics Institute, Belgrade

Abstract: Organization of operational and other socio-technical, artificial systems (for the purpose of efficient and effective functioning thereof) is in conflict with natural growth of entropy or disorder in the system and its surroundings. Depending on the selected organizational form and model, this conflict results in the emergence of different organizational paradoxes and pathological conditions. Although often treated in organizational theory and practice casually, even humorously as non-essential system incidents, organizational paradoxes and pathologies deserve, in our opinion, serious attention in studying the occurrence and effects thereof, as well as efforts to eliminate their consequences. This enclosure is just a brief sketch of the basic manifestations of organizational pathology.

Key words: organization crises, organizational paradoxes, organizational pathology, globalization pathology .

1. INTRODUCTORY NOTES

Definition and understanding of the key words in this paper, paradox and pathology, require - given their number and variety, very careful approach, constraints and sophisticated interpretations of the causes of emergence thereof and of the most important consequences of their effects (see /2/). As anger and hatred are not a priori negative feelings in psychology, the pathology of some organizational solutions, within the organization, is not always inevitably and a priori bad for the company. This practically means that the term pathology, within the context of organizing, has to be understood as a deviation from the expected rather than as inevitably harmful phenomenon in organization of the company.

In natural sciences, allelopathy is known as favorable impact of weeds (in small doses, of course) on the quality of grains, vegetables, etc. Reading "gloomy" texts written by "depressing" philosophers has positive effects on some people and helps them out of depression. A bit more complex examples are isoquants (the-same-quantity lines) - IQ and isotimes (the-same-cost lines) - IT whose mutual correlation (IQ + IT) leads to the rule of a declining revenue growth. This is yet another confirmation that rectilinear rules do not exists in the natural, real systems; there are no straight lines but, in the long run, these are all curves, usually upward at the beginning, then flat and subsequently downward, or vice versa.

In any case, even though organizational pathology provokes negative attitude as first response, it deserves careful and impartial approach, hoping such approach will yield benefit in trying to improve the effectiveness and efficiency of organizational systems. In the following part of this paper we shall briefly address the most famous organizational paradoxes and pathologies: the Iron Law of Oligarchy, Gresham's Law of Planning, Parkinson's Law, Peter Principle and globalization pathology.

2. EXAMPLES OF ORGANIZATIONAL PATHOLOGY

The Iron Law of Oligarchy was first developed (see /4/) by Robert Michels in 1925, in his paper "Zur Soziologie des Parteiwesens in der modernen Demokratie" based on the analysis of the structure of socialist parties (there were many at the time) in the period before the First World War: "Who says organization says oligarchy". Bureaucracy was born from the party organization, associated with the party leader, implying mutual interest (of both the apparatchik and the leader) in maintaining their own positions. The primary means of conquest and maintenance of power is the control of communication within the party. The young and ambitious (free thinkers who swing the boat) are either co-opted into the party's apparatus (fewer of them) or expelled from the party by virtue of various machinations. Instead of fighting for real goals of broad masses, they impose on them (on people) the goals tailored to the needs of the party and the party's apparatus. Instead of implementing what the majority thinks, they impose their thinking on the majority. They suppress the initial goals, often the party's original militant goals, in favor of conservative goals because the parties practically lose their existence in war or, at least, significantly lose importance and influence. Organization (the party) is the mother of the power of those elected, over those who elected them. This process applies to all kinds of associations (regardless of their primary goals) and to companies in which the power is concentrated at the top, among the company's management, while the tendency of imposing conservative strategies strengthens.

Gresham's Law of Planning inherited some parts of the Iron Law of Oligarchy as it also shows tendency of an organization to be a vehicle for achieving own goals, but in a different way. It was first developed by (see /4/) March and Simon, as the Law of programmed activities, and later by Merton (using the analogy of the original Gresham's Law according to which bad money drives out good money). We experienced this during inflation in the 90's when the government, together with tycoons-to-be, "implemented" the original accumulation of capital in post-self-management Serbia.

A shortcoming of programmed activities rests with the fact that the organization, frantically sticking to the plan, becomes rigid and consciously disregards changes in the environment (such changes have to be mitigated by organizational changes). It is very difficult to stand up to programmed activities (see /6/) because they simplify communication, precisely define selection of information, stabilize the organization and reduce the need for coordination. Gresham's Law of Planning implies that programmed actions and plans become obstacles to significant changes, because one insists on the procedure (as long as the change does not make the actualities discredited or lost), even more through institutionalization of adopting and implementing innovation and through procedural problems of cooperation between the company's organizational units (including ministries) which are the drivers of certain stages in an innovative change.

Parkinson's Law has (see /7/) a psychological background and relies on two principles. First, every superior strives to have his underlings who are rivals between themselves, thus (which complies with the principle of hierarchy) he has at least two and, preferably, even more underlings. Second, each underling fills his working hours with "activities" and instantly comes to a point when he feels overburdened with work, thus setting the grounds for asking for assistant employees (again, at least two). His superiors support such demands as they enlarge the organizational unit they lead. This results in (see /1/) growing hierarchy (the number of levels) and in an increasing number of employees, independently of the actual need for jobs in favor of the company (institution, ministry, etc.), but for the purpose of meeting the two principles mentioned above.

Today, the topical debated in Serbia concerns the reduction of public spending and, within this framework, primarily the retrenchment of employees in state administration and public enterprises. The current situation is a complete carbon copy of the Parkinson's Law. No one addresses the issue of tasks that are really necessary (required) and that have to be done by the state administration and public enterprises. Certainly no one is talking about the maximum amount of costs that may be borne by the state, i.e. taxpayers, (expressed as a percentage of GDP) for the assigned tasks which have to be done for that amount of funds, whereby the number of employees and their salaries are not the issue of prime importance for the taxpayers. In this way, we are missing the essence but are discussing the salary grades, social maps and other details which end up in the traditional saying: "A storm in a teacup".

Peter Principle reads that in every hierarchy, every employee gets promoted to his/her level of incompetence: an excellent locksmith becomes a bad manager; a good economist becomes a bad CFO, etc. It is clear from the said that, after a while, most of the positions in every organization are occupied by those who are unfit for the posts. On the other hand, the tasks are carried out by those who have not yet reached their level of incompetence. Extending this principle to allround managers is justified by the standpoint that management in different companies and at different levels is actually the same. In that way, a good caterer can be a director of a large public transportation company. Disappointingly, this standpoint is actually correct, provided that such managers have reached the level of incompetence according to Parkinson, which most often really is the case. Such a manager may be equally unsuccessful at all levels and in all companies.

The four foregoing examples of pathology were defined after mass occurrence thereof. Globalization principle (primarily related to business, but also to other human activities) is (see /5/) a premeditated instrument or a method of an unlimited increase in profits. According to this principle, globalization means unlimited and free movement of financial capital worldwide, without verifying the origin, the quality (by abolishing the gold standard under the slogan that it is detrimental to the progress of business operations, unlimited opportunities for abuse have opened up), and other characteristics of money, as is normally required of goods (and, partly, of services as well).

Thus, under the same principle of globalization (see /3/), financial flows are unrestricted, commodity flows are under strict control, and labor flows are disabled because the difference in wages, trade-union rights and other rights "there" and "here" is enormous. At the turn of this century, it was evident that financial capital pushed industrial capital and human resources on the siding. Only few countries in Europe still care for the middle class as a "buffer" between the extremely rich and the poor. Forcibly disabled labor flows create enormous pressure in these regions. According to the latest estimates, over 175 million people worldwide currently migrate from "controlled zones" to rich countries. The same source (globalization pathology analysts) estimates that migrations will include about one billion inhabitants on Earth in the next twenty years.

3. CONCLUSION

Any opposition to disarray, i.e. to growth of entropy which implies any kind of organizing, causes problems and crises in the long run. Wherever a man stands up to the natural order of things by means of artificial systems, one can expect spontaneous (or other) actions of the natural state of things. We believe that organizational pathology is a consequence of the natural and legitimate response of the factors, inadequately understood and articulated in organizational terms within organized systems of all types and sizes. Mitigation or avoidance of the occurrence of pathological conditions is a major, yet unexplored problem. The prime focus of individual efforts is, correctly, on an attempt to understand the mechanism that generates pathological conditions. The search for solution to problems may be commenced only upon grasping the details of the emergence of pathological incidents.

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IMPORTANCE KNOWLEDGE MANAGEMENT AND INNOVATIONS FOR THE FASHION INDUSTRY

Gordana Čolović[1], Danijela Paunović[1], Goran Savanović[1], Slobodan Pokrajac[2]
[1]The College of Textile – Design, Technology and Management
Belgrade
[2]Faculty of Mechanical Engineering, University of Belgrade

Abstract: *Products on the market can not last forever and they must innovate and change permanently, especially in garment industry. It is known that a pair of denim has been sold in the market for the last 100 years, but they are still in fashion and are a real challenge. Their life cycle is constantly repeating, no matter whether they are recycled in the final stage or turned into waste. The desire for change in that case can become an obligation. Fashion is in a constant state of disappearance and reappearance. It never really exists.*

A leader, by his position, should not be satisfied with the things as they are, but he should be leading in his field with ideas about a new product, customer service, efficient distribution, reducing costs, a new form of communication and sales and so on.

Key Words: *knowledge management, innovations, fashion industry*

INTRODUCTION

Innovation can be defined as the process of converting new ideas into commercial success on the market. Innovation is a process in which new ideas are transformed through economic activity into a sustainable results that has value. Sustainability requires integration with those who recognize the value of innovation, with customers and market and implies a very rigorous and continuous measurement (Livingston, 2000). As defined by Gurr (2001), innovation is an applied idea that makes benefits (An Idea-Applied-To Create Benefit). Innovation is the commercial application of discovery.

Imitation comes up frequently when discussing invention and innovation. The time difference between the presentation of innovation and imitation can be various and depends on the right on intellectual property, complexity, secrecy and alike.

It is very difficult to make a strict distance between the words creativity and discovery (invention). Creativity is the process or activity, whereas invention is the result of that activity. Creativity is a long and not an easy process. It seems that creativity is better described by the word activity than the word process, because there are no rules in creativity, or if there are, those rules are not known. Even the most creative minds can not always explain how their creative process works. In contrast to this, the invention can be clearly described on paper, and must be well documented if one wants to patent.

Ideas for innovation can come from various sources: opinions and suggestions of consumers, achievements in science and technology, monitoring the competition, experience of sellers, etc. In order to make the news of an innovation, it must take you where news is used both by PBS (production–business system) and environment. A good orientation of innovation (a new collection of garments) is reached through intuition.

INNOVATIONS IN FASHION INDUSTRY

Although most people think that creation is a "child's play," the road to go from idea to realization is a long and arduous one. Creative solutions emerge subconsciously, because the process of imagination has not yet been sufficiently explained, so there is no recipe how to create. It is an absolutely unique and individual act that happens depending on the designer talent, his imagination and expertise. A designers has a very responsible job because he should not ignore the components of quality that a product should posses.

When creating, a fashion designer must know what the purpose of a final garment will be (men's, women's or children's clothes), whether it is for a known customer with special requirements or a customer is anonymous, whether it is for a fashion show which has a bit if a stage character. Also, he must know the psychology of colours, basic aesthetic rules of design, materials at his disposal, he must constantly think about the price of the product, and, most importantly, to keep things within the fashion trends.

Speaking about garments, it is necessary to satisfy individual tastes of buyers, design and fashion trend, ensuring individuality and solving issues on durability, and comfort, because the quality of garment is based on creating successful brands and reputation in the market.

Permanent changes which represent fashion imply creativity of a designer team. Consumer needs are one of the starting points in creating clothes, because the information a designer receives from the marketing department designer must be realistic, clear and precise with a recommendation for the level of garment quality and timely so as to have a new collection in the market at the right time. Ideas for new creations can come from various sources: opinions and suggestions of customers, achievements of science and technology, monitoring the competition at fairs, fashion shows, web sites, experiences of sellers and so on. In fashion industry's the most successful producers are those who have organized and expert teams for design and marketing, because they dictate current fashion cycle, and introduce new fashion creations easily, thus surprising the competition.

If creating is seen within the PBS techniques of "brainstorming", it should be based on 3D- image of a man as a human being. We use our brain to think with the help of factors and process knowledge. Anyone who thinks about the future of his PBS (Adamovic Alihodzic, 2002), should have a 3-D human being in front of him (Figure 1) and 3-D PBS (Figure 2). New PBS should have a vision as an image of the future where third dimension should be a "brain storm" (brainstorming) in practical and professional life.

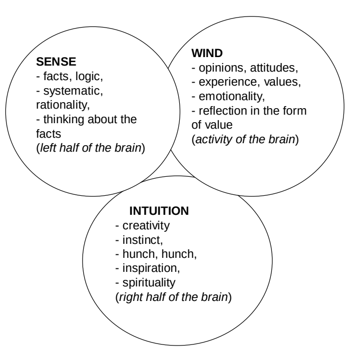

Figure 1: 3-D man

In creating a 3-D structure of PBS, the culture and dynamics are the basis for success and survival of PBS.

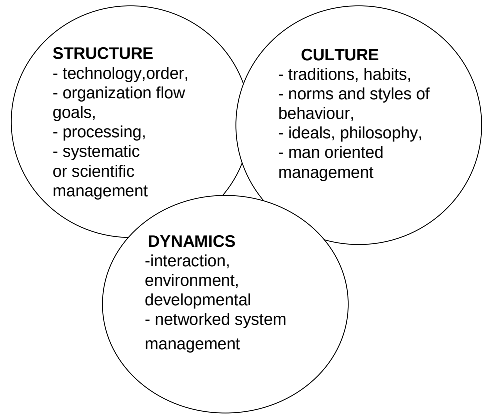

Figure 2: 3-D PBS

In practice, many existing ideas which have proved to be popular are often combined, i.e. existing designs based on the target market are often processed (redesigned). It is often more rational for a producer to use market information to improve or develop the existing fashion products than to create and introduce the new ones. Redesign of existing models enables creating new collections and survival on the increasingly demanding fashion market. Figure 3 shows a virtual collection of Ramax company (Colovic, 2012).

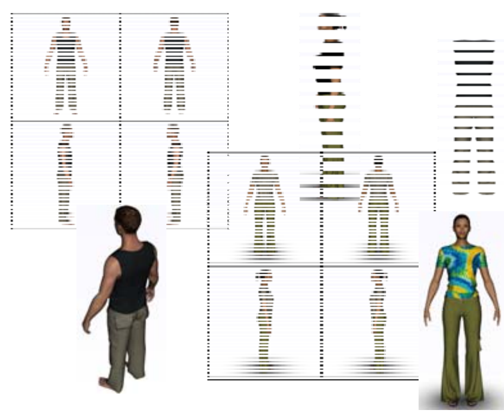

Figure 3: Ramax company virtual collection

Market success in open world markets must be based on the production of attractive products that exceed customer expectations. For the application of AQC (Attractive Quality Creation) concept it is sometimes enough to have a brilliant idea especially in garment industry where the attractiveness of ideas is often a main reason for the choice of products. Success in innovation depends predominantly on two key elements - the technical resources (people, equipment, knowledge, money) and the ability of an organization to manage them.

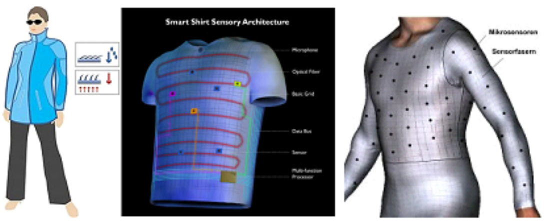

Figure 4: Smart garment

KNOWLEDGE MANAGEMENT

Successful innovation is clearly and strongly correlated with how the company selects and manages projects, how it coordinates inputs of various functions, how they are connected with costumers, etc. The ability concept in managing innovation leads to another important issue – how abilities are created as time goes by. There must be a learning process, because it is not enough to gain experience. The possibility of knowledge management is becoming increasingly important in today's so-called knowledge economy. Creating and improving knowledge within modern organization is becoming a crucial factor in achieving and maintaining its competitive advantage.

Knowledge management has a role to ensure that people have the knowledge they need where they need and when they need, i.e. the real knowledge in the right place and at the right time. There are many definitions of knowledge management, such as:

• Knowledge management is to discover, develop, utilize, deliver, and absorb knowledge inside and outside the organization through an appropriate management process to meet current and future needs. (Ouintas, Lefrere and Jones, 1997).

• Knowledge management is a process that helps organizations find, select, organize, disseminate, and transfer important information and expertise necessary for activities. (Gupta, Iyer and Aronson, 2000).

In fact, knowledge has always been the driving force for social and economic progress. In this sense all economies have been and are knowledge based. There are many types and forms of knowledge. Also, there are complementary definition of knowledge (Nonaka, Toyom and Konno, 2000):

● knowing which information is needed ('know what')

● knowing how information must be processed ('know how')

● knowing why which information is needed ('know why')

● knowing where information can be found to achieve a specific result ('know where')

● knowing when which information is needed ('know when').

A common portrayal is that of a knowledge hierarchy that goes from **data** (facts and figures) to **information** (data in context) to **knowledge** (information with meaning) to **wisdom** (knowledge with insight). Nevertheless, the most important distinction is that between explicit and tacit knowledge. According to Nonaka and Takeuchi (1995) **explicit knowledge** is knowledge that is expressed in formal language and can be shared in the form of hard data, documents, scientific formulae, manuals, codified procedure and the like. **Tacit knowledge** is know-how that is higly personal and difficult to formalize and express in words. Tacit knowledge has both cognitive and technical elements such as mental models, crafts and skills an individual has.

Knowledge management promotes an integrated approach to identifying, capturing, retrieving, sharing, and evaluating a firm's knowledge assets. We consider that knowledge management is key factor of successful transition processes in all transition countries (Pokrajac S. 2007).

Strategic view on knowledge management considers the union between technology and human factors as a basis for market survival. Some authors even differ the very nature of the concept of knowledge management from other strategic concepts just according to passion, courage and confidence of a knowledge leader.

Knowledge management requires turning personal knowledge into corporate knowledge which can be shared and appropriately applied in the organization. It is most commonly defined as the collective knowledge, including experience, skills, information and data of an organization. Three key factors of knowledge management are people, technology and organizational processes. This concept of management is a key activity in organizations because knowledge is considered to be the most important resource that provides competitive advantages and competitive markets.

The objective of general knowledge management system is to provide the right knowledge, in the right form, to the right people at the right time. Proper knowledge management allows individuals the access to information they need to perform their tasks contributing to meeting the overall objectives of organization at all levels of organization. Knowledge must be applicable in making and implementing decisions, and available with very little effort. If knowledge is used in a smart and strategic way, it makes pure profits. The concept of knowledge management is the ability to reach the information that will allow everyone in the organization to make the best decision in a relatively short period of time.

According to data from KPMG's European Knowledge Management Survey, a major application of the concept of knowledge management in the following areas:

• Marketing and sales - 53%
• Services - 53%
• Operations - 51%
• Human resources - 43%

• Research and development - 43%
• Strategy - 36%
• Distribution channels - 32%

CONCLUSION

Creating a brand and success comes largely as a result of innovation. While competitive advantage can arise as a consequence of the size of the company or disposition of resources, more and more dominant position in the market occupied by companies that are able to mobilize knowledge, technology skills and experience to constantly create new products, and processes and services. The presented conceptualization of knowledge management is based on the need for synergy between the capabilities of advanced information technologies and human creativity and innovation to realize goals in turbulent business environment. Concluding this paper, we can say that the knowledge management is the mental, behavioural and cultural shift from the old adage 'knowledge is power' to the new mindset **'sharing knowledge is power'**.

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RE-INDUSTRIALISATION OR THE ROAD THAT MUST BE TRAVELLED

Slobodan Pokrajac[1], Nikola Dondur[1], Sonja Josipovic[1]
[1]Faculty of Mechanical Engineering, University of Belgrade, Serbia

Abstract. *The aim of this paper is to affirm re-industrialisation by strengthening innovation in industry, but wider as well, as the form of new business and developmental culture. Our starting point is that all innovations are welcomed, first of all technological. Hence, we should create the setting in which creative energy of all citizens of our society will be (re)generated and mostly focused towards industry, since it provides the best conditions to materialise innovation in the new (exchange) products and processes. This must be done selectively, first in the sectors where there are best technical, technological, staff, financial and market conditions, and then this should spread to other production sectors as well.*
Key words: *industry, re-industrialisation, innovations, industrial policy, EU*

1.INTRODUCTION

The term re-industrialisation refers to a number of initiatives and programmes for economic and production development of the areas affected by the industrial and socio-economic crisis. Now, more than ever, both Serbia and Europe need their real economy to support growth and the opening of workplaces once againin the new phase of re-industrialisation. Industry still has a strong stimulating effect on the entire economy. There are estimates that a hundred new workplaces in the industrial sector would open up additional one hundred workplaces in other branches of economy. Re-industrialisation has become the centre of attention of the European Union and all other advanced economies as well. In its Communication on the European Industrial Renaissance adopted on 22nd January, 2014, the European Commission called upon all member countries to recognise the vital importance of industry in creating new workplaces and growth, and systematically include the issues connected with competition into all policy areas.[1]

All this speaks in favour of the argument that national states should initially help their economy, especially in the research and development sector (R&D), since the expansion and pace of the whole process of re-industrialisation depends on the efficiency of innovative work. Hence, our primary starting point is that, in Serbia, in spite of the brain drain, there is still enough creative potential, and that the state, not the free market, can and must provide strong support to re-industrialisation. Global and European experiences, in the years of the largest and so far longest world economic crisis, have become an additional inspiration for arguing that the process of revitalisation of the national economy has to start from industry itself.

In our paper, we will endeavour to show that re-industrialisation is not an aim "in itself", but always and just the means for strengthening the whole economic foundation of our society, increasing employment and competitiveness of economy, with industry as its driving power. In addition, we have started from the premise that this is only possible by using the new knowledge and new technologies, i.e. **innovation**. Industry has been selected as the focal point not only because it is the branch in which various innovations (technological, organisational, managing etc.) are created and implemented fastest, but also because our country has already had many developed industrial branches and companies with high global reputation, conquered markets and business reputation. Meanwhile, we went through a period of unprecedented de-industrialisation and catastrophic deterioration of industry. The causes were numerous: poorly implemented privatisation process, physical devastation caused by air-raids, technological obsolescence, economic sanctions etc. However, it is still out belief that there is hope for industry, which implies that much can be done for

[1]http://ec.europa.eu/enterprise/initiatives/mission-growth/index_en.html

the whole economy sector in Serbia if we start from theselectiverevitalisation of our industry. We should begin with those branches where human resources were preserved, i.e. knowledge and creative capital, as well as the markets, especially the foreign ones. This implies that it is neither possible nor necessary to revitalise everything we used to have, but thatcertain production capacities should still be preserved (machine-building industry, textile industry, food industry, certain sectors of chemical and pharmaceutical industry, certain sectors of electrical industry, military industry et al.).

It is with this respect that the term **re-industrialisation** has been coined, used in this paper as the*terminus technicus*. It encompasses numerous measures, means, methods, policies, participants,all aimed at revitalising industry (some of its chosen sectors). It does not advocate "going back to the past", but instead promotes a strategy of selective industrial modernisation and revitalisation at the same time. By recovering one industry sector, there will be created realistic conditions for gradual recovery (and modernisation) of other sectors in the next phase, and then the next ones etc. This kind of approach, which is a segmental, phase, step-by-step approach (but implemented in every region simultaneously, so that there are many steps and many realised projects at the same time), regardless of its being slow and long-lasting at this moment of raging financial crisis, serious deficit of human resources, impoverished research and development sector, lost export markets and other limitations, seems the only realistic and the only autonomous way of coping with the developmental bog of the current de-industrialisation. At the same time, it relativises the overly high expectations from foreign investments, the so-called strategic partnerships and similar models that inevitably lead towards new massive borrowing, unemployment, lack of research and other effects that turn "our" industry and its capacities into a foreign one. Insatiable passion for selling, along with problematic analyses that seemingly justify this, impose the following question: is it worthwhile for the buyers to buy what we are offering?

In the developed parts of the world, especially in America and Europe, re-industrialisation implies an ambitious plan of building modern and sophisticated, ecologically responsible and energy efficient industries that hire highly trained staff and have the support of top universities. The driving force of change is not the market but the state, which should create the new industrial "state of mind" which implies the new distribution of tasks and fruits of labour among the government, trade unions and employees. The small countries have to settle for harsh conditions and changeable mood of big investors. Serbia and its concept of reforms havedefinitely confirmed this.

2.INDUSTRY HAS NO ALTERNATIVE

We simply cannot do without industry, in its standard meaning[2]. It secures well-paying jobs, commercial innovations; it is a key factor in reducing deficit and strongly contributes to ecological sustainability: it also has the largest potential for sustaining or expanding employment. This is the beginning of the Metropolitan Policy Program, a very important and widely based initiative for revitalisation of the American industry, published in February 2012 bythe Brookings Institution, one of the most respected and most influential American institutes. Almost at the same time, the EU Directorate for Research has started the New Growth Path in Europe andinitiated a grandiose research project focused on the new pattern of economic growth,with the revitalisation of industry as the main goal.

Industry has to become the centre of attention if Europe wishes to remain the global economic leader. The document *Europe 2020* has established a strategy aimed at fostering growth and new workplaces through sustaining and supporting strong, various and competitive industrial basis in Europe that offers high-paying jobs, at the same time becoming less polluting.

Today, Germany creates the lion's share (31%) of industrial value added in the EU. A long way behind comes Italy with a share of 13%, then France with 10%, the UK with 10% and Spain with 7%. In terms of internal value creation structure there are marked differences between the individual countries. In 2012 the industrial share was 23% in Ireland, 22% in

[2]This note bears special relevance since it should point towards some conceptual distinctions. It especially refers to the phrase "creative industry" as the concept that has been used in the Western economic and sociological literature for the past 15-20 years and refers to a wide range of indubitably creative human activities, such as: media industry, publishing, entertainment, marketing, art, museum activities etc., but not to the real industrial sector, which is the focus of attention in this paper. The inappropriate use of the term "industry" creates a terminological confusion in our language, since the traditional meaning of the term"industry" is also wrongly associated with the above-mentioned areas, as well as with other work fields that are lucrative and bring profit (banking industry, tourist industry, entertainment industry…). In our opinion, this is unacceptable and therefore we advocate the understanding of industry as a particular form of productive work, both technologically and organisationally speaking, which creates material goods with a recognisable value in use (food, clothes, means for work, energy, transport means, apartments, medicine etc.). It is clear that the "creative industry" sector is also very important for the entire economic and social life, as well as for industry in its primary meaning, especially for the manufacturing industry, but, in our opinion, it still cannot be treated as the field of classic industry. For more details, see: R. Florida, *The Rise of the Creative Class,* New York, Basic Books, 2002.

Germany, 16% in Italy, 13% in Spain, 11% in the UK and 10% in both Greece and France [1].

All this speaks in favour of the argument that market logic cannot produce the new paradigm, patterns and direction of changes, but that this must be done by the state (and the EU) through subsidies, loans or infrastructure. Therefore, we should not ask whether the state should do it, but how the state should do it. The renowned Harvard economist DaniRodrik argues that industrial policy is a 'state of mind' rather than a series of specific actions.

Industrial production that is the foundation of modern civilisation has no limitations and the most developed countries today are those that have a developed manufacturing industry. Although service sector accounts for 50% of gross domestic product in the majority of countries today, it is important to know that most of these services are directly or indirectly related to industry. The growth of industrial production increases theneed for production inputs (raw materials, semi-manufactured goods, energy, workers) and the transport of goods to the customers, which directly increases the demand for transport services, and, in turn, increase in these services makes higher the demand for transport vehicles, warehouses etc. The importance of manufacturing industry has been confirmed additionally and yet again by the current global financial and economic crisis. The struggle to alleviate the crisis and revitalise the economy is basically reduced to preserving domestic production and workplaces in the manufacturing industry. Consequently, the salvation of banking sector has mostly been in order to preserve domestic production and employment.

When it comes to Serbia, the process of de-industrialisation, i.e. the weakening and "destruction" of industry has been going on intensively for over twenty years, causing large damage to the entire economy and the entire society. Among other things, the process has led to the following:

- high reduction ofthe number of employees in industry and the accompanying fields,
- increase in the trade deficit – due to the increase in imports and lowered export capacities,
- the loss and obsolescence of the knowledge necessary to create new products,
- the lack of ability of scientific institutions to produce results useful for the development of the society,
- reducing economy to the colonial position with respect to the multinational companies and creating illusions about life-saving foreign investments,
- the change of the value system of the society – where production and industrial knowledge are appreciated less and less,
- jeopardising the economic and increasingly even the political sovereignty of the Republic of Serbia.

3. STATE'S RESPONSIBILITY FOR RE-INDUSTRIALISATION

De-industrialisation has mostly been the consequence of leaving the national economy to the "invisible hand" of the market in the situation when all clever countries have clear industrial policies and goals. As a matter of fact, industrial policy can create the missing conditions and elements for an efficient, competitive and profitable production in the areas where there is a "critical" number of other conditions. The above-mentioned very influential advocate of industrial policy, DaniRodrik, has stated that "industrial policy can be viewed as a coordination device to stimulate socially profitable investments" [7].Neither the invisible hand nor the private entrepreneurs can replace the role of industrial policy, and this cannot be their role either. Active industrial policy that will be harmonised with regional, educational, technological, financial, monetary and other policies is the foundation of economic growth and social development. The main feature of the development should be the change of structure – the process of taking economic resources from the traditional low-productive branches and transferringthem to the modern industrial branches based on knowledge and cutting-edge technologies. This process cannot be automatic and asks for much more than good market functioning. These facts shed new light on the importance of the factor of innovations and technological modernisation in general, as the condition for preserving successful business functioning and competitiveness. The experiences of numerous countries have shown that all this can be possible if clear developmental goals and the agents of their accomplishment are defined, as well as the deadlines.

The current economic crisis (no economic crisis has ever lasted so long, this one has been going on since 2008) has confirmed the importance of industry for economic stability, employment, innovations, as well as for international success of European economies. The industry accounts for over 80% of European exports and 80% of the innovation sector and private research. Around 15% of workplaces in the EU belong to industry, and, additionally, every workplace in industry creates 1.5 to 2 workplaces in other sectors. Furthermore, industry jobs nowadays are high-quality jobs with an above-average payment. Industry itself is not the goal but a means of employment and preserving a high standard of living and quality of life. If innovations are the key incentive to economic growth, entrepreneurs are the synonym for innovations – which implies that there is no better moment for entrepreneurs' action than the time of crisis. It may sound shocking and illogical, but stepping out into something new, unknown, risky, but at the same time both challenging and potentially extremely profitable, definitely reflects a high measure of entrepreneurs' courage. Hence, it is time to set out resolutely.

For successful innovation, at least three key elements must be provided:

1. there have to exist the technologies that will enable the realisation of innovative ideas,
2. there has to be the need, that is, the market, i.e. people who are ready to use or buy the innovation, and
3. there have to exist the possibilities for transforming the innovative idea from the available technological components into a usable product or service.

In this process, we must avoid the so-called "European paradox", i.e. the fact that Europe is at the very top of scientific achievements, but lags behind in economic growth, i.e. that high science does not automatically produce either new technologies or economic growth. Therefore, we need an *innovation policy* starting from the tenet that R&D is the necessary but not a sufficient condition for the development of technological changes. Hence, it is necessary to replace the linear model of innovations on which scientific policy is based. In addition, the neo-classical model of growth must be replaced with an **interactive model of innovations**. According to this model, innovation can occur in any of the five phases of an innovation cycle (discovery, research market, design and testing, redesign and manufacturing, distribution), and does not necessarily include scientific research.

4. CONCLUSION

This paper has shown that Serbia must vigorously and urgently revitalise and strengthen the production sector of economy, by focusing on the world of labour and quality production intended for export. It must rely primarily on its own growth sources, activate domestic savings (deposits in banks over ten billion euros and a couple of billions more in home depots) and reduce the burden of overpriced foreign loans that often imply acceptance of humiliating conditions of foreign investors and creditors. A similar model of *endogenic growth* was implemented by some Asian countries several decades ago, and it has provided astounding economic results today.

As the most organised and the most powerful social institution, the state has been analysed not only as a catalyst of the re-industrialisation process, but also as a very active, and even the most responsible participant in re-industrialisation. After all, the state does bear the biggest responsibility for a tragic, expensive and harmful de-industrialisation. Furthermore, following an example of good practice of all countries of the European Union, our country should also create and implement active industrial policy. Serbia must create its own model of industrial policy in such a way as to take into account some of the facts that refer to joint EU industrial policies, especially the ones referring to the strategy Europe in 2020. As an EU candidate country, Serbia must pay attention to the fact whether joint industrial policy has become a vital part of the strategy of the sustainable development of industry and the politics of re-industrialisation explicitly advocated by the EU. This would clearly indicate that industry is a source of development and progress of the EU since it contributes most to the growth of productivity of all economy sectors.

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OPTIMAL PRICING STRATEGIES FOR INTERNET MARKETING ON TIME-SENSITIVE PRODUCTS

Ping-Hui Hsu[1], Hui-Ming Teng[2]
[1]Department of Business Administration, De Lin Institute of Technology, New Taipei, Taiwan, R.O.C.
[2]Department of Business Administration, Chihlee Institute of Technology, New Taipei, Taiwan, R.O.C

Abstract. *Internet marketing is a form of marketing strategy which utilizes the internet always to promote business by providing discounted selling price. Since the customers' demand depends on the selling price, how to determine the pricing strategy is the priority to the retailer. In this study, a profit model is developed and the optimal solution of the model is derived. An algorithm is developed to obtain a pricing strategy such that the profit is maximized. Numerical examples and sensitivity analysis are presented to illustrate the model.*
Key words: *Internet marketing; Time-sensitive product; Pricing*

1.INTRODUCTION

Internet marketing is a form of marketing strategy which utilizes the internet to promote business. Enterprises can deliver their products, services and advertising through their commercial websites. Consumers acquire information and purchase products directly from these websites. Nowadays, most enterprises have been practicing internet marketing and advertising time-sensitive products. Time-sensitive product is heavily advertised for a period of time and loses its original value after the sell-by date; examples include movie tickets, train and plane tickets. A time-sensitive product is different from other traditional commodities, as it bears potentially higher loss after the sales period.

For example, as a result of globalization in recent decades, the demand for air transportation has increased, and with increasing accessibility to the internet, online travel companies servicing hotels and airfares were created. These websites purchase flight tickets from the airline companies, and in turn post these flight tickets on their own websites. Online travel websites usually offer cheaper fares in order to promote online bookings and increase demand. Customers can search and compare airfare information among websites before placing their orders. Since, the availability of airplane seats is time-sensitive, websites companies gradually increase ticket prices on the websites as the departure date is approaching, and decrease ticket prices a few days before the departure to sell out the remaining tickets. This study aims to determine what pricing strategy is most effective and to determine how many seat tickets to purchase, in order to maximize profit and reach a win-win scenario for both the website company and customer.

Kimes et al. (1998) classified the time-sensitive products by price and demand, implemented diverse pricing options for different products and predicted market demand. Shih et. al. (2013) developed a search engine optimization (SEO) mechanism for internet marketing strategy that can be used by an enterprise to improve the ranking of its website in the search engine results. Most research in the past discussed the concept and technology of internet marketing, but little on the inventory problem. This study aims to determine what pricing strategy is most effective and to determine the optimal ordering quantities to reach a win-win scenario for both the website and customer.

2. ASSUMPTIONS AND NOTATION

The mathematical models presented in this study have the following assumptions:

(1). There are no interdependencies between ordered items, and therefore a single item model is assumed.
(2). The demand rate is deterministic and stationary through time.
(3). The replenishment is instantaneous.
(4). No shortages are allowed.

Meanwhile, the mathematical models have the following notations:

T	The selling period
t_1	the critical time of the largest demand during selling period; for considering real situation, $t_1 > T/2$
c_p	the unit purchase cost, \$/unit
K	the maximal unit selling price, \$/unit
Δ	discount rate for market price; market price: $c_p + \Delta(K - c_p)$
$p(t)$	the unit discounted selling price function of time t , \$/unit, $c_p < p(t) < K$
$D(t)$	The real demand function of time t
F	constant, used in Eq.(5) and Eq.(6)
G	constant, used in Eq.(5) and Eq.(6)
Q	the ordering quantity
c_o	the ordering cost, \$/order
δ_1	lower discount rate, that is 100(1- δ_1)% off, decision variable
δ_2	higher discount rate, that is 100(1- δ_2)% off, $0 < \delta_1 < \delta_2 < 1$., decision variable
h	inventory holding cost per item, \$/unit/unit time
TR	the total revenue per cycle
TC	the total cost per cycle
TPU	the net profit per unit time

3. ANALYSIS OF THE MODEL

In this section, a model is formulated to obtain the net profit. Throughout this study, a single product is assumed. The retailer orders a batch from the supplier of the products, Q, with the unit purchase cost c_p, and sells to customers with discounted selling price $p(t)$ on the internet for promotion sake. Since the customers' demand depends on the selling price $p(t)$, it is important for the retailer to know how to price the item for the optimal profit. Assume that the items (eg. airplane seats) are time-sensitive, generally, the customers' imaginary demand (the demand that customers expect to get them without considering the price) increases during time [0, t_1] while it decreases during time [t_1, T] (Please refers to Fig. 1). Due to this situation, the retailers gradually increase the prices of the items as the critical time t_1 is approaching, and decrease its prices a few days before the end of selling period T. (Please refer to the unit market selling price in Fig.2) Thus, the real demand will be affected by the price. In this study, if the retailer improves management and administration of internet transaction, then the discounted selling price $p(t)$ will be used for promotion sake. (Please refer to the discounted selling price in Fig.2)

The unit discounted selling price function $p(t)$ is as follows,

$$p(t) = \begin{cases} p_1(t), 0 \le t < t_1, \\ p_2(t), t_1 \le t < T. \end{cases} \quad (1)$$

Where

$$p_1(t) = c_p + \delta_1(K - c_p) + \frac{(\delta_2 - \delta_1)(K - c_p)}{t_1} t, 0 < \delta_1 < \delta_2 < 1, 0 < t < t_1. \quad (2)$$

$$p_2(t) = c_p + \delta_1(K - c_p) + \frac{(\delta_2 - \delta_1)(K - c_p)}{t_1 - T}(t - T), 0 < \delta_1 < \delta_2 < 1, t_1 < t < T. \quad (3)$$

Responding to the unit discounted selling price, the real demand $D(t)$ is as follows,

$$D(t) = \begin{cases} D_1(t), 0 \le t < t_1, \\ D_2(t), t_1 \le t < T. \end{cases} \quad (4)$$

Where

$$D_1(t) = \frac{F - p_1(t)}{G}, 0 \le t < t_1, \quad (5)$$

$$D_2(t) = \frac{F - p_2(t)}{G}, t_1 \le t < T. \quad (6)$$

With F, G are constants, $F > K$.

From the above assumptions and notation, we know that the inventory level $I(t)$ at time t satisfies the following two differential equations:

$$dI(t)/dt = -D_2(t), \quad t_1 \le t \le T. \quad (7)$$

with initial condition $I(T) = 0$, one has

$$I(t) = \frac{(T-t)(2FT - 2c_pT + \delta_2c_pT - \delta_2KT + \delta_1c_pT - \delta_1KT + \delta_2Kt - \delta_2c_pt + 2c_pt_1 - 2Ft_1 + 2\delta_1Kt_1 - 2\delta_1c_pt_1 + \delta_1c_pT - \delta_1KT)}{2(T-t_1)G}, t_1 \le t \le T. \quad (8)$$

Then $I(t_1) = \dfrac{(2FT - 2c_pT + \delta_2c_pT - \delta_2KT + \delta_1c_pT - \delta_1KT + \delta_2Kt - \delta_2c_pt + 2c_pt_1 - 2Ft_1 + 2\delta_1Kt_1 - 2\delta_1c_pt_1 + \delta_1c_pT - \delta_1KT)}{2G}$. (9)

And $dI(t)/dt = -D_1(t)$, $0 \le t < t_1$, (10)

with initial condition $\lim_{t \to t_1^+} I(t) = I(t_1)$, one has

$$I(t) = \frac{(\delta_1 - \delta_2)(c_p - K)t^2 - 2t_1(F - c_p - \delta_1K + \delta_1c_p)t + t_1T(2F - 2c_p + \delta_2c_p - \delta_2K + \delta_1c_p - \delta_1K)}{2t_1G}, \quad 0 \le t < t_1, \quad (11)$$

With the ordering quantity Q,

$$Q = I(0) = \frac{T(2F - 2c_p + \delta_2c_p - \delta_2K + \delta_1c_p - \delta_1K)}{2G}, \quad (12)$$

The inventory system is shown in Fig.4.

The total revenue per cycle $TR(\delta_1, \delta_2)$ is as follows,

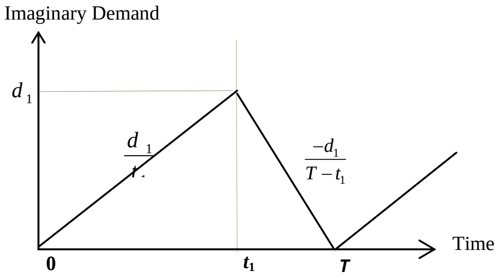

Figure 1. The figure of customers' imaginary demand.

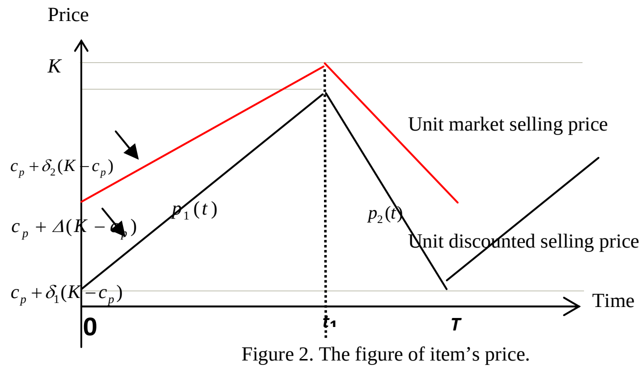

Figure 2. The figure of item's price.

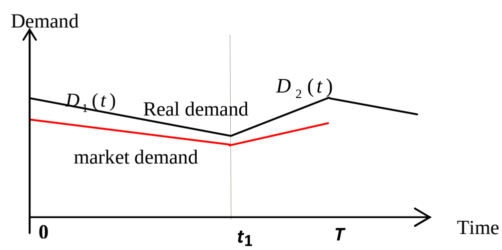

Figure 3. The figure of customers' real demand.

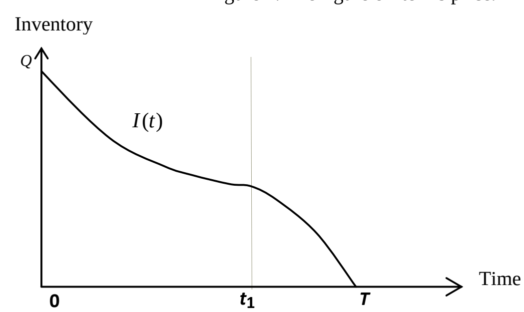

Figure 4. The figure of inventory system.

$$TR(\delta_1,\delta_2) = \int_0^T D(t)\,p(t)dt = [2Tc_p^2(3\delta_1+3\delta_2-\delta_1^2-\delta_2^2-\delta_1\delta_2-3)-2TK^2(\delta_1^2+\delta_2^2+\delta_1\delta_2)-T(6\delta_1Kc_p+6\delta_2Kc_p$$
$$+3\delta_1Fc_p+3\delta_2Fc_p-4\delta_1^2Kc_p-4\delta_2^2Kc_p-6Fc_p-3\delta_1KF-3\delta_2KF-4\delta_1\delta_2Kc_p)]/(6G) \quad (13)$$

The total cost per cycle $TC(\delta_1,\delta_2)$ is as follows,

$TC(\delta_1,\delta_2)$ = Purchase cost + Inventory cost + Ordering cost $=QC_p+\int_0^T I(t)dt\; h+C_o$, (14)

where

$$\int_0^T I(t)dt = [T^2(\delta_2c_p-\delta_2K+2\delta_1c_p-2\delta_1K+3F-3c_p)-t_1T(\delta_2-\delta_1)(K-c_p)]/(6G) \quad (15)$$

The net profit per unit time $TPU(\delta_1,\delta_2)$ is as follows,

$TPU(\delta_1,\delta_2) = \frac{1}{T}[\,TR(\delta_1,\delta_2)-TC(\delta_1,\delta_2)\,]$ (16)

Since the unit discounted selling price $p(t)$ of the item is lower than that of market price $c_p+\Delta(K-c_p)$ for marketing, then the problem can be formulated as follows:

Maximize: $TPU(\delta_1,\delta_2)$ (17)

Subject to: $0\le\delta_1\le\delta_2\le 1,\; 0\le\delta_1\le\Delta.$

From Eq.(17), the domain of the problem is closed and bounded, which means the optimum of the problem occurs at either relative maximum of $TPU(\delta_1,\delta_2)$ in the interior of the domain or at the boundary of the domain, $\delta_1=0, \delta_1=\Delta, \delta_1=\delta_2, \delta_2=1$.

The following solution procedure is used

Solution procedure

Step 1. Check the concavity of $TPU(\delta_1,\delta_2)$.(Hessian matrix function of $TPU(\delta_1,\delta_2)$ is positive)

Step 2. Find both the relative maximum of $TPU(\delta_1,\delta_2)$ in the interior of the domain and at the boundary of the domain.

Step 3. Find the maximal value of Step 2, the optimum is obtained.

Since

$$\partial^2 TPU\Big/\partial\delta_1^2 = \frac{-2(c_p-K)^2}{3G}<0, \quad (18)$$

$$\partial^2 TPU\Big/\partial\delta_2^2 = \frac{-2(c_p-K)^2}{3G}<0, \quad (19)$$

$$\partial^2 TPU\Big/\partial\delta_1\partial\delta_2 = \frac{(c_p-K)^2}{3G}, \quad (20)$$

and

$$\text{Hessian}(\delta_1,\delta_2)=\frac{(c_p-K)^4}{3G^2}>0, \quad (21)$$

which leads to the function *TPU*(δ_1, δ_2) being strictly convex with respect to (δ_1, δ_2). The positive-definite Hessian matrix results in optimal (δ_1^*, δ_2^*) values without restriction. Hence, setting $\partial TPU / \partial \delta_1$ = 0, and $\partial TPU / \partial \delta_2$ =0, the optimal discount rate δ_1^*, δ_2^* without restriction, can be derived by MAPLE 13 software as follows:

$\delta_1 = \dfrac{F - c_p + Th - t_1 h}{2(K - c_p)}$, and the optimal higher discount rate δ_1^* = min{ δ_1 ,1}

(22)

$\delta_2 = \dfrac{F - c_p + t_1 h}{2(K - c_p)}$, and the optimal lower discount rate δ_2^* = max{ δ_2 ,0}

(23)

Example 1

To validate the theory, the numerical parameters are as follows:

T=6 months, t_1=5.5 months, c_p=500/unit, K=2000/unit, Δ =0.3 h=$2/unit, c_o=$300/cycle, F=2100, and G=2.

The problem can be formulated as follows:

Maximize:

TPU(δ_1, δ_2)= (24)

$$-375000\delta_1^2 - 375000\delta_2^2 - 375000\delta_1\delta_2 + 601625\delta_1 + 602875\delta_2 - 4850$$

Subject to: $0 \le \delta_1 \le \delta_2 \le 1,\ 0 \le \delta_1 \le 0.3.$ (25)

Firstly, we consider the interior of the domain, $0 < \delta_1 < \delta_2 < 1,\ \ 0 < \delta_1 < 0.3.$ Using Eq. (22) and Eq.(23), the solution is δ_1 =0.534, δ_2 =0.537. However, this solution does not satisfy the constraint (25). Secondly, we consider the boundary of the domain: (a) { $\delta_1 = 0$, $0 \le \delta_2 \le 1$ }, (b) { $\delta_1 = \delta_2$, $0 \le \delta_2 \le 0.3$ }, (c) { $\delta_1 = 0.3$, $0.3 \le \delta_2 \le 1$ }, (d) { $\delta_2 = 1$, $0 \le \delta_1 \le 0.3$ }. In (a), the maximum is *TPU*(0,0.804)=$237456; in (b), the maximum is *TPU*(0.3,0.3)= $255250; in (c), the maximum is *TPU*(0.3,0.654)= $302199, and in (d), the maximum is *TPU*(0.3,1)= $257262. Hence, by comparison, the optimal profit per year is *TPU*(0.3,0.654)= $302199, that is, the lower discount rate, δ_1 =0.3, the higher discount rate, δ_2 =0.654 and the optimal ordering quantity is Q^*=2654 units. When without discount, the net profit per year is *TPU*(0.3,1)=$257262. The profit increase is (302199/ 257262)-1=17.5%.

Example 2

The numerical parameters are the same as Example 1 except Δ =0.6. The problem can be formulated as follows:

Maximize:

TPU(δ_1, δ_2)=

$$-375000\delta_1^2 - 375000\delta_2^2 - 375000\delta_1\delta_2 + 601625\delta_1 + 602875\delta_2 - 4850$$

(26)

Subject to: $0 \le \delta_1 \le \delta_2 \le 1,\ 0 \le \delta_1 \le 0.6.$ (27)

Using Eq.(22) and Eq.(23), the interior solution of the domain is δ_1 =0.534, δ_2 =0.537, *TPU*(0.534, 0.537) =317556. In the boundary of the domain: (a) { $\delta_1 = 0$, $0 \le \delta_2 \le 1$ }, the maximum is *TPU*(0,0.804)=$237456 ; (b) { $\delta_1 = \delta_2,\ 0 \le \delta_2 \le 0.6$ }, the maximum is *TPU*(0.535, 0.535)=$317555; (c) { $\delta_1 = 0.6$, $0.6 \le \delta_2 \le 1$ }, the maximum is *TPU*(0.6,0.6)=$ 312850; (d) { $\delta_2 = 1$, $0 \le \delta_1 \le 0.6$ }, the maximum is *TPU*(0.302,1)=$257264. Hence, by comparison, the optimal profit per year is *TPU*(0.534, 0.537) =317556, the lower discount rate, δ_1 =0.534, the higher discount rate, δ_2 =0.537 and the optimal ordering quantity is Q^*=2391 units. When without discount, the net profit per year is *TPU*(0.6,1)=$224000. The profit increase is (317556/ 224000)-1= 41.8%.

4. CONCLUSION

Internet marketing is a form of marketing strategy which utilizes the internet to promote business. The retailer orders a batch from the supplier and sells to customers with discounted selling price on the internet for promotion sake. Since the customers' demand depends on the selling price, therefore, how to determine the pricing strategy is most important to the retailer. In this study, the profit model is developed and the optimal solution of the model is derived. The sensitivity analysis shows that as the discount rate for market price (Δ) increases, *TPU*(δ_1^* , δ_2^*) and % profit change all increase. That is, higher market price leads to higher profit. This study will also help the business managers understand the nature of internet market pricing dynamic.

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SMART METER- READY TO MARKET SOLUTION ANALYSIS

Dejana Popović[1], Predrag Popović[2]
[1,2],University in Belgrade, Institute of Nuclear Sciences“Vinca“, Certification Bureau,biro@vin.bg.ac.rs, Serbia

Abstract:*This work is focused on a specific segment of devices that facilitate a smart use of energy. Throughout this document a Smart Meters Solutions analysis will be showcased. The aim of this work is to combine and explain key information about the technology being implemented, analysis of the market solutions, basic types of smart meter systems as well as hardware and software combinations.*

Key words: *smart meter, smart meter systems, analysis, hardware, software*

1. INTRODUCTION

Energy and its sustainable use has become the top priority for both developing and developed countries. With the upcoming growth of both population and energy consumption, being able to be more efficient and effective with the allocation of this resource is a challenge that the world and its leaders are embracing. Although of the efforts the impacts of an unbalanced use of natural resources have led the world to a critical situation where the environment and the society are under an unhealthy and dangerous burden. The development of technologies and the engagement of energy users towards a more conscious use of the energy they consume is critical, as well as, the development of the market to allow this innovative solutions to be both reliable and affordable to ensure that their potential is achieved and their expected benefits delivered.

2. SMART METERS AND SMART METER SYSTEMS

Understanding the role of smart metering and how these systems bring value to the consumer by supporting the sustainable development of the market is a critical step to overcome uncertainty regarding their accuracy and safety.

The concept of smart meter can be defined in general terms as [1] electronic measurements devices, installed by the utilities at the consumer facilities to allow communication of the consumption of energy (gas, electricity, water). These devices have been used by utilities to deliver accurate billing information, for a part of their customers. A first the devices were mainly used by industrial consumers given the higher consumption and the need of specific consumption data, to allow the right and best quality service to be delivered, and also to provide specific and detailed billing data. The evolution of the market and consumer needs facilitated a decreased price on the technology, and increased need of information by all consumers, leading to the migration of these systems from the industrial sector to all customer classes. From the consumer side smart meters can be defined as [2] communication and control systems, which have the ability to directly empower the consumers to understand, control, produce and earn from energy. Through this definition the consumer becomes an equal partner in the energy value chain. A broad view of smart metering, published by the European Commission [3] states that an intelligent metering system or “smart meter” consists of an electronic device used to measure the consumption of energy, delivering more information than a conventional meter, and that can transmit data through a communication network. In this perspective, the key feature of a smart meter is the possibility of bidirectional communication between the consumer and the supplier/operator; the system should also promote the dissemination of services that improve energy efficiency within the home. On a market perspective, shifting from old and static meters to smart active devices is a matter of increased importance for competition in energy markets.

A considerable array of definitions for what smart meter and smart metering is, are available in the literature and in industry reports. From the definitions stated above [1], [2], [3] it is possible to build a comparison table to highlight different focus of different authors (Table 1.)

Table 1. Smart meter definition comparison

Smart meter definition comparison			
Author	(Obenchain *et al*, 2011)	(SEDC, 2012)	(Martin, 2011)
Key concept	Electronic devices, providing billing information to allow better management by the companies and utilities.	Electronic devices, that allows consumers to manage and benefit from a better control of their energy expenditure.	Intelligent meters, that provide more and better information, allowing energy efficiency to be improved, while increasing competitiveness of the energy market.
Focus on	Utility benefits from smart meters, and management of resources	Consumer benefits from smart meter, as well as, utilities.	Consumer, utilities and the market benefit from the roll-out of smart meter technologies.

The general structure of the smart meter (Figure 1.) consists on a hardware combination of the meter and the platforms needed to gather the information, and the necessary software and communication layer that transmits, processes and enables the system to communicate consumption data for accurate billing, controlling and monitoring purposes.

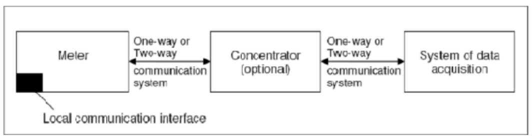

Figure 1. The general structure of a smart meter

The general system architecture as demonstrated in Figure 1. represents the possibility of "one-way" or "two-way" communications between the different layers of the structure.

The evolution of the systems technology from "one-way" communications to "two-way" communications is linked with the shifting from the Advanced Meter Reading (AMR) systems (one-way communication) to the Advanced Metering Infrastructure, AMI, (two-way communication). The main differences between these two systems, AMI and AMR, are [1]:

<u>AMI:</u> Consists on the combination of the electronic meters with two way communication technology, for information, monitoring and controlling energy use;

<u>AMR:</u> Utilized one-way communications to collect meter data only.

The evolution of the communication system and its impacts on the smart meters capabilities are represented on the diagram below (Figure 2.), including the evolution of functionalities and the stakeholder benefits as a result of these evolutions.

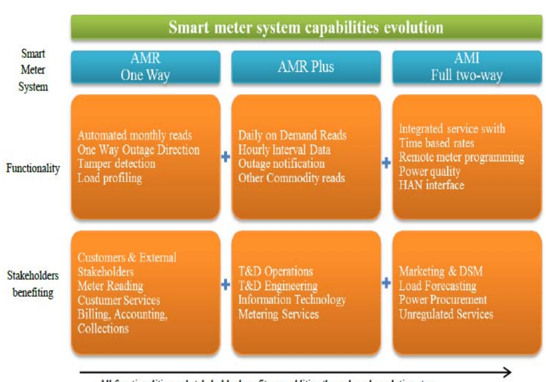

Figure 2. Smart meter system capabilities evolution, adapted from [1]

3. READY TO MARKET SOLUTIONS ANALYSIS

Smart meters combine an electricity, gas or water meter with a communication module which enables communication over a network with the utility / energy service provider. The meter market is dominated by a few large international groups such as Itron, Elster and Landis+Gyr.Some smaller specialized companies are active in the network equipment market.

a) Analysis framework and characterization

According to a research carried out in the UK, as many as one in three people confuse smart meters with energy monitors, or in-home display monitors[3]. This is not a big surprise as is through devices that people receive data from their smart meters. Market solutions for advanced metering infrastructures typically include both of these devices, as well as other hardware and software.

This section presents an overview of smart meters and accompanying technologies, firstly by explaining the basic communications network between the smart meter and utility companies, followed by combinations of customer interfaces and software solutions for energy consumption monitoring by the end user.

Smart Meter Technologies

Smart Meter Systems are varied in technology and design but operate through a simple general process. The Smart Meters collect data locally and transmit via a Local Area Network (LAN) to a data collector. This transmission can occur as often as 15 minutes or as infrequently as daily according to the use of the data. The collector retrieves the data and may or may not carry out any processing of the data. Data is transmitted via a Wide Area Network (WAN) to the utility central collection point for processing and use by business applications (Obenchain*et al*, 2011). Since the communications path is two -way, signals or commands can be sent directly to the meters, customer premise or distribution device.

Basic Types of Smart Meter Systems

There are two basic categories of Smart Meter System technologies as defined by their LAN. They are Radio Frequency (RF) and Power Line Carrier (PLC). Each of these technologies has its own advantages and disadvantages in application. The utility selects the best technology to meet its demographic and business needs. Factors that impact the selection of the technology include evaluation of existing infrastructure; impact on utility legacy equipment, functionality, technical requirements as well has the economic impact to the utility's customers (Obenchain*et al*, 2011).

Radio Frequency – RF

Smart Meter measurements and other data are transmitted by wireless radio from the meter to a collection point. The data is then delivered by various methods to the utility data systems for processing at a central location. The utility billing, outage management, and other systems use the data for operational purposes. RF technologies are usually two different types:

- **MeshTechnology**- The smart meters talk to each other (hop) to form a LAN cloud to a collector. The collector transmits the data using various WAN methods to the utility central location. Mesh RF Technologies' advantages include acceptable latency, large bandwidth, and typically operate at 9157 MHz frequencies. Mesh technologies disadvantages include terrain and distance challenges for rural areas, proprietary communications, and multiple collection points (Obenchain*etal,* 2011).
- **Point to PointTechnology-** The smart meters talk directly to a collector, usually a tower. The tower collector transmits the data using various methods to the utility central location for processing. Point to Point RF technologies advantages include little or no latency, direct communication with each endpoint, large bandwidth for better throughput, some are licensed spectrum, and can cover longer distances. The disadvantages of point to point RF networks are licensing (not for 900MHz), terrain may prove challenging in rural areas (Line of Sight), proprietary communications used for some technologies, and less interface with DA devices.

Power Line Carrier - PLC

Smart Meter measurements and other data can be transmitted across the utility power lines from the meter to a collection point, usually in the distribution substation feeding the meter. The data is then delivered to the utility data systems for processing at a central location. The utility billing, outage management, and other systems use the data for operational purposes (Obenchain*et al,* 2011).

- PLC technology advantages include leveraging the use of existing utility infrastructure of poles & wires, improved cost effectiveness for rural lines, more effective in challenging terrain, and the capability to work over long distances.
- PLC disadvantages include longer data transmit time (more latency), less bandwidth and throughput, limited interface with Distribution Automation (DA) devices , and higher cost in urban and suburban locations.

There are other Smart Meter Systems in use that differ from those described above. However, these are generally a hybrid or combination design, a slight variation of the basic types, or niche products. The major Smart Meter System Technologies in use today are of one of these basic types.

Data management

Planning for proper data interfaces of the Smart Meter System and the utility legacy systems is imperative. The correct meter, at the correct premise, communicating properly to the utility billing system, with correct data will insure an accurate and timely bill generated for the customer.

A software system not part of the utilities' traditional metering systems but required to operate a Smart Meter System is a Meter Data Management System (MDMS). MDMS is a major component of Smart Meter deployment and operations. This software platform receives meter data from one or multiple Smart Meter technologies, verifies and stores the data, and delivers data subsets to the utility operations applications such as billing (Obenchain*et al,* 2011). An MDMS is installed and operational prior to Smart Meter deployment and is designed to meet the utilities core business needs as well as Smart Meter support.

The data system required for supporting Smart Meter deployments is determined by data requirements and number of customers. For small utilities, usually less than 100,000 customers, the Smart Meter head-end can handle the data management needs. For medium and large deployments of Smart Meters, however, the massive data and functional requirements demands a more sophisticated data management system.

b) Hardware and Software combinations

There are numerous hardware and software solutions in the AMI market. Typically they include a smart meter providing data through an in-home display with various output functions. Data is accessed through the in-home display or through web-based applications for PC and as of recently mobile applications. In-home displays can also receive consumption data from home networked smart devices (washing machines, fridges, televisions, A/C, etc.).

These devices are very diverse, presenting data in various shapes and forms, ranging from simple displays that provide information on energy consumption in kWh, projected resulting GHG emissions and past, present and future prices, to more elaborate displays mimicking speedometers or providing color coded signals to consumers on their consumption patterns. The following section provides an overview of some devices and their applications available to consumers.

i. Tendril Insight (http://www.tendrilinc.com)

The display communicates with networked smart devices, such as thermostats and electricity meters, within the home; to provide data on the consumption rate in kWh and also the cost of energy usage, current and previous. Data collect from the Insight is sent to the utility provider, allowing them to produce accurate monthly bills. The device also acts as a platform for the utility provider to send messages to the customer, informing them of the latest offers and rates of electricity.

ii. GEO – Minim Energy Monitor

(http://www.greenenergyoptions.co.uk)

Originally designed for British Gas, this device displays how much energy is used within the household. The speedometer shows the amount of energy currently being used, the center shows the total amount of electricity that has been consumed, whilst the bottom bar allows setting monthly consumption targets.

iii. Tendril Vision (http://www.tendrilinc.com)

The Tendril Vision allows consumers to manage their energy consumption in an easy to use manner that keeps them engaged and participating in the process. Providing current and historical household energy usage, as well as calculating the real time price of their usage. Customers can create their own rules for consumption over different periods of time; an alert is created if the terms of the rule are broken. The vision shares data between the customer and utility provider over the Tendril Platform, which requires internet access. The platform contains characterization software which analyses, predicts and compares the consumption of the user with that of others, providing useful features for utilities. The device has features such as current weather and forecast information, thermostat features and a clock. This data can be used to predict how much energy consumption will occur in certain weathers. The vision also has a color scheme, allowing the consumer to easily distinguish between energy consumption.

iv. GEO – Solo

http://www.greenenergyoptions.co.uk)

The GEO – Solo is has features such a speedometer and total electricity consumption. The Solo also has a fuel gauge resembling feature which acts as a target setter for the day, if the reading is below that of the bar, then energy has been saved. This function tells the user that they are not only saving energy, but also money. The Solo will also alert users to any unusual amounts of energy consumption for the time of day.The Solo is ideal for collecting data as it can back up data for up to two years on an internal SD card. Data can be downloaded GEO online platform, providing a more in-depth analysis of energy consumption.

vi. Alert Me Smart Energy (www.alertme.com)

The Alert Me Smart Energy meter communicates energy usage to the display unit, online platforms and mobiles through apps. Operating at a frequency of 2.4 GHz, the alert me meter is capable of ignoring most interference. From your display unit, online or mobile apps consumers can monitor how much energy their household is consuming and get an accurate estimate of what likely bills. The device also monitors what appliances are on all the time and calculates a base load. From that information the meter will generate alerts if it notices any anomalous readings. If the Smart Meter is in combination with Smart Plugs the device enables monitoring the individual energy consumption of each appliance. The traffic light system shows what appliances are saving or wasting energy. Furthermore, appliances can be turned on and off from mobile phones.

4. CONCLUSION

Smart metering is a way to reduce energy consumption, which is otherwise projected to keep growing across the Europe over the next two decades. Smart meters have the proven ability to enable significant changes to the current scenario regarding energy consumption. Their purpose is to improve efficiency, not just at the household level, but utility-wide. For energy providers, smart meters promise to slash uncertainties in electricity consumption data and billing, eliminate the cost of manual meter readings and alert utilities to problems and outages more quickly and effectively.

The development of smart metering and the evolution on has the potential to change the energy industry and the interactions between consumers and distributors of electricity. Providing more and better quality information, these devices set the basis for realistic demand side programs and initiatives, focused on reducing unnecessary consumption, and shifting flexible load outside of peak hours. Reducing the peaks on demand will be possible through dynamic pricing, feedback and strong consumer engagement.

The array of smart meter enabled in-home displays on today’s market is very broad. As can be concluded from the above examples, some devices provide superior functionality and data than others. Marketed solutions are continuously improved to provide customers with a better overview of their energy consumption and more advanced controls such as remote monitoring and control of appliances. More advanced functions come with a higher price. The consumers will choose which device they will acquire based on their needs, their level of adoption of sustainable energy practices and the investment they are willing to incur. The next section explores in greater detail software solutions for energy consumption monitoring.

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INFLUENCE OF ELECTRONIC BUSINESS FOR ACHIEVING COMPETITIVE ADVANTAGES

MSc Maja Novak
MSc Sanja Stanisavljev, Technical faculty “Mihajlo Pupin”, Zrenjanin

Apstract: *This document deals with the topic of competitive advantage and information technologies that influence the ways organizations do business to acquire competitive advantage. Three generic strategies are described along with uniqueness and expenses generators. Then value chain is introduced as a tool that will be used to describe the influence that information technologies have on competitiveness. Following that technological aspect of competition was introduced and general technological influence was shown. After that information technologies that exert the biggest change in the way that organizations acquire competitive advantage were described. Then the influence of information technologies was elaborated through the use of the value chain describing how each segment of the value chain was changed with the use of information technologies. In the end conclusion was drawn about the way that information technologies exert influence on competitive advantage of organizations*.

Key words: *competitive advantage, e-business, organization*

1. INTRODUCTION

Internet technologies have opened the door to the concept of a fully digital economy in that it enabled the creation of innovative business approaches in the field of sales, buying and creating internal business processes. The focus of modern business organizations to the global market involves integration of information and communication technology, which ensures the flow of spatial data with no restrictions. Changing the concept of business, new technologies and integrated set of changes in relation to the environment but at the same time and within the organization itself. In the structure of the market place of information obtained unavoidable element, in addition to products, services and money.

The acquisition of market advantages, application and use of electronic means as virtual channels, and in business has proven to be a cost-effective and efficient way of exchanging goods and services. The success of the organization is based on the ability to define strategies and objectives, which will provide an adjustment to market requirements and the application of new technology and software solution, with the use of appropriate tools for measuring the results achieved in all the phases of the individual activities.

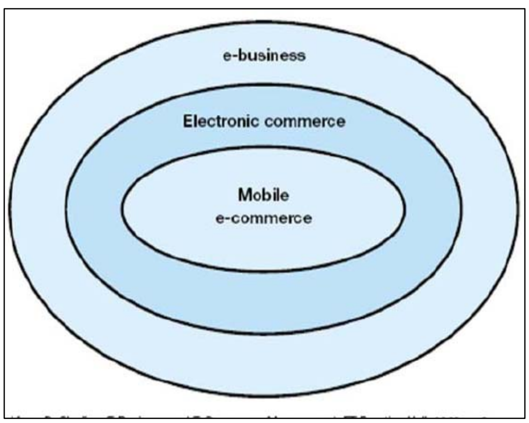
2. E-BUSINESS

Electronic business in the broadest sense may be defined as any process that organizations realized by means of computer networks, assuming both internal and external communication flows. Electronic business is defined by comprehensive e-commerce, because it involves the buying and selling of products and services and also, providing service to customers, cooperation with business partners, the use of e-learning (e-learning) and transactions within the organization. In accordance with this definition, electronic commerce is, therefore, based on the use of all forms of information and communication technologies (ICT). The main processes of the organization, which is being realized within the framework of e-business, including manufacturing (services), customers and internal, management focused business processes. Examples of electronic business processes are: [5]

Production - oriented production processes including procurement, ordered meal, conduct automated replenishment, process payments and other electronic communication with suppliers, but also to control the production and all the processes that are directly attributable to the production process;

Customers - processes that are focused on customers include marketing, e-selling, processing and payment of the ordered meal and support the

customer relationship; Internal or control focused jobs - including automated services to employees, training, information portal, video conferences and recruiting staff.
Under electronic commerce means buying and selling of goods and services, customer care, collaboration with business partners, electronic transactions within an organization where cases of transfers may be: documents, money, resources, etc. People often equate the concepts of electronic business (e-business) and electronic commerce (e-commerce). Electronic commerce is only a part of e-business. Electronic commerce can be defined from two aspects. The first aspect relates to communication (delivery of goods, services, information and payments through a computer network), while the second relates to trade (buying and selling of goods, services, information over the Internet).
Electronic commerce or e-business is one of the areas of information technology which have greatly changed the value chain. Electronic business can be considered such a business in which the use of electronic means to conduct business internally or externally. Internal activities include intranet linking employees, exchange of information and knowledge and support management reporting. E-business also includes services after purchase, and cooperation with business partners, for example, joint development of new products and general cooperation on a project.



Picture 1: E-Business and areas containing [2]

The term e-commerce or electronic commerce is a subset of electronic commerce and consists of conducting transactions and sales over the Internet or other telecommunications networks.
The term mobile e-commerce or as it is called m-commerce is a subset of electronic commerce that deals with all of the above, but with one difference consisting in the fact that this type of trade is limited to mobile networks and mobile devices such as mobile phones handheld computers and PDA device.
This quite young field can be traced chronologically or through its forms and types of e-business.

3. THE BENEFITS OF E-BUSINESS

As the basic advantages of the electronic business are: the reduction of transaction costs - if well designed e-commerce, such an approach and concept allows a deduction of costs to the end user, and the entire process significantly automated.
Big purchases per transaction - as an example often cited Amazon (book store on the Internet) in relation to the traditional supply Bookshops (book stores). It is possible to see a short explanation / description of the book, and details related to its publication as well as the opinions of other customers on the occasion of its contents.
The embodiment of the entire economic / sales process - if the web presentation through which the business is carried on the Internet well consolidated in the economic process - the consumer may offer additional information. For example, Dell (computer manufacturer) for each computer offers next switching / configuring the computer and adequate supply, where the customer has access to your transaction, i.e. the stage of realized buying.
The market offers a different way of shopping - in addition to traditional purchasing companies complement its product range and through the concept of "buying of houses-where e-commerce represents a more comfortable way of shopping. Newspapers offer via web presentations are sure: the possibility of defining the scope of purchases over several days, the choice of products with insight into current prices, the possibility of a simple comparison of the prices of products offered and different vendors the ability to search large catalogs of products.
Extensive catalogs of products - companies have the option of presenting a very wide range of products, which has been hampered in the traditional ways of selling, as an example in this regard is often cited Amazon where it offers 3,000,000 books. [6]
Improving inter-relationships with customers - web presentation provides the possibility of creating an interactive relationship with customers who do not require additional costs, thereby increasing customer satisfaction, which is most often positively reflects on purchases.
Electronic commerce provides the ability to create entirely new business models. A significant advantage of electronic commerce is certainly offers flexibility in line with the real situation on the market, i.e. changes to the products offered, price and similar elements can be implemented relatively quickly which achieves flexibility. In this sense general characteristics electronic business that companies recognize as their chance are: innovative products and business models, continuous and virtually unlimited access to the world global market, orientation towards customers,

individualization, and flexibility to the customer, more efficient operations and lower costs.

Difficulties in electronic business include: monitoring visits web presentations within which realized sales, tracking re-visit the web presentation - the percentage of repeated transactions within the web presentation, differentiation against the competition, tracking and analyzing purchases realized within the web presentation - in Within this work is necessary to ensure proper processing of credit cards, the integration of electronic commerce with traditional business. [1]

4. E-BUSINESS IN SERBIA

The introduction of e-business involves many organizational changes. It is based on: a more efficient and more modern work organization adapted use of modern information technology, Internet usage in the performance of most business transactions, organization and implementation of modern information systems, the use of standardized documents, the application of electronic signature, digitalization Affairs and using cryptographic protection mechanisms. Almost all developed countries have adopted legislation on e-commerce and electronic signatures, to establish the certification bodies and bodies for the accreditation of certification bodies, beginning with the release of citizens –intelligent card to safely engage in e-government, etc. The European Union has adopted a program of Europe in which the planned activities to ensure that Europe 2010 becomes economically fully competitive and dynamic knowledge-based society. Of e-business is in the midst of a little less present in relation to the existing knowledge and needs. Our society has lagged behind in the past decades to follow modern technological trends, and because e-commerce should be used as one of the opportunities for rapid growth. In our country we have at the expert level monitor trends in e-business. Research was conducted by euro stat methodology, the territory of the republic of Serbia. based on the research of the Republic Institute for Statistics, the following results on the use of the Internet and the use of E - government services (E-Government): Domestic: When research used a sample of 2000 households. The use of the Internet: the Internet in Serbia is 26.3% of households; most households have a modem connection to the Internet (73.4%), WAP and GPRS us 16.1% and 12.1% of ADSL households; Broadband (broadband) Internet connection uses 7.3% of households in Serbia. Apart from allowing quicker access to the Internet, a broadband Internet connection is also one of the basic indicators of development of the use of information and communication technologies in the European Union since 2005 (the percentage of households owning this type of connection); Number of Internet users has increased compared to 2006 by 3%; Over 1 700 000 persons used the Internet in the last three months; Over 850 000 persons use the Internet every day. [7]

5 THE IMPACT OF E-BUSINESS ON THE ACHIEVE COMPETITIVE ADVANTAGE

Regarding the primary activities such as inbound and outbound logistic, e-business solutions enable companies to atomize processes and effectively monitor and control inventory, which improves planning and the effectiveness of those processes. Atomization of the processes enables to save time and thus increase effectiveness. In another primary activity – operations, applied e-business solutions improves flexibility and the production of goods, which meet demand more accurately. Marketing and sales through e-business solutions provides new marketing and sales channels, enables to receive clearer picture of the market. In the primary activity such as service, e-business enables enterprises to spread information to their clients much faster.

Further, for the procurement processes e-business may be beneficial by enabling companies to minimize the number of transactions and reaching the suppliers much faster. In the area of human resources management, e-business through e-learning enables companies to develop new capabilities faster. To sum up, e-business value may be created by e-business application through several broad areas: knowledge management, information management, atomization, coordination and faster processes. By applying e-business into usual business processes, companies may improve various business processes by shorter shipping time, faster response to demand, much faster exchange of information in the whole value system, which is very important because the communication between the suppliers or manufacturers abroad might be very complicated and very time-consuming process.

Further, Christensen conducted a survey in Norwegian enterprises seeking to find out if e-business had a significant positive impact on sales, profits, return on investments and return on equity. 330 companies actively engaging in e-business participated in the survey. Survey results were analyzed using descriptive statistics, cross tabulations and exploratory factor analysis. The results showed that 21,4 % of companies reported increase in sales, 14,8 % reported increase in profits, 13,1 % - return on investment, 10,8 % - return on equity [3]. Based on the results, authors argued that usage of e-business in most cases had no significant impact on firm’s financial and economic indicators. The study also revealed that e-business in Norwegian enterprises is in its infancy and that the companies “put all their efforts into relatively simple and primitive e-business solutions”. Based on the findings authors stressed the role of management in the development and implementation of appropriate e-business model in order to create competitive advantage.

Based on the literature review it may be concluded that integration of e-business solutions in the usual business processes may improve all activities throughout the value chain however e-business impact on the improvement of firm's financial performance of the company is debatable. In many studies when analyzing e-business impact on business process from the benefits perspective, the benefits created by e-business are very often associated with the value creation and competitive advantage of the firm. Relating the benefits created by e-business with the competitive advantage in a way suggest that investments in e-business solutions may generate better performance and thus lead to better financial performance. However, there is also lack of empirical studies analyzing whether positive e-business impact (benefits) really lead to the competitive advantage, what is usually claimed in various studies.

6. CONCEPTUALIZATION OF E-BUSINESS BENEFITS AND COMPETITIVE ADVANTAGE

The benefits induced by e-business solutions are often associated with the competitive advantage in various studies, but the concept of competitive advantage is usually applied as a self-evident. Though the approaches of competitive advantage doesn't provide with the clear definition of the concept, they are useful in developing the indicators for the competitive advantage. Based on the literature review on competitive advantage, the term is interchangeably related with the company's financial performance, however the financial indicators differs across various studies. It's known that the ultimate goal of any company is to generate profits, by which the success of company is usually measured. Thus, following this logic, profitably working company in any industry has a competitive advantage, which defines company's good performance.

The analysis of competitive advantage is possible only when comparing different companies on the certain dimension, which might be different in each case. Seeking to find out whether one company has a competitive advantage over the other there is necessary to define the reference point or put in other words, to answer the questions on what several rivals are being compared. Though it seems promising conceptualization of the term, it raises the problem when there is a need to identify competitive advantage upon one dimension in a big sample. Different authors approach to competitive advantage differs from the developed approach to competitive advantage in a sense that it is a relative position oriented and not the result oriented. However, the relative better position or resource possessed by one company is also an important stimulus for the improvement of financial results. Thus, the logic of linking certain resources with the improved financial performance and claiming that certain resource is important in gaining competitive advantage seems to be appropriate when analyzing whole industry. [4]

The increase in sales due to the usage of e-business solutions was included in the measurement of competitive advantage with the assumption that the assessment of profitability takes more time than the assessment of increase in sales, which is also important indicator of improved firm's position in the market, which is an important aspect of competitive advantage. Thus the two indicators for competitive advantage used in this research were increase in profits and increase in sales.

7. CONCLUSION

E-business solutions such as supply chain management, resource planning system, e-commerce and others create diverse benefits for the business. Although the integration of e-business solutions in the usual business processes may improve all activities throughout the value chain, e-business impact on the improvement of firm's financial performance of the company is debatable. Most of the studies analyzing e-business impact on the usual business processes emphasize e-business benefits understood as the improvement of those processes and relate them with the competitive advantage. Put in other word, studies on the e-business benefits regard e-business solutions as an important source of competitive advantage; however, the empirical research exploring the relationship between e-business benefits and competitive advantage is limited.

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THE IMPACT OF NEW IT ON FORKLIFTS ON SCM

Svetlana Dabić Ostojić[1], Momčilo Miljuš[1], Dragan D. Milanović[2]
[1]Logistics Department, Faculty of Transport and Traffic Engineering, University of Belgrade
[2]Industrial Engineering Department, Faculty of Mechanical Engineering, University of Belgrade

Abstract: Problems related to efficiency and other performance measures functioning of SC are very wide spread. They can be generated by various causes, and the area of information is one of the particularly vulnerable. At the global level, this problem has been largely explored. Therefore, the application of new solutions in the field of micro activities is directed at the individual members of the SC. The work of forklifts, as equipment that is almost indispensable in realizing intralogistics activities here can be of significant impact on the functioning of the SC. For this reason, the application of new IT solutions for forklift is becoming a place of significant research. This paper presents some possibilities of applying IT in forklifts as well as assessment of the achieved effects
Keywords: IT, SCM, forklifts

1. INTRODUCTION

The term *supply chain (SC)* is met in literature since 1980s, but his precise definition still doesn't exist. That is the consequence of complexity and variety of specter where SC is met – based *on type and characteristics of products, industry type, target market, politics and supply resources, number of members and their impact on the operation of the supply chain, their geographical position, size, function and role in the SC, ways of realization of information, materials and financial flows, etc.).* Within numerous definitions, we can see that SC covers the exchange of goods and information in logistics processes that starts with the procurement of raw materials to delivery of finished products and/or services to the end user; thereby all the suppliers, service providers and users must be connected in order so that SC can be effectively operated (Stocs and Lambert (2001), Chorpa and Mendl, (2004), Simchi-Levi, Kaminsky, and Simchi-Levi (2009) et al., Glosary of SCM Council…).

Without going into the issue of definitions, it can be concluded that the research in the field of SC so far mainly dealt with the analysis of its functioning at the global level. SC is analyzed in terms of the functioning of all its members. Considering their mutual relations, the analysis included the realization flows between them ranging from procurement of raw materials to the realization of end user's demand. In principle, global analysis of one SC doesn't give us full insight into elementary activities within its members, such as suppliers, manufacturers, storage facilities, wholesale, retail stores, etc. For example, for inventories in SC, analysis are made on global level (location of warehouses, inventory level in SC, inventory management), for production systems (production type, flexibility of production technology etc.) (Sohn and Lim, 2008, Pulevska-Ivanovska and Kaleshovska, 2013).

Successful functioning of one SC is so important, that today it is not enough to only analyze global functioning of members and their mutual connections in that domain and to follow the flows of materials, information and finances. Having in mind that competition on the market is getting stronger, from aspect of one, for example, factory, it is necessary to overview and improve internal processes, so that SC could exist and could improve its competitive ability (Marinagi, Trivellas and Sakas (2014)).

Therefore, in recent years, increasing attention is paid to the elementary logistics activities in the field of intralogistics in terms of the functioning of the SC. In these activities of intralogistics, a conventional forklift is today still an typical device as one of the key **m**aterials **h**andling **e**quipment (MHE). Due to the large number of tasks that it realizes, it could be noted that the quality of its rational functioning is of high importance for the performance and competitive stability of the SC.

Forklift is the tool that is constantly being improved in various areas (engine, working speed, costs, safety...). One of the areas with huge improvements is areas of IT (information technologies) usage on forklifts and their impact on SCM (Supply Chain Management). So the aim of this paper is to show the importance of current and introducing new IT solutions related to the usage of forklifts in some of logistic activities within SCM.
Having all that in mind, this paper has several sections besides introduction. After the introduction, second section describes mutual relationship between information, information technologies and SCM. Third section of this paper analyzes characteristics and potential problems that occurs during classic exchange of information with forklift driver. It is introduction to the fourth section that deals with analysis of usage of new IT, that allow improvement of work of some of the members of SC, in which forklift executes material handling activities (MHA) (storage, production objects, distributive centers...). Fifth section, conclusion, has observation related to above-mentioned problem, but also ways of future researches related to usage new IT in SCM.

2. SCM AND IT

The key of successful SCM is information. Information is being collected, processed and tracked since 1980s, when the term SC was used for the first time (Chopra and Mendl, 2004). At the time, information was in paper form with characteristics of being late, delay, errors, missing data etc. Today, the flow of each information must be allowed between all members in SC whether it is products or services. All members of SC (procurement, production, transportation, storage, wholesale, retail) have important information. Availability and accessibility of information is key to value added creation in SCM, and aiming competitive advantage of SCM on the market (Moharana, Murty, Senapati and Khuntia, 2011). The information that are usually gathered, analyzed, processed in almost every domain of SCM are related to: inventory level, sales, tracking orders, production plan and program, production capacity etc. It is clear that the quality and other parameters related to information (accuracy, timeliness, completeness, connectivity, the way it is presented / available, availability, compatibility, transparency, security and others) are very important, but they are not the object of research in this paper.
The customer is the initiator of the functioning of the entire system of business and all economic activities. Therefore, it is important to respect the characteristics of customer's demands in order for SC to survive, but also to strengthen its position in the increasingly demanding competitive environment. Customer requirements are rapidly changing on a daily basis, which causes the appropriate IT. The usage of modern IT presumes exchange of information between all the members in chain, despite his complexity (Fasanghari, Roudsari and Chaharsooghi, 2008). Modern IT are characterized by presence of complex and huge data bases. That allows better quality of decision making in all segments of SCM, but also faster and more efficient answers to customer's requests. That is the consequence of the fact that even the information in micro-activities can be important for SCM.
All mentioned above resulting in the lot of IT solutions on the market that are more and more adapting to execute the customer's request. Modern IT in SCM have a significant impact on the shortening of product life cycle, faster customer response, reducing the time from the moment of occurrence of requirement to its fulfillment, better forecasting, reducing inventory levels. (Sohn and Lim, 2008).
Lately, from aspect of IT the usage of internet is getting more important. The development of internet, and other and more modern IT and their evolution led to the transformation of traditional SCM to e-SCM (Pulevska-Ivanovska and Kaleshovska, 2013). From 2000 there is huge increase of usage of internet (Chorpa and Mendl, (2004)). That also generated requests for improving modern IT, with the aim of to maintaining and improving market competitiveness. Internet allows easy access to information, good availability, choosing the right/good strategic partners and creating strong relationships within SC, and the choice of appropriate technology business for the SC members. At the same time, new software solutions were developed and adopted which created preconditions for faster capital turnover and higher economic benefits compared to traditional SCM.
Modern IT are lately becoming very important in terms of analyze of activities that are carried out at the local level, or within each of the members of the SC. To achieve more efficient and cost-effective operations for some SC members is sometimes very important to have information about what is happening in the context of material flow, for example. within a given production system, warehouses, DC,... as a member of SCM. In that context, relation forklift – SCM can be very important. Because of the wide range of options of information exchange between the forklift driver and forklift fleet management system, the following sections give shorter analysis of the characteristics in this area.

3. CHARACTERISTICS AND POTENTIAL PROBLEM IN SCM IN CLASSIC INFORMATION EXCHANGE WITH FORKLIFT DRIVER

Lately, it is evident that there is constant development of new solutions related to the construction of MHE with the cyclical realization of demands in intralogistics. One group of these equipment are forklifts. Depending on needs and potentials of SCM members, various forklifts with different technological and technical characteristics are being used. But, classic counterbalanced forklift with counterweight and manual control is still vastly spread and used in realization of material flows and handling in many factory plants, distribution centers, warehouses and others. There are many reasons for that, and primary ones are (compared to “new”, more sophisticated and automated solutions): less investment costs, more flexibility, simplicity of implementation and others. There are also some disadvantages as consequences of workforce engagement (drivers with appropriate training). This is primarily related to problems in staff scheduling that work in more shifts, finding a replacement in the event of sickness, unplanned absences, etc. In some situations, these problems can be solved by some organizational measures or by outsourcing.

Despite all type of potentially usable solutions for mentioned problems, the problem of offline information exchange between forklift driver and forklift fleet management system remains present (Martin, H. 2002). In dynamic working conditions, in classic IT forklift driver must permanently (physically) accept demand(s) for task realization (series of tasks) and to inform appropriate person (service) upon realization. That increases unproductive time (delays) in forklift's work. Problem(s) are potentially present in other situations that forklift driver can meet. For example, if the driver did not understand the requirements of the task, some errors could occur because of the subjective and/or objective reasons, such as: the picking of goods on the wrong location, wrong picked unit, errors in order-picking (delivery of wrong goods), wrong place of putt-off, etc. The consequences of these errors are not limited only to working place of forklifts (plant, warehouse, etc), but can also cause series of problem for other members within SC. These problems are related to delays of delivery, supplies of inadequate goods, the necessity of subsequent (usually emergent) delivery, requirements for the realization of reverse flows, etc., and all consequences that result from them.

Since modern business conditions are less tolerant for such errors, various ways for their rationalization and/or elimination were searched for. Studies were conducted in various areas (automation, computerization, etc.). Particularly interesting area is related to the IT segment whose one segment of usage will be shown in the next section.

4. NEW IT FOR COMMUNICATION WITH FORKLIFT DRIVER

The domain of development and usage of IT in logistics and SC is very pronounced in recent decades. It is reflected in the implementation of a number of technical innovations that provide the preconditions for a more efficient and rational realization of the number of processes in the field of logistics. Some of them are practically an indispensable part of equipment (GPS, ITS….), and new communications provided their even more intensive usage. Especially we today cite a variety of applications for mobile phones and tablets that provide range of amenities for users in the domain of finding the desired location, availability of equipment, etc (Mauer, 2015).

This trend is slowly transferred into the field of intralogistics where the implementation of above mentioned solutions is more and more met. In the field of work of forklift driver, there is a significant number of problems related to the information exchange about the tasks that he should realized or have realized. The usage of various IT could be met with their solving. Modern solutions are met by the name of *paperless* and on-line/open-loop (Martin, H., 2002) technology. The key aim of this technology is to speed up, simplify and secure the information exchange between forklift driver and management system where forklift operates (for example, WMS in warehouse systems).

Various solution for this information exchange are present in praxis, and the typical ones are those based on terminal built in the forklift cabin (Figure 4.1). The task assignment is realized by showing on the display, and the driver confirms the acceptance of information (via keyboard, touch screen...) and start to the task realization.

Picture 4.1 Some elements of IT equipment on forklift (Mauer, 2015)

The task can contain more information, and the basic ones are: pick-up location, type and shape of goods to be picked and the put-of place. Eventual additional confirmations on realization of partial activities could be realized by scanning appropriate bar code (Figure 4.1, detail on the left side) etc.

The management system can be equipped with additional capabilities that make the preconditions for the increase of forklift work rationality. Applications can contain routing models for optimization of movement of forklift; tracking time engagement in real time and need for potential intervention like increase of safety at work (obstacles on aisles, routes crossings etc), planning periods of planned maintenance or intervention to malfunction problem on forklifts etc. In order to increase flexibility and efficiency, mobile printer that are equipment add-on could be seen as part of IT equipment (Figure 4.2).

Figure 4.2 Mobile printer on forklift (Mauer, 2015)

5. CONCLUSION

It is very important that all members of SC are using IT. This paper has shown only one segment of this usage that deals with information exchange between forklift driver and forklift fleet management system.

Integrated systems of tracking of forklifts activities are being offered lately. The demands for transport and handling activities are automatically optimized by routes and are assigned onto appropriate resources, independently from forklift type.

By rule, logistics managers lack important parameters related to transparency (for example, he doesn't have information about when is the unproductive time for forklift and amount of it). It is important to define clear difference between the time that this equipment spends on work and period that it doesn't realize the demands (Mauer, 2015). Modern IT provides the solution of these problems in the domain of SCM. The basics for further information are gained through such data analysis that allows huge savings in costs. The planning interval for service and maintenance of forklifts is enabled, in order to minimize its unproductive time.

In combination with mobile applications, all elements of work process of forklift are available/displayed in details (it is possible to re-arrange tasks, so that “proper” forklift is at the proper time at the proper place in order to deliver goods for further processing). That allows better process of integration between all in-plant transporting equipments, which is the consequence of usage of *paperless* technology. Some researches shows that this procedure makes preconditions to increase the productivity of forklift up to 30%. Further implementation of modern IT in SCM provides the possibility to increase ecological efficiency, safety, economical efficiency and many other advantages resulting from it.

We can see that the question of investments for implementing modern IT is present as serious problem in the series of SME (as members of SC). According to literature, it was seen that ROI for fleet of up 10 forklifts is about 14 months. From that reason, the usage of suitable methods of analysis and forecast is very important and depending on place and role of concrete member of SC.

The directions for future research in this field are numerous. Some of them deal with implementation of modern IT in all segments of business of all members of SCM. In the scope presented in this paper, usage of described technologies provides transparency that allows members of SC the insight in realization of micro-activities even within certain members of SC where the tasks are being realized by forklifts with driver. All this provides information to SC users/members that can be very important for making operative and tactical decisions. This allows better productivity and all other advantages coming from it.

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GUIDELINES FOR SUCCESFUL CLOUD SELECTION

Marija Rakic-Skokovic[1], Darko Stefanovic[1], Bojan Lalic[1]
[1]Faculty of Technical Sciences, University of Novi Sad, Serbia

Abstract. *In order to be successful and become a leader in their market area* ***o****rganizations need IT to be an enterprise backbone, focused on core goals of organization business. In past decade Cloud computing has become more and more significant as a potential solution in delivering greater business and IT agility, quicker access to application enhancements or innovative new cloud-optimized applications. Cloud computing offers many features, which when properly utilized can unleash exponential results. Selecting the appropriate solution and moving to a cloud is complex process that has to be properly managed. Once organization makes a decision about moving to a cloud, it steps to the next phase of choosing provider of cloud computing services. In this paper some of the main questions that organization should take under consideration when choosing the cloud solution are presented.*

Key words: *cloud computing****,*** *cloud provider, cloud service.*

1. INTRODUCTION

In recent years, cloud computing has been considered to be one of the most important paradigm shifts in computing technologies. As an emerging concept, it has attracted much attention in both academic and commercial area. Metaphor "cloud" refers to the ubiquitous accessibility and availability to computing resources by means of Internet technologies [7][8]. There are a large number of cloud computing definitions given by different technologist. From a business perspective, Marston, et al. [4] define cloud computing as "an information technology service model where computing services (both hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location. The resources required to provide the requisite quality-of service levels are shared, dynamically scalable, rapidly provisioned, virtualized and released with minimal service provider interaction. Users pay for the service as an operating expense without incurring any significant initial capital expenditure, with the cloud services employing a metering system that divides the computing resource in appropriate blocks."

Cloud computing is enabled through the use of virtualization technology. As a base there is an application (hypervisor) that runs on a host computer. This application simulates physical computers which can run any type of software (operating systems or end-user applications) by creating one or more virtual machines, [5]. Hardware level consists of independently located datacentres which incorporate a variety of physical devices (hard drives, processors, network devices). The effective management of servers is enabled in the next layer - the combination of the virtualization and the management software layers. Thanks to the virtualization technology, cloud computing offers robustness and reduce traffic congestion. The management layer has ability to monitor traffic and respond to changes by creating or the destroying necessary server nodes. Implementation of security monitoring and rules throughout the cloud it is also possible. The diagram below shows common cloud architecture.

Figure 1 Cloud architecture

2. NEED FOR CLOUD COMPUTING

In order to scale up company's IT infrastructure so it can meet ever changing business needs, organizations have to invest time and money. The scaling process can be slow and inefficient if entire IT infrastructure is located on premises. As a more agile and efficient way of building their IT platform, companies nowadays are adopting cloud computing as a solution. Cloud computing technology enables companies to maintain their data and applications by using central remote servers over internet. It provides on demand resources and services over the internet with the power of scalability and reliability.

Some of key cloud computing characteristics are [9]:

- **Flexibility/Elasticity**. Computing resources and capabilities can rapidly and elastically be delivered to users, as needed (in some solutions automatically), to promptly scale up or down.
- **Infrastructure scalability**. According to demand, new nodes of cloud architecture can be added or removed from the network, with few modifications to software and infrastructure set up.
- **Access over broad network**. All capabilities are available and can be accessed by use of various devices over the network (e.g., mobile devices, PCs, PDAs).
- **Independence of location**. Resources provided are situated in geographically independent locations, generally unknown to the customer.
- **Reliability.** The use of multiple redundant sites improves reliability, making cloud computing suitable for disaster recovery and business continuity.
- **Cost effectiveness and economies of scale**. In order to be cost effective, cloud implementations have a tendency to be as extensive as possible. To lower costs large-scale cloud deployments can often be situated in low-priced real estate and close to inexpensive power stations.
- **Sustainability.** It offers more efficient systems and improvement of utilization of resources.

3. CLOUD COMPUTING DEPLOYMENT MODELS

Architecture solutions for cloud computing have four deployment models described below [1][2][6][8]:

- **Public cloud**. Computing infrastructure and/or application is shared across different business units, large industry group or personal users and available to general public. It is owned and managed by a provider of cloud service.
- **Private cloud**. The cloud infrastructure is implemented within the organization's private firewall. It can be located on or off corporate premises, and it's usually controlled by the organization's IT department, but it can be hosted and managed by a third-party service provider.
- **Community cloud**. This type of cloud supports a specific community that has common business objectives and concerns (e.g., compliance considerations, policy, mission, security requirements, or legal issues). The infrastructure is shared by several enterprises in the group. It can be located on or off corporate premises and it can be governed by one or all of the organizations in the group or by cloud service provider.
- **Hybrid cloud**. It represents a combination of a private (or community) cloud platform with the use of services provided from a public cloud provider. One or several touch points between the environments enable portability of data and applications. The communications between different infrastructures (public and private), which operate independently of each other, is empowered over an encrypted connection with the use of standardized or proprietary technology.

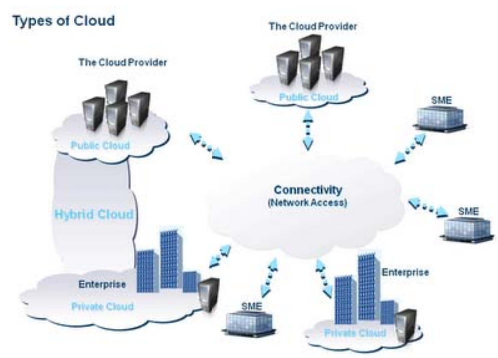

Figure 2 Different cloud types

4. CLOUD COMPUTING SERVICE MODELS

Cloud Computing Framework is defined as a Service Oriented Architecture (SOA) in majority of literature reviews, offering three main areas of services [1][2][6][8]:

- **Software as a Service (SaaS).** This type of cloud service represent software distribution model which offers a large range of applications from productivity applications (e.g., word processing, spreadsheets, etc.) to software for Enterprise-Resource Management (ERM) or Customer Relationship Management (CRM). Instead of installing and maintaining software, users access the applications that are developed and owned by service provider and centrally hosted on the cloud, by using a thin client (mobile application or web browser). Benefits of this model include centralized configuration and hosting; software release updates without requiring reinstall, and accelerated feature delivery.
- **Platform as a Service (PaaS)**. This category of services provides platform (hardware and software tools) for the creation of application, delivered over the Internet to their users as a service. An advantage of this model is the ability to provision all aspects of software development (design, testing, hosting, version control and maintenance) over the Internet.

- **Infrastructure as a Service (IaaS)**. This mode of services refers to remote on-demand delivery (through the Internet) of a full cloud computing infrastructure (e.g., storage devices, virtual computers, servers, network…). Benefits of this model include pay-per-use and resource elasticity to match the computing demands.

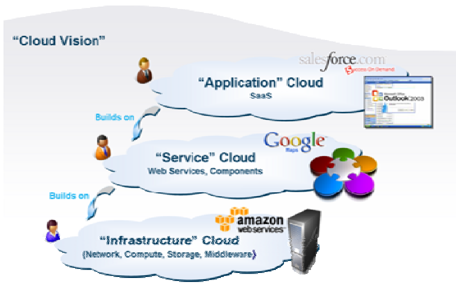

Figure 3 Services of Cloud Computing

5. CHOOSING CLOUD SOLUTION

One of the several IT technologies that are making today's headlines is Cloud computing. Vendors that provide various cloud services aggressively promote a large number of different ways organizations can benefit from choosing their solution. These benefits are presented in a way that on the first look it seems that organization should move entire IT "into the cloud". However, it is obvious that questions can also be raised for every named benefit. Choosing one solution among variety of cloud computing solutions that are offered by a large number of companies can be very challenging.

Starting point in process of selecting a cloud solution should be to conduct a basic analysis of requirements based on: organization business needs; benefits that organization is looking for; parts of business that are suitable for moving to a cloud; the use of the system by employees; should organization use cloud-based infrastructure and keep control in-house, buy the entire process as a service, or do it partially; are selected services enterprise-ready and do they offer the high enough levels of security and governance; how much money and time organization can invest in this project; how can organization make use of new capabilities?

Once organization makes a decision to move to a cloud, the next step is to choose right cloud computing service provider. Some essential questions that has to be taken under consideration when evaluating if the potential provider is right one for organizations particular needs are listed below, [3].

5.1. What types of cloud services are provided?

Making decision on which type of services to choose will be dictated by organization's cloud computing needs. There are software-based cloud offerings from various vendors, such as for online storage, accounting or customer relationship management (CRM). A large range of general-purpose cloud computing services is available in the cloud market. These services include IT networking infrastructure with on-demand access to application software and virtual servers.

5.2. What is a pricing structure?

As a cloud user, organization should only pay for services that uses. Organization has to be aware or possibility of initial indirect costs, which can be hidden in case of some none reputable cloud vendors. From the starting point the pricing structure should be pay-as-you use, with the possibility to add or scale services as needed. In this case organization should be informed of a price for scaling options. Depending on the vendor, fees can be charged annually, semi-annually, monthly or hourly.

5.3. What type of security is offered?

A major concern when investigating a possibility to store company's critical data in the cloud should be issues of security. Standard security measures should be implemented and constantly updated by provider. Among measures that it would be good to have are: anti-virus detection, firewalls, routine security audits, data encryption and multifactor user authentication. It's also important to ask does cloud provider checks background of employees who will have access to cloud data in order to prevent potential cybercriminals or stealing of identity. Providers should also answer questions about compliance with industry specific government legislation.

5.4. What is data centre location and is it safe?

Along with online security, the actual location and security of the data centres of cloud infrastructure where company's information will be physically stored are also important. There are questions regarding data centre protection from natural disasters (e.g. floods, fires, storms, earthquakes…) and thieves. Standards for Attestation Engagements 16 (SSAE 16) certification demonstrates that a company's products, systems and data are compliant with the industry security standards for customer access and privacy, data centre physical security and data redundancy.

5.5. What happens in case of data lose?

There should be some mechanism to solve the problem in case that cloud provider loses organization's data. Organization should carefully examine company's Service Level Agreement (SLA) and look at provisions dealing with this issue. Users are entitled to know will there be adequate compensation for their losses. Cloud provider should have some procedures in place to mitigate the risks of data loss. History of any significant issues that came out as a result of losing customer data should also be known.

5.6. What customer support services are available?

It is important to know when technical support will be available online or by phone (every day, working hours?) and what is average response and resolution time. Is there a partner network which can provide local support, if it is needed?

5.7. Can a cloud scale up to meet organization's business needs?

As business grows, so will cloud storage needs also grow. Cloud provider should be flexible. Users should be able to extend storage capacity or add new services over time. If there is a plan to increase staff, it is important to know if additional users can easily be added to organization's account.

5.8. What's provider's history of downtime?

A period of time during which users cannot access a cloud provider is called downtime. The best option would be if this kind of situation never happens, or at least on very few occasions. Not being able to access the cloud data and application can be very disruptive and costly for organization's business. It would be prudent to ask vendor of their downtime history logs if not posted online.

5.9. How difficult is to set up?

First step after choosing and signing with a cloud provider usually is to configure organization's account and add employees as users. At most cases cloud vendors will provide introductory guides that can be accessed on line. Large vendors help users by walking them through the process of installation and setting up of their services. Additionally, organization needs to consider are the new services like anything that the staffs already use and how much training will be needed in order to use the new system?

5.10. Can organization get data back?

Important question to consider is what will happen with data if an organization decides to change cloud providers. Is it possible to retrieve all the data without loses and in what form?

5.11. Can it be tested?

Before organization makes a commitment a good idea would be to first try out chosen solution. Possibility of running a new cloud service in parallel with organization's existing systems will enable exploration of new features and benefits. Also, organization can consider a pilot wider deployment, as another option.

6. CONCLUSIONS

Cloud-based solutions provide organizations with an access to enormous computing power at a cost that is in line with their own business model. By relaying on a highly scalable IT platform it helps companies to reduce the cost of operating, provisioning and deprovisioning of IT resources. It is essential to examine organization's current IT system and business needs in order to determine which type of cloud computing solution can be of best help in achieving specific goals. Considering the fact that the cloud computing does not represent one explicit term, but more of an analogy for a global network, it is clear that best utilization of its advantages depends on individual cloud focus.

When revising business reasons to move partially or entirely to the cloud organizations can face a multitude of good reasons, but none of them is absolutely perfect. While some companies are looking for solution to cut costs, another will take advantage of the flexibility offered through cloud solution. In order to take the best advantage of implementing cloud solution, organization needs to make sure that entire project is fully planned, monitored rigorously and accurately costed.

If an organization makes wised choices when selecting cloud solution it can fully benefit from getting information technology on enterprise-level at negligible costs.

ACKNOWLEDGMENT

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ERP IMPLEMENTATION INDICATORS

Nebojša Lapčević[1], Dragan Lj. Milanovic[1], Marija Milanovic[1],
[1]Faculty of Mechanical Engineering, University of Belgrade, Serbia

Abstract. *This paper provides an analysis of working with ERP (Enterprise Resource Planning) systems in the world and Serbia, showing the specific issues that shows in the life cycle of ERP system. Comparing these results we are given directions for the development of ERP in Serbia in order to achieve as much capacity utilization of ERP in the company as well as the quality of information that ERP provides.*
Keywords: *ERP in Serbia, cloud.*

1. INTRODUCTION

Most enterprises around the world have already adopted ERP, and beside them small and medium enterprises (SMEs). They find it cost-effective and necessary for competitiveness to follow this trend. Although wide-intensive integration of ERP happens in the last few years, the ERP has a good pedigree software package that has been around since the 70s of the last century [1]. ERP system with the aproach of increasingly powerful cloud and web technologies is experiencing a transformation that more can call evolution. It is no IS, which corresponds to a given query data from the database. Today, it is a system that is able to unite the economy, industry, medicine, sociology, ecology and other aspects of human activity both in their community and the environment. ERP system today can be integrated using mathematical models to predict trends, to assess risks, to make choices, to educate users members, controls processes in real time, users can access it at any time via mobile devices. Only a decade ago, this ERP possibility dreamed its biggest supporters and enthusiasts who had a vision of the development of ERP.

2. ERP IN SERBIA

Make a virtual case, and as a place of events we choose Serbia. We got to test two modern hybrid cars, both have navigation, automatic pilot, telemetry control. Vehicles should be driven the distance between point A and point B through the morning rush hour. The first vehicle drives a driver who is a foreigner and does not know road but knows all the functions of the vehicle, and the other driver knows the road and believes it will win because he has won before in the local rallies.

The final result of this case, is that the first driver reach the goal before the second convincingly without any problems, while others had big problems and even thought about quitting, with constantly commenting that he would be faster with his old car. ERP users have a similar impression of ERP in Serbia.

What is really behind this? According to the European Commission, the backbone of the European economy are SMEs. Serbia has the largest number of employees SMEs, too. Geographic distribution of manufacturing companies has changed in the last 20 years. Large enterprises have been extinguished or slowly dying out, small and medium were formed by taking part in its segment. Most often, it was the same product lines, quite often with the same people and equipment as the large enterprises. Large enterprises were placed in towns, thus employees in addition to achieving tangible wage they have cultural and educational progress where employees are actively involved in social community.

With disappearance of large enterprises, small and medium-sized enterprises are created in rural areas, which were suitable for building new facilities or the adaptation of existing ones because it is agricultural land turned into a building land. Such SMEs exclusively depend on the awareness, vision and good will of the owners to develop their business. However, the owners of these small and medium-sized enterprises often do not have explanations for situations that are happening to their businesses. ERP system is one of those situations. It very often happens that the owners of small and medium-sized enterprises informed themselves from informal sources that there is a system that will handle warehousing issue. They bought the cheapest ERP that are found on the market, or at someone's recommendation expecting a miracle, also they set the cheapest workers as operators because their informal sources says that "the ERP system is so simple that anyone can work in it." However, the truth is somewhere on the opposite side.

3. ERP IN SERBIA AND WORLDWIDE

Observing at the progress of ERP in modern societies, modern economies, we see that ERP systems are quite advanced from its initial applications. Where Serbia arrived in the implementation of achievements that an ERP system can offer?

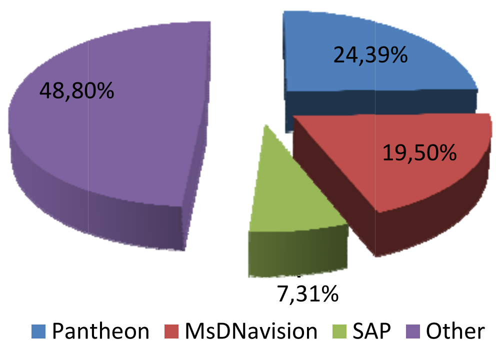

Figure 1. Research 2013 for doctoral studies, the distribution of ERP in Serbia

This issue Department of Industrial Engineering deals since 2012. The survey of 2013 (Figure 1) founded that in Serbia the most popular ERP System with 24.39% is Pantheon, followed by MsDNavision with 19.5%, SAP with 7.31%, and almost half of the respondents have some other ERP usually it is a domestic vendor.

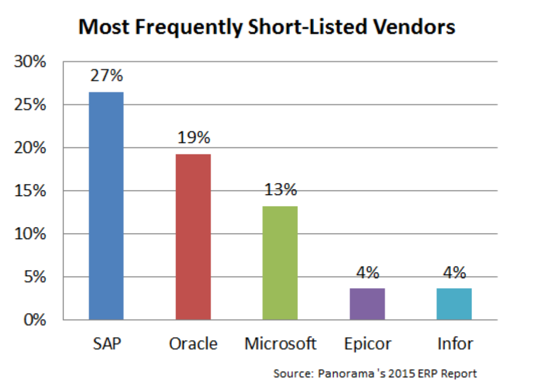

Figure 2. Distribution of ERP in the world [3]

A recent survey conducted by the consulting company *Panorama Consulting Solution* in 2015 (Figure 2.), the most common ERP in the world, with 27% is SAP, Oracle 19%, Microsoft 13%, 4% Epicor, Infor 4%.

However, not all implementations of ERP systems in the world are successful. Figure 3 shows that 58% were successful implementations, 21% failed, and 21% neutral or those where respondents are not confident in the success of the implementation.

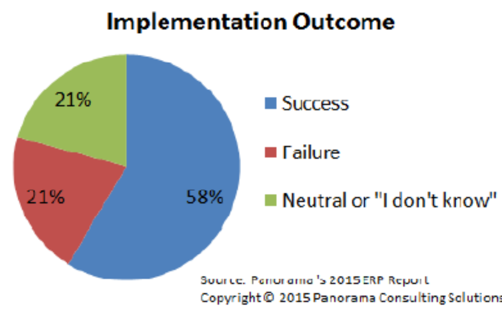

Figure 3. Implementation outcome in the world [3]

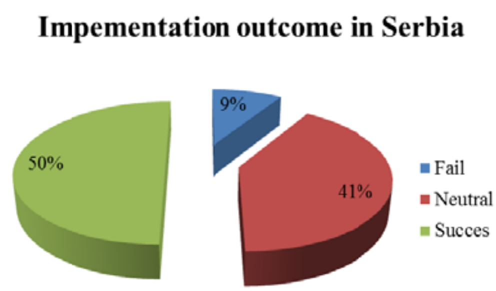

Figure 4. Implementation outcome in Serbia

According to research by the Department of Industrial Engineering (Figure 4) in Serbia successful implementation was 50%, neutral 41% and 9% failed.

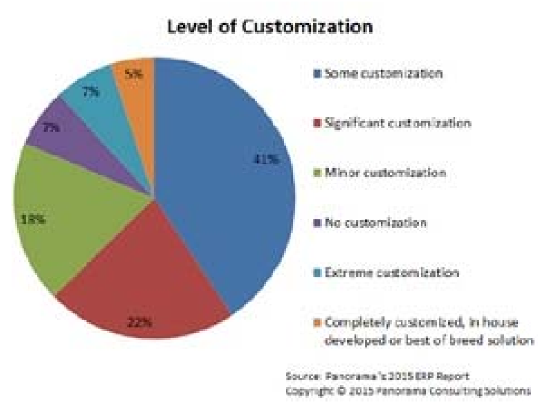

Figure 5. Level of ERP customization in the world [3]

On Figure 5. we can see how much ERP customize in the world, and Figure 6 in Serbia. When implementing, the practice has shown, that it is necessary to perform a specific customization of ERP to comply with the organization.

Figure 5 shows that significant and very small customization represent 63% of customization while Figure 6 shows that extreme, significant, above expect, more then average and average makes 69% customization in Serbia.

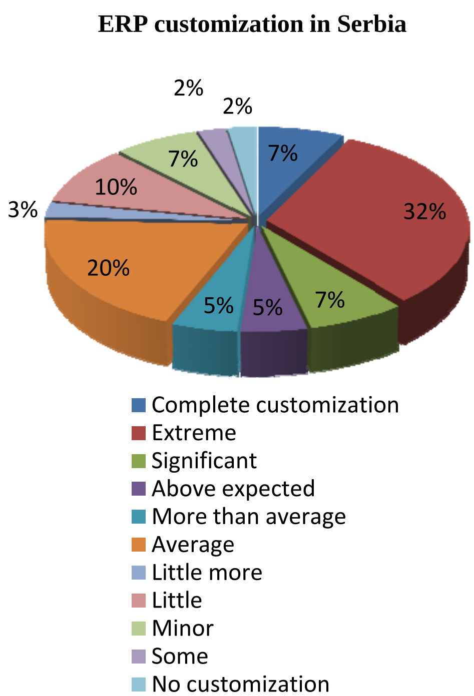

Figure 6. Level of ERP customiazation in Serbia

4. EXAMPLE OF APPLYING CLOUD IN SERBIA AND WORLDWIDE

To show how much we follow world market trends we compared the company in Serbia that use cloud services to enterprises in the world. Companies in Serbia that use the Internet and cloud service in any form of business are 3.80% (Figure 7), while the world just for the hosted and off-site use of cloud, ERP software uses 11% (Figure 8).

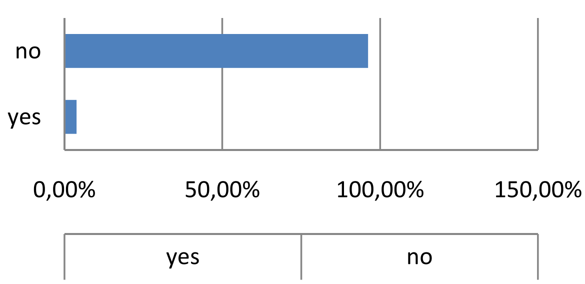

Figure 7. Serbian companies that use cloud in 2014, the source of the Serbian Republic Agency for Statistics [2]

The reasons for such little use of cloud in Serbia, the respondents stated that the high cost of these services 24%, security risk 21%, lack of knowledge about cloud 19%, law insecurity 14% (Figure 9).

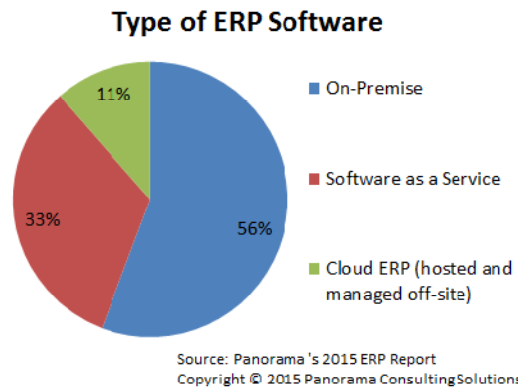

Figure 8. Type of ERP software in cloud in the world [3]

As reasons for non-implementing ERP in cloud respondents cited lack of information about services provided by the cloud 40%, other reasons 30%, security risk 20%, the risk of data loss by 10% (Figure 10).

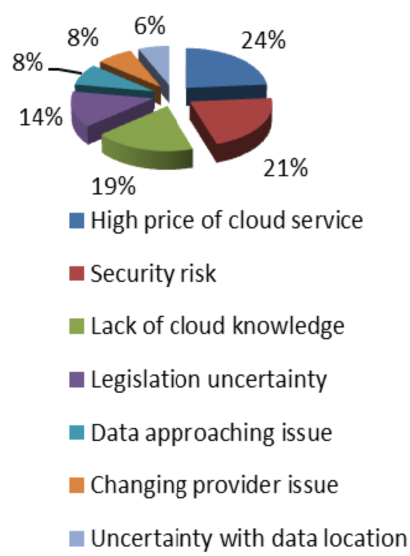

Figure 9. Reasons for not using Cloud in Serbia, source Serbian Republic Agency for Statistics [2]

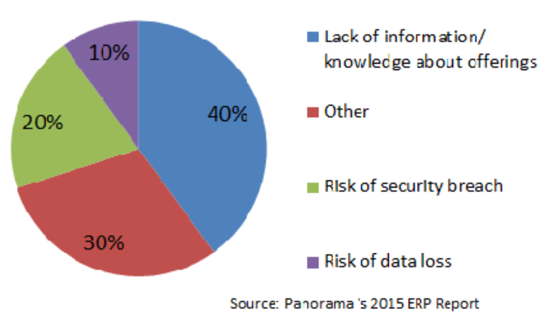

Figure 10. Reasons for not Implementing ERP in Cloud [3]

5. CONCLUSION

Comparing presented results of those surveys it is clear that the Serbian market in the segment of ERP applying greatly differs from the world market. Market size (7.5 million people), determines the need for ERP (Figure 1). The price and quantity of data to be processed are defines Serbian buyer to ERP to smaller local vendors rather then large and robust ERP system. The success of the implemented ERP (Figure 4) indicates that a large number of enterprises are not sure of the success of the implementation. This shows the insufficient use of the ERP system potential.

Analyzed level of ERP customize, indicates that the Serbian organization not ready to accept technological innovation in business such as ERP.

The comparative analysis of using cloud in Serbia and the world, beside the price, which represents the biggest barrier to Serbian companies, lack of knowledge about the cloud is an indication that modern technologies are advancing rapidly and that Serbian companies have to invest in employees training and in the education of owners to keep up with world technologies and survive on the market. Since the use of ERP in the cloud observing the world situation at the beginning (Figure 8.), there are chances to reach this gap. To achieve this, it is necessary to eliminate the reasons relating to knowledge of the cloud, bring new laws and resolve infrastructural problems.

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SOFTWARE INFRASTRUCTURE FOR GLOBAL PRODUCT ENGINEERING

Svetomir Simonović
Ph. D., Technical College, Visoka tehnička škola, Bulevar Zorana Đinđića 152a, 11070 Novi Beograd, e-mail:svetomir@sezampro.rs

***Abstract*:.** *In order for Engineering in global circumstances to be possible it is necessary for the process to have strong informational basis. It seems that existing informational infrastructure expressed through internet technology and existing 3D CAD application can be efficiently used under supposition that lightweight data formats and procedures are developed. Desirable properties of the lightweight data technology are enumerated and the MAN example presented .*
Key words: *Lightweight Technology*

1. INTRODUCTION

Due to the combination of a global work force, global production and development resources and a need for speed, the technology of the information systems must be appropriate. The collaborating information systems must be integrated and able to gather, process, distribute, and share data quickly. Commonly, a common design database enables a global "concurrent" engineering process, i.e., various departments at essentially the same time, come together from the very beginning of the design phase even if globally dispersed, as is depicted at Figure 1. These impose considerable expectations concerning data formats and efficiency of software used [1,2,3,4,5].

Using piles of drawing is not anymore the only product data storage and exchange solution for companies that collaborate in the product design stage, internally communicate or make contracts with their suppliers and, as a result of using 3D CAD software, is continually replaced by exploiting of 3D electronics models [6]. However, thereby, the problem of interoperability between various CAD systems is arising, which incite companies to squander considerable amounts of time and oney resources making an effort to cope with the problem **[7]**. Especially, interoperability problems appear in the course of the moving of 3D CAD models created in environments of one 3D CAD application to another application 3D environment, or between various versions of the same 3D CAD application. Although this effort is assisted by classical technologies, such as IGES and STEP, these formats carry an overhead with them due to robust geometry representations that yield a large file size.

In addition to the problems created by data formats that differ from originating CAD data format, frequently it is not permissible for an organization or a department to expose the native CAD files to other organizations or other departments. So, it is necessary to provide customers (both internal and external) with the information they need without compromising the security of the information contained within the CAD model [8].

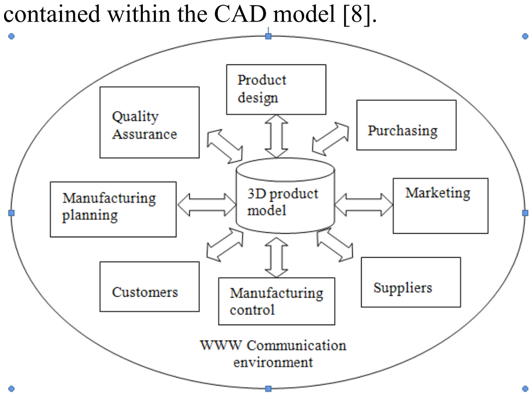

Figure 1. Globally integrated Product Engineering

Also, if native file formats are used, problems of portability and scalability appear with companies that design and manufacture exceptionally large objects, whether regarding geometry scale of objects or their complexity. So, in order to support distributed design collaboration, current software providers strive to establish its 3D CAD applications on more recently appeared file formats. The main reason is that these file technologies are capable to store product information in a lightweight, 3D format, which is not feature of IGES and STEP technology.

2. DRAWBACKS OF CLASSICAL 3D CAD

Classical 3D data comes with a considerable problem, namely, the high costs needed to generate it. Classical 3D CAD is very expensive. Compared to 2D data, classical 3D CAD data is difficult to handle because of the extra dimension of depth. Classical 3D CAD also requires time and money to learn. Especially, classical 3D CAD data cannot easily be shared on the network and classical 3D CAD systems to read the data are very costly and sofisticated, and thus cannot be made widely affordable to potential users.

In classical 3D CAD, parts can be designed by various designers, and the assembled product that is displayed can be composed of a lot of parts, so, data volume can be massive. Typical examples are the automobile and airplane industries, which use high-end 3D CAD systems where data volume is reportedly 20 Gigabytes for cars, and 5 Terabytes for airplanes. Unfortunately, classical 3D CAD is unable to display such enormous data. When data volume to be displayed reaches the level of several hundred megabytes, the display response of the classical CAD declines noticeably. Usually, an industrial machine is consisted of 3,000–5,000 parts, and devices like a printing or copy machines comprise about 5,000–8,000 parts. Reportedly, if the number of parts exceeds 5,000, the display response of classical CAD drops drastically. Obviously, at such an huge data volume, real-time data sharing on the network cannot be done. However, lightweight 3D technology successfully solves this problem. According to reports, some lightweight applications allow 3D CAD data exceeding 10 Gigabytes to be displayed.

Existing CAD/CAM systems are made to work together through format conversion. Internally, each application works independently and uses its own data representation. A typical model of global engineering design implementation is a star-shaped structure with a network database as the central node (Figure 1). One problem of this implementation is that each of the existing CAD systems usually uses a different data format. So, data format conversion between each CAD system and the central database is necessary. Sometimes, manual augmentation of the product design is applied to obtain extra information required for a particular application. Standard data formats, such as Initial Graphics Exchange Specifications (IGES) and Data Interchange Format (DXF), are used to store models in the database. [3,4] For example, the CAD design may contain only points, lines, and arcs in the model data a while the CAM system needs to know the width/length/depth of a slot that is not available from the part design explicitly. Such information has to be available in a format that can be used by a CAM system. This heterogeneous approach can easily integrate various existing components. It does, however, build barriers against a full implementation of the global product engineering concept [5]

When part interference is to be checked by classical CAD, it is necessary to remove irrelevant parts from the CAD layout in order to be able to generate the 2D images and cross-sections and to visually check the cross-sections. This leads to human error problems such as overlooked interferences and extra man-hours needed. Lightweight technology resolves these problems by automatically detecting all interferences taking into consideration complete CAD model [2].

3. LIGHTWEIGHT STATE OF THE ART

Lightweight 3D which can express large volumes of 3D data lightly and accurately is growing in importance. Since most of the popular PCs are 32-bit systems, technology to display large volumes of 3D data on these 32-bit PCs is important. Consequently, lightweight formats have emerged that can display large volumes of 3D data on standard PCs. So, the value of the existence of lightweight 3D data has increased more and more in companies. The cost-performance of individual projects is said to depend heavily on the accumulation of IT assets and degree of use. In other words, companies with a solid IT infrastructure will earn greater profits from these projects than companies without such infrastructure.

Leading CAD vendors in Europe and the USA who have realized the usefulness of lightweight 3D data are also starting to move into this area.

Dassault Systemes of France licensed XVL technology from Lattice for a lightweight 3D format 3D XML. Dassault Systemes' 3D CAD software, CATIA, is extensively used in the automotive and aero-space industries.

At the same time, UGS of the USA is promoting a lightweight 3D format called JT. JT includes both polygon data for display and precision data for CAD data exchange.

The largest PC CAD company, Autodesk, promotes a format called DWF for displaying lightweight 3D polygon data. Such CAD companies promote their respective formats using engineering-type applications.

In 2006, Adobe entered the market with 3D PDF (Portable Document Format). PDF is a very popular document format for distribution. 3D PDF adds

Universal 3D (U3D) to PDF. U3D is a lightweight 3D format developed by Intel, Adobe, and the 3D Industry Forum, which includes Lattice. Support for U3D enables 3D PDF to display 3D models in PDF documents. The first version of U3D format employed polygons (triangles) to represent geometry. Its advantage is the capability of quickly displaying geometry on computers. Its drawback is that a lot of polygons are needed to accurately represent smooth 3D CAD surfaces, and that makes the file sizes of polygon-based formats very large. The goal for a lightweight 3D format is to have high accuracy with small file sizes, and companies are engaged in technological competition over this.

As to international standards, they are not always successful in the world of 3D. There have been many graphics standards like CORE, GKS, PHIGS, VRML, and X3D that have not taken off as anticipated. This may be due to the intense development of the technology; by the time standards are established, they quickly become obsolete. In software arena, as long as the data can be converted from one format to the other, applications will be able to read it. Consequently, the core of the problem of using lightweight 3D lies not just in the data format, but also in the applications that use the 3D data.

4. DESIRABLE PROPERTIES OF LIGHTWEIGHT DATA

Following desirable properties of lightweight 3D technology can be enumerated:

- Light 3D application should allow creating 3D data incorporated into HTML files. It would eliminate a need for a separate viewer to open a 3D file and can be effectuated by integrating the evolved 3D lightweight technology with XML.
- The format and associated software should be structured so that extremely large numbers of components can be quickly loaded, shaded and manipulated in real-time.
- The resulting multi-CAD assembly should be managed such that changes to the original CAD product definition files can be automatically synchronized with their associated files resulting in a multi-CAD assembly that is always up-to-date.
- It could be used for Digital mockup (DMU) work, which allows engineers to validate that a product can be assembled together without interferences long before a physical prototype could be produced.
- This "spatial validation" should be enabled by precise measurements and cross-sectioning as well as sophisticated clearance/interference detection.
- Leveraging lightweight formats for digital mockup should allow users to reduce or eliminate costly physical prototypes and decision-making should occur much earlier in the development process.
- It should support the interactive display of very large assemblies (i.e. those containing multiple thousands of components).
- The lightweight file format should be capable of storing an arbitrary number of faceted representations with varying levels of detail (LODs). For example, when the whole product is displayed on the computer screen the hosting application should display only a general, crude view of the model. However, as the user enlarges a particular area of the model, correspondingly finer representations should be loaded and displayed. Over time, unused representations should be unloaded to save memory.
- The data model should be capable of representing a wide range of engineering data. This data should span the broad range from utterly lightweight data representation, containing no more than facet data or it should be full fledged, including geometry representations in strict accordance to NURBS together with product attributes, product structure, meta data and Product Management Information. It should also provide for multiple tessellations and be capable of displaying various levels-of-detail.
- It can be used as a CAD interoperability format for exchanging design data for Collaborative Product Development, where lightweight files are created by translating data from various CAD systems
- It should be suitable for internet collaboration. Collaboration based on lightweight data should allow organizations to send lightweight visualization data to concerned parties much more easily than sending the corresponding classical CAD files. Also, real-time, on-line collaboration should be encouraged because the volume of across the internet communicated 3D data is reduced.
- It should provide an inherent security feature such that intellectual property does not have to be shared with inappropriate parties.
- It can be used in animations
- It can be used in renderings
- Lightweight technology should be capable of performing clearance checks. It should be able to calculate interference in large models without having to subdivide the data each time.
- It can be used on handheld devices. [2,3,4,5,6,7,8,9,10,11,12].

5. THE EXAMPLE OF MAN NUTZFAHRZEUGE

An example of applying lightweight 3D technology is MAN Nutzfahrzeuge’s adoption of XVL lightweight technology. MAN had a company-wide product data management system (EZIS), in which it on a regular basis stores XVL data. When a CATIA file is referenced in the system, a corresponding XVL file is automatically generated and stored in EZIS. XVL tool named XVL Studio is used for product design and viewing of designed products is enabled by 3D XVL Player that is installed on nearly every company`s PC and is also used for viewing and discussion with suppliers and customers, etc. In order to avoid network transmission of CATIA files which contain important design information, MAN sends XVL files or IGES files converted with XVL Studio to other parties. For the sake of security, instead of sending high accuracy CATIA files, MAN transmits XVL files with appropriately diminished accuracy. The users of the system can also choose other type of the output as is a HTML page by using a tool named "XVL Web Master". MAN utilizes XVL as a communication means in all processes. To achieve this, the company established a system that ensures that staff requiring 3D data can access XVL easily. MAN is planning to totally eliminate use of 2D data for the purpose of QA and to use XVL based 3D data for better dimensional and geometrical verification of the product and in order to significantly reduce QA information exchange time, both in internal and external communications. Having intention of exploiting the XVL flexibility, MAN also plans to output 3D PDFs in Adobe format for the sake of technical illustrations. As to the assembly instructions MAN is planning to display XVL based animated instructions to eliminate the time and labor required for preparing static images for visibly clearer and faster on-the-job guidance and training [2].

6. CONCLUSION

Software infrastructure for global product design can be organized as combination of classical and lightweight 3D CAD system in following manner: Units which job is to generate, update or change 3D data, such as the design department, should carry out 3D design activities on classical CAD systems. However, entities that only need to review ore use 3D data will have exceptional benefit if apply lightweight data technology for the following three reasons:

1. There is no need for expensive PCs
2. No sophisticated training required
3. Data can be efficiently exchanged via global network

Departments such as production technology departments, factories, quality assurance departments, service departments, maintenance departments, marketing departments, and suppliers mainly just need to display lightweight 3D data and exceptionally to use some of the desired functions of lightweight data technology previously enumerated. So, creating an world wide web environment that allows these departments to access and view lightweight 3D data is all that is needed to start using 3D data throughout the global enterprise.

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PROCESSOR SYSTEM ARCHITECTURES AND SECURITY

Zlatko Langović[1], Brankica Pažun[2], Duško Tomić[3]
[1]Faculty for Business Studies, Megatrend University, Serbia
[2,3]Faculty of Engineering Management, Alpha University, Serbia

Abstract. *There has been intensive development in telecommunications, financial services, industrial complexes. The system development is enabled due to hardware and software, as well as cloud computing and mobile systems development and data center. The importance of processor is huge because these devices i.e. computer systems represent the base for developing all layers of a modern information system. Future trends in processors developing are defined in the form of an improvement of CISC and RISC concepts and their synthesis into SoC platform. Security technologies implemented in processors- enable better security functions in information systems. This paper presents development of security technologies and processor architectures, and their impact on business information system.*

Key words: *AES, ARM TrustZone, HSA, x86*

1.INTRODUCTION

CISC and RISC architecture concepts represent a challenge for companies engaged production and development of processor technology. These concepts appear in the form of X86 and ARM architecture.

New solutions developing is defined through integration in the form of multiple cores on the same platform, SoC systems. In a given SoC platforms are implemented HSA (Heterogeneous System Architecture), GCN (Graphics Core Next Architecture) and CUDA (Compute Unified Device Architecture) subsystems that generate stronger processor architectures.

Due to achieving information system full potential, ther is necessity of existing high-quality security and energy efficiency.

Security technologies implemented in processors of major companies are: Intel TXT and Intel AES-NI, Intel Virtualization Technology (Intel VT), Trusted Execution Environment (TEE) and ARM TrustZone features.

2.TRADITIONAL PROCESSOR ARCHITECTURES – CISC AND RISC

According to the second quarter server shipments, Gartner figures for 2014, the revenue from x86 servers grew by 12.7% in Europe [4].

Intel-represents the idea about implementation of traditional x86 and achieving low power consumption with optimal capabilities sustention.

Intel has introduced line of Intel Xeon processor products D [5], which brings Intel's first system-on-chip (SoC) based on the Intel Xeon processor. Multi-core processor is implemented in the form of a SoC (System-on-chip SoC).

The line of products Intel Xeon processor D is based on the latest Intel 14-nanometer technology. Characteristics of SoC systems are small dimensions and low energy consumption.

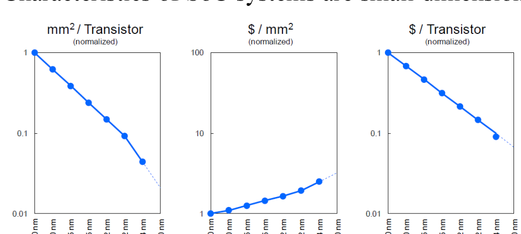

Fig.1. Cost per Transistor (Source: http://www.intel.com)

New Intel Pentium M [5] chip with a new 14-nanometer technology i.e. x86 processor, has better performance and lower energy consumption. Application of Intel M processor could be seen in cloud computing, IoT (Internet of Things), personal computers and mobile devices.

Zen, the name of the new high-performance processors, belongs to AMD. [7] This processor has one cluster for integers processing. Processor allows "deeper" pipelining and stronger effect during single-threaded tasks execution. Increased number of kernels improves parallelization process properties.

Due to AMD data, given processor has two 256bit units that enable better execution of 512b's tasks with numbers with floating point. These characteristics allow execution of relatively simple tasks in smaller intervals.

Optimal use of RISC system is now in data centers and mobile systems.

The phenomenon that is increasingly present in the business environment is IoT which generates a large amount of data that need to be preserved. This need for keeping data foregrounds data centers.

IoT market, including hardware, software, services and security, will increase from $1.3 trillion in 2013 to $3 billion in 2020, IDC predicts by 2018, 40% of the IoT-created data will be stored, manage and analyze near, or on the brink of a network. [8]

Processors with ARM architecture enter the market of server machines.

Samsung as processor manufacturer, uses ARM matrix. Processor is made in 14-nanometer technology. Unlike its predecessor, the processor 22 or 20 nanometer technology, the new processor has smaller dimensions and greater efficiency. [10]

Market analysts expect the ARM processors share of 20% of server shipments by 2019. [9]

3.CONTEMPORARY PROCESSOR ARCHITECTURES

New processor solutions appear in merging form of CPU and GPU on a single chip so-called SoC system. AMD has started applying this concept in Fusion processors line [6], while Intel has implemented given graphics resources in line Westmere, Sandy Bridge, etc. [5]

The main advantages of this integration is simplicity and graphical resources availability (for server machine) without adding graphics devices, which increase consumption.

This configuration can support desktop virtualization, perform redering video material without environment help. This group includes two processors: Xeon E3 [5] and AMD Opteron X. [6]

Given integration could improve graphics functions to some extent, toward low energy consumption and financial investment. GPU isolated on the graphics card does not overload computer resources, but investments are higher, with increase in energy consumption.

AMD has developed an architecture HSA (Heterogeneous System Architecture) [12], which allows developers to address "any" processing unit, and do not have to write separate sets of instructions, for CPU and for graphics subsystem. For example, different sections of the processor hardware (mostly CPU, GPU) are able to address shared memory.

HSA Foundation defines development and standardization process. This organization develops software tools at the API low level due to more productive implementation of mentioned concept. API is defined by HSAIL (HSA Intermediate Language), which allows developers writing code in appropriate higher-level programming language. Compiler translates code into HSAIL, while HSA working environment generates corresponding binary code.

AMD has developed a range of tools ie. development libraries and APIs, with the purpose to provide HSA utilization in Java, C++, OpenCL, C++ AMP, C#, OpenMP and Python, according to optimal hardware resources usage and energy savings. [16]

Nvidia CUDA (Compute Unified Device Architecture) technology presents a similar technology. Given system includes PTX function (Parallel Thread Execution). [7]

CUDA performs only on Nvidia graphics cards, while HSA belongs to open technology claster.

There has to be mentioned attemptation of two systems CISC and RISC processors integration on a single chip, defined in Skybridge project [6] [13]. This project was officially abolished recently [14].

AMD solution, Skybridge, allowed integration of technology HSA with ARM core and X86 core on the same platform (SoC system). Two chips use compatible interface that enables common memory controller usage, PCIe interface, the cache structure, with implemented HSA system, with the same I/O standards.

AMD has presented Carrizo, the new AMD APU. Improving could be seen in new x86 Excavator processor cores combined with GCN (Graphics Core Next Architecture) GPU. HSA technology has been integrated in the chip. Given subsystem combination enables better product performance. This is the first AMD SoC processor designed for mobile PC market. [6]

AMD announced the new APU product that includes Zen core and graphics unit, codenamed Greenlend. It is assumed that this APU would own HBM (High Bandwidth the Memory) subsystem, as well. This platform has four channel DDR4 and PCI 3.0. Support for DDR4 has ECC with speeds up to 3200 MHz, with total capacity of 256 GB per channel. Each core has 512KB L2 cache. Each cluster of four Zen cores share 8MB L 3keša. Graphics performance are up to 16 GB HBM memory and flow about 512 MB s. Given chip can consist of 16 Zen cores, while server version can have 32 cores. [15]

4.PROCESSOR SYSTEM SECURITY

Security companies have become particularly important in today's development of ICT technologies, ie. Cloud technology, Open Daylight, NFV, SDN, etc.

Stuxnet is malicious software discovered in 2010 and designed to attack the PLC (programmable logic controllers industrial) systems [17] [18].

Today data is transfered through an unknown cloud system, and mobile device users move out outside of the secured corporate space, etc. Data movement in this environment creates necessity for higher quality security levels. Intel creates new products with improved security for potential users. Intel's solution are: Intel Xeon processor E5 family and Intel Xeon E7, providing new levels of hardware security capabilities. Due to enhance security at the company level as well as in Cloud systems, Intel has developed a number of options.

Intel Platform System Protection Technology with Intel Trusted Execution Technology (Intel TXT) defines software component integrity that is hardware based. This system enables increased safety in virtualized workload managing.

Function Intel Data Protection Technology with Intel Advanced Encryption Standard New Instructions (Intel AES-NI) strengthens data protection. Intel AES-NI enables secure transfer through decryption. Intel Data Protection Technology with Intel Secure Key provides additional data protection due to creating high-quality keys for cryptographic protocols.

Intel Virtualization Technology (Intel VT) increases security of hardware-based Cloud infrastructure through isolation of virtualized workload. [5]

Advanced security features implemented in Intel TXT and Intel AES-NI improve information system security, as well as Cloud structure safety.

Smart phones and tablets provide large set of services for consumers. To realize their full potential, mobile devices require not only energy efficiency and performance, but safety as well.

ARM operates with its partners and standardization organizations due to simplier and faster platforms and devices development with security features based on TrustZone technology. As a part of this initiative, ARM has created TrustZone Ready Program, designed to simplify the development of chipsets and devices with hardware-supported system Trusted Execution Environment (TEE). [11]

ARM technology is built into millions of smartcards and SIM devices. Central components of given devices are the SecurCore subsystems which allow flexibility and traditional microcontrollers programming.

Strong protection has a family of Cortex-M processors. This system provides cryptographic protection, security, storage and professional entropy sources, such as random number generators, partners are already enabling a secure Internet of Things.

AMD generates a dedicated AMD secure processor implemented in the corresponding AMD Accelerated Processing Units (APU). ARM TrustZone, technology with system approach, operates at higher hardware layers, creating safe environment and sharing the CPU setting to two virtual “worlds”. this response tasks are active in the "secure world" standard operations are active in the area "Normal World." Given technology ensures the security of sensitive data, that is, applications. With this system provider services, ie. business system key resources are protected. [6] [19]

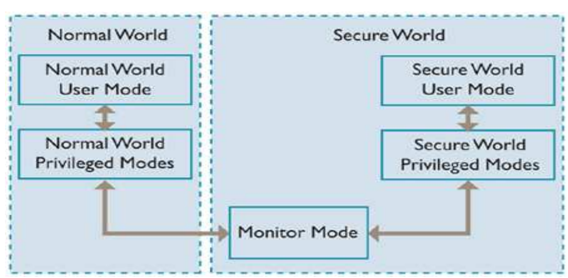

Fig.2. TrustZone (Source: http://www.anandtech.com/show/6007/amd-2013-apus-to-include-arm-cortexa5-processor-for-trustzone-capabilities

5.CONCLUSION

Processor system development takes place in several directions. Traditional architectures continue to live in the form of x86 and ARM concepts. Leading companies develop given systems in sence of better performance, energy consumption and security features. The 14-nm technology is commercialized with tendency of decreasing value in the future. ARM enters the server machine market, while x86 in the field of mobile systems. The new approach performs existing concepts' synthesis into a heterogeneous system, as SoC platform. Given platforms require new HSA, CUD and CNG architectures, which enable system managing at higher programming level. Security processing functions fulfill security services of various business systems, for example, banking systems and telecommunication companies, industrial complexes, etc. They reduce system complexity and energy consumption, as well. Development of processor architecture ie. security functions enables information system development. Further, information system development leads to business system development, characterised by less costs and higher productivity and efficiency.

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THE AGILE APPROACH IN INDUSTRIAL AND SOFTWARE ENGINEERING PROJECT MANAGEMENT

Miloš Jovanović[1], Bojan Lalić[1], Antonia Mas[2], Antoni-Lluís Mesquida[2]
[1]Faculty of Technical Sciences, University of Novi Sad, Serbia
[2] University of the Balearic Islands, Department of Mathematics and Computer Science, Palma de Mallorca, Spain

Abstract. *The paper presents the agile approach in industrial engineering and discusses similar ways of agile development in different disciplines. Societal changes and technological innovation brought significant changes in the market, leading to highly demanding users and frequent changes in product design. Agile is implemented in different disciplines as a response to current changes in the market. Industry 4.0 as part of "High-Tech Strategy 2020 for Germany" involves agile principles and brings latest technological trends in production process. Agile framework was firstly used in manufacturing but along with that it started to develop as a lightweight framework in software development. Agile is interdisciplinary and brings flexibility to organization. For successful implementation of agile principles, experiences and recommendations from all the industries should be used.*
Key words: *Agile manufacturing, Industry 4.0, Agile software development, Project management*

1. INTRODUCTION

Dynamic business environment and mass customization have led to changes in the production companies, and implementation of agile manufacturing systems is evident in last decades. On the one hand highly customized products requested by the clients, and on the other hand offered from the producers, caused a change from mass production paradigm to agile manufacturing [1]. The main driving force behind agility is change [2]. Nagel and Dove introduced the concept of agile manufacturing in their report [2][3] and they noticed that this theory came as response to dynamic business environment.

Throughout the years manufacturing has changed significantly. After the Second World War in the 1950s production was rigid with little flexibility with aim to produce as many products as possible at the lowest price. After that, in the 1980s quality was additional variable that should be considered and Total Quality Management (TQM) was introduced in the production. After that, competitiveness, integration and proactivity was in the focus and agile manufacturing came as a logical continuation to cope with mass customization. Normally, society was impacted by industrial change, but in the case of current changes in manufacturing it can be discussed that it is vice versa and that current social habits and needs in the society push industrial production to the next level and transformation. Use of new technologies brought more demanding needs of the customers arising from different social trends like use of social networks and smart devices [4].

Similar trend may be observed in the IT industry and software development. In the late 60s and 70s different project management associations and communities of practice have emerged (PMI, IPMA, PRINCE2) thus creating recognized standards to be used for managing projects. Software development process is project based, and definition of standard processes to be performed in project initiation, planning, implementation, control and closing was a very important step in this field. Projects in manufacturing, IT or any other industry were at that time (in 1970s) predictable, requirements were not changing rapidly and plan driven (standard) project management methods were used very well in the given business environment. Similar to introduction of Agile Manufacturing in some production companies in the IT industry Agile Software Development was introduced. Fundamental principles underlying agile manufacturing and software development are basically the same and experience and ideas from one can be applied to other.

2. TRADITIONAL PROJECT MANAGEMENT

A project management methodology is a set of appropriate repeatable processes that help introduce consistency, flexibility and efficiency while improving quality in managing an enterprise's (or department's) projects. It typically consists of process descriptions, templates, roles and responsibilities, life cycles and work breakdown Structures, together with other support information [5]. Three traditional project management frameworks are most widely used in practice and they will be introduced in this section.

The leading non-profit professional association in the area of Project Management is Project Management Institute (PMI®) founded in 1969 in the USA. PMI provides global leadership in the development of standards for the practice of the project management profession trough his standard document, A Guide to the Project Management Body of Knowledge (*PMBOK Guide*), globally recognized standard for managing projects in today's marketplace. In 1999, PMI became first organization in the world, which has its Certification Program attain International Organization for Standardization (ISO) 9001 recognition. PMI's Project Management Professional, known as PMP, certification is the world's most important industry-recognized, truly global certification for project managers.

PRINCE 2 is acronym for Projects IN Controlled Environments. It was established by The Central Computer and Telecommunications Agency in the 1989, and the UK Government uses it extensively. PRINCE 2 does not describe the techniques and approaches that a project manager can use to produce and accurate estimate. This is left to the PMBOK Guide, which describes in detail the different estimating techniques that can be used, so those two approaches are in fact complementary.

IPMA is acronym of International Project Management Association and it is a non-profit Swiss-registered organization headquartered in Amsterdam, Netherlands. IPMA is the world's first project management association, which actively promotes competence in project management for individuals, project teams, businesses, organizations and government agencies.

3. AGILE SOFTWARE DEVELOPMENT

Agility can be defined as the ability to create and to respond to change in order to create value in turbulent business environment. It is based on several business principles like continuous innovation, product adaption, shortening delivery times, adjustment of people and processes, and getting reliable results [6]. Therefore, it is common to say that agility is also the ability to balance between flexibility and stability.

Agile trends are very important today; so much that even Project Management Institute created new agile based exam in their certification program, The PMI-Agile Certified Practitioner (PMI-ACP). According to PMI, this is the fastest growing certification, which spans many approaches to agile such as Scrum, Kanban, Lean, eXtreme Programing (XP) and Test-Driven Development (TDD). PMI market research shows that Project Management practitioners are embracing agile principles as a technique for successfully managing projects [7]. Adaptability is the key characteristic of agile approach even more important than predictability, which is the basis of the traditional approach. Change is inevitable, so new approaches embrace changes and acknowledge that it is almost impossible to create complete project plan at the beginning of the project [8]. Agile approaches are more about communication and collaboration between project team members, not only about pure process following. Therefore, team members are more involved in decision-making. From 2001, with creation of Agile Manifesto, agile approach has gained more significant visibility and in this document core values and twelve principles underlying Agile are defined. Even though Manifesto was written for agile software development all of the core values can be applied almost directly to the agile project management. Core values are: individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation and responding to change over following a plan.

4. TRADITIONAL VERSUS AGILE PROJECT MANAGEMENT

Traditional approach is more appropriate for projects with clear initial requirements and clear project goals, therefore it can be said that traditional approach involves a very low level of uncertainty and for those kinds of projects are expected to have very low requirements change rate. On the other hand, projects managed by agile approach are characterized by a high level of uncertainty, unclear projects goals or incomplete and unpredictable requests and for some it could be assumed that will be significantly changed during the course of the project. With agile methods, development begins before the requirements are well defined. Also, the impact of the human factor and especially communication between project team members are more pointed with the agile approach. One of the consequences in agile project approach is the lack of documentation, so therefore, project knowledge is mainly tacit. Table 1 refers to difference between traditional and agile approach.

Characteristics	Traditional approach	Agile approach
Requirements	Clear initial with low	Creative, innovative,

	change rate	unclear requirements
Users	Not involved	Close and frequent collaboration
Documentation	Formal and required	Tacit knowledge
Project size	Bigger projects	Smaller projects
Team members	Not accentuated, distributed team	Collocated team, smaller team
Project plan	Linear	Complex and iterative

Table 1. Traditional versus Agile approach

5. AGILE MANUFACTURING

Competitive business environment forces manufacturers to continuously improve and involve new services requested by their clients and end users. Therefore, dynamic business environment and mass customization trend led to changes in the production companies transforming them from mass production paradigm to agile manufacturing [1]. Agile manufacturing is a new concept in manufacturing intended to improve competitiveness of the organizations [9].

Group of authors presented a relationship between lean (just in time) and agile manufacturing [10]. Their research shows that many authors in the field have the opposite opinion, one consider lean and agile manufacturing as mutually exclusive concepts, while others consider lean and agile as mutually supportive concepts. Lean manufacturing focus is on cost cutting and optimization of operation activities in terms of value added activities, while agile manufacturing focus on flexible production leading to agile response to customer demands. Zelenovic defined flexibility of a production system as a measure of its capacity to adapt to changing environmental conditions and process requirements [11].

Agile as a term or framework is mentioned in more areas such as: manufacturing, supply chains, business, workforce, capability, software development between others [2], [12]. Agility is referred to as flexibility of the organization or system towards external inputs, such as client demands or changes in business environment.

First industrial revolution involved mechanical production facilities in the 18th and 19th century. Following this second industrial revolution brought electrification and labor division in the end of the 19th century. Digital revolution (third industrial revolution) started around 1970s and advanced automation, electronics and IT systems began to be used in manufacturing process. Nowadays we are facing the fourth industrial revolution (Industry 4.0) which is officially recognized as a term in 2011 [13], and refers to a strategy for competitiveness for German manufacturing industry (part of "High-Tech Strategy 2020 for Germany"). According to the Industry 4.0 working group, future business will establish global networks to incorporate machinery, warehousing systems and production facilities in the shape of Cyber physical systems thus bringing completely new approach to production – embedded manufacturing systems called smart factories. This trend is also accepted and predicted by other organizations and governments: General Electric [14] presented its report on implementation of internet in production systems in "Industrial Internet – Pushing the Boundaries of Minds and Machines", US government supports R&D activities in Industrial Internet under "Advanced Manufacturing" program [15].

Industry 4.0 as a current trend in German and worldwide industry is a true example of agile manufacturing, should significantly decrease New Product Development (NPD) lifecycle and provide a solution to high demanding market requests. Group of authors made a literature review of scientific articles in this area with the aim to better define term Industry 4.0 and create ground for further applied and theoretical research [16]. In their report six different design principles in Industry 4.0 are identified: Interoperability, virtualization, decentralization, real-time capability, service orientation and modularity. Also, the four most important components in Industry 4.0 are identified: cyber-physical systems, internet of things, smart factory and internet of services. It may be observed that changes in manufacturing defined by industry 4.0 are highly dependent on latest IT technologies and that basically Industry 4.0 mean implementation of current IT trends in production companies.

6. CONCLUSION

Societal changes and development of new information technologies created fruitful ground for the 4th industrial revolution – Industry 4.0. Big data, internet of things, internet of services, social networks created new possibilities and highly specific demands of information society. This trend may be observed in process industry such as manufacturing but also in project oriented organizations. Flexible and agile approach is nowadays used in software development, manufacturing and basically any industry. Agile principles in manufacturing may be used in software development and vice versa. Practically, fundamental values underlying this change are coming from societal changes and it is logical that different industries are changing in the same way and those principles from one may be used in another. Moreover, Industry 4.0 in production is strongly reliant on new IT and involvement of big data concept in production process so it can be observed that changes that are brought by industry

4.0 principles are implemented in an agile way. In order to implement an agile framework in the organization, trends and experience from different industries should be observed and used in the best way.

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PREDICTING ENERGY CONSUMPTION USING CURRENT BIM SOFTWARE

Marko S. Jarić[1], Nikola J. Budimir[1], Igor Svetel[1*]
1 Innovation Center, Faculty of Mechanical Engineering, University of Belgrade, Kraljice Marije 16, 11000 Belgrade, Serbia
* corresponding author: isvetel@mas.bg.ac.rs

Abstract: The Building Information Modeling software accompanied with energy consumption prediction applications are recognized as technology that will help building industry to become more efficient. To test that claim we performed energy consumption simulation on the single building model using currently available BIM applications and software energy analysis tools. The results from the test runs are show significant variation, even within different versions of the same application. The paper discusses on the reasons for that variation and how that influences use of the BIM tools in the combination with software energy analysis tools.

Key Words: Building Information Modeling, BIM, energy analysis, ArchiCAD, Revit, simulation results comparison

INTRODUCTION

The building industry is under pressure to provide value for money. Two areas in the building design have been recognized as promising to achieve above mentioned goal: design and construction documentation without errors, and energy consumption reduction. In software arena the Building Information Modeling (BIM) software accompanied with energy consumption prediction applications are recognized as technology that provides necessary support in that endeavor.

Responding to that requirement, software companies developed plenty of applications [1]. The ArchiCAD and Revit are two main commercial BIM applications that both provide support for simulation of building energy consumption. The ArchiCAD uses built-in EcoDesigner application that enables designer to calculate energy consumption of the building directly in main BIM application. The EcoDesigner application comes in two versions, one that comes free with main ArchiCAD application that enables detailed energy consumption simulation, and extended EcoDesigner STAR version, that gives same results as free version, but enables custom result reports in accordance with requirements of different energy efficiency certification programs. The Revit application also has built-in Energy Analysis Tool, but also offers additional services like Green Building Studio (GBS) [2] – the web based application based on DOE-2 simulation engine [3]. In addition, until recently, Autodesk offered stand alone Ecotect Analysis application, that provided energy consumption simulation and offered diverse visualization tools that enabled designer to gain better understanding of building's energy efficiency.

Many third party software developers offer their solutions for energy consumption simulation. Among them the Riuska application [4] is the only one that uses IFC format to import building data, instead of gbXML. The core of the program uses the world-wide renowned DOE 2.1E simulation engine.

The applications are marketed as designer friendly tools that enable quick and accurate estimation of building's energy consumption. To test that claim we performed energy consumption simulation on the single building model using above mentioned energy analysis tools.

MODEL

The evaluation of the energy analysis simulation tools was conducted on the identical building model made in the ArchiCAD 16 BIM application.

The building model is the single floor family house with the outside walls made of blocks, plastered on the outside and with styrofoam insulation 5mm thickness. The total area is 213.1 m2 and the volume is 434.9 m3. Heating of the object is done with the boiler station. The 70% of the energy required is realized by using natural gas, and 30% using oil. For the analysis only the lower level of the house was considered as heated with the area of 106.5 m2 and the volume of 287.6 m3 (Figure 1 and 2).

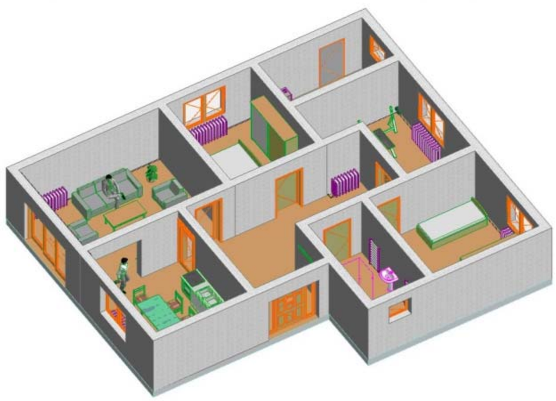

Figure 1. Axonometric view of the ground floor of the residential family house for analysis

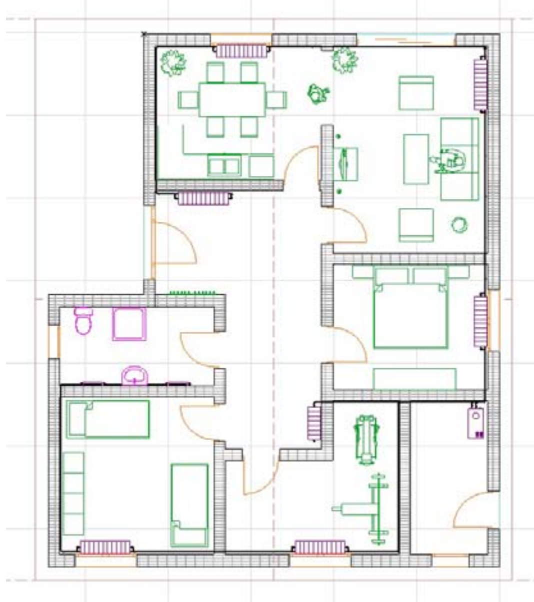

Figure 2. Ground floor of the residential family house for analysis

The tests with the EcoDesigner were performed using native ArchiCAD 16 model. Model transfer to Revit and Riuska was achieved using IFC interoperability standard format [5], and to Ecotect Analysis and GBS using gbXML file format [6]. The model modification in target applications was kept to minimum, only adjustments necessary for application to operate was performed. That way we wanted to test how applications function without detailed and specialized knowledge about each particular tool.

RESULTS

The results from the test runs are shown in Table 1 and Figure 3. It is obvious that they significantly vary, even within different versions of the same application.

Simulation software	Total energy consumption, kWh	Total annual costs, EUR
ArchiCAD 16	64215	2517
ArchiCAD 18	43576+28459	1448
Ecotect Analysis	59611	2337
Revit 2013	40564	1669
Revit 2015	51721	2129
GBS 2013	54161	2925
GBS 2015	19930	-
Riuska	45149	1779

Table 1. Obtained results

The difference in results obtained using ArchiCAD application is the result of many changes introduced in the new software version. First, since version 17, ArchiCAD introduced improved concept of building materials that accounts to more precise calculation of building element’s thermal properties. Second, the notion of thermal blocks is introduced in the building simulation model to provide more accurate calculation. And last, the whole algorithm is improved to take into account new features and to provide simulation results that are closer to real conditions in the buildings. The fact that unmodified building model is used in the new software version can explain paradoxical result that shows larger energy consumption but lesser annual cost in the ArchiCAD 18.

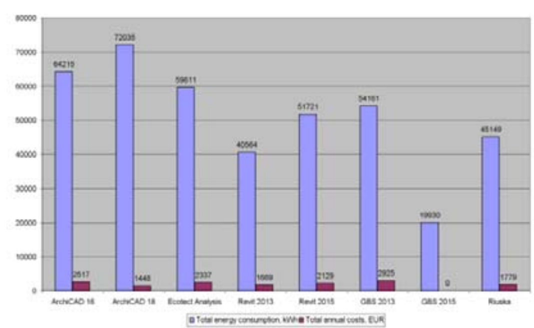

Figure 3. Chart representation of obtained results

In the case of Ecotect Analysis tool, Autodesk has decided to discontinue software development. The program was criticized because it uses not so precise energy consumption calculation algorithm that was intended for calculation by hand. On the other hand, the algorithm enabled fast calculations that, accompanied with extensive set of visualization tools, provided excellent environment for exploration on effects that particular building design can have on energy efficacy.

In the case of other Autodesk products, like built-in Energy Analysis Tool in Revit application and Green Building Studio (GBS) the information on product improvement is scarce. It is obvious that functionality of Ecotect Analysis is replaced with new functions in this software, but Autodesk also introduces new cloud based services, and it is not clear which tool provides replacement for particular functionality.

The results in the new Revit version shows consistent increase in energy consumption and annual cost that can be explained by more precise calculation engine that accounts for more parameters in the simulation. Also, it can be attributed to better interoperability between ArchiCAD and Revit applications.

The GBS 2015 exhibited most erroneous behavior. Compared to other programs the obtained result is wrongly low, and we can not obtain any result for total annual cost. The GBS application works like a kind of black box, taking gbXML file as input and providing results. When a model is imported to Revit from another application, prior to export to GBS it is necessary to establish zones in the model. The gbXML import routine in the GBS application is quite sensitive to the way zoning is accomplished, and if the file is not formatted appropriately it simply refuses import and gives no information what went wrong. So we can conclude that the new application version requires different model preparation in order to get valid results from GBS.

The result obtained with Riuska application is similar to other results. Since no information was provided on new software version we performed only one test. The main difference of Riuska is that it does not require transfer of BIM model to the simplified gbXML file format, but uses IFC model as the input file enabling designer to use full BIM model to evaluate energy consumption.

DISCUSSION

Conducted tests do not speak anything about actual precision of the application's algorithms. For that end more accurate models should be prepared. But they clearly demonstrates that simple association of the BIM tools with computer based energy consumption simulation tools does not bring about quick and easy solution for designing energy efficient buildings.

Historically, energy consumption simulation tools required three dimensional computer model of the building to generate their results. And in the era of the paper based building documentation it was requirement that hindered their use. The rise of BIM applications, that provide detailed computer based model of the building containing not only three dimensional data but also information on all physical and functional characteristics of the building components, brought about hope that merging BIM with existing energy consumption simulation tools will bring solution to the quick and easy design of energy efficient buildings. Unfortunately, as the tests show, we are still far away from that ideal.

The advances in the building model brought up by BIM applications have not been followed by the energy consumption simulation tools. They still use simplified building model as before. Since the algorithms that use simplified model have reached the level of precise prediction of the actual energy consumption, there are no reasons to use detailed model. Second, the time needed to perform calculations with simplified model is still restrictive in the case of complex models.

For that reason, it is necessary to obtain good understanding how the simplified model is created from the BIM model. In ArchiCAD and Revit applications that task is achieved using building zones. The default settings produce models that can be used to obtain energy consumption simulation but, as tests show, a precise knowledge how zones interact with building elements is necessary for accurate predictions.

Also, simple existence of the interoperability format, like gbXML, is not sufficient to establish data transfer without information loss. No rules exist to define what information is necessary to include in the gbXML file, and there is no regulatory body to guide that process. For now, in order to obtain precise results from energy consumption simulation it is necessary to have detailed knowledge what information each BIM tool includes in gbXML file, and also to know what information each simulation tool requires. The process is also complicated by the fact that each software developer introduces changes in their import and export routines in each new software version. In the absence of the regulatory body this development is often unsynchronized.

The last reason for large difference in the results obtained in the tests is the fact that each simulation tool requires characteristic information. The tools often provide default values, but obtained results are imprecise. For exact results, at this level of development, it is necessary to employ energy consumption simulation specialist who have detailed knowledge on requirements of each particular simulation tool, and also have knowledge how to obtain necessary information.

We can make question, is there any value in the ability of getting inaccurate result based on quickly generated energy models from BIM applications. While these results can not be used to make any exact prediction on future energy consumption of the building, they are still valuable aid in designing energy efficient buildings. The relative values of the results are still accurate, meaning that any increase or decrease of the results accurately shows energy efficiency of the design.

CONCLUSION

The lack of precise results, characteristic for conducted tests, is not reason to ignore link between BIM applications and the energy consumption simulation software tools. For precise results it is necessary to include professional that has good knowledge on energy consumption simulation. Also, it is necessary for building designers to know how to prepare energy model in order to achieve fruitful collaboration with energy specialist.

On other hand, designers are free to use all tools to obtain imprecise results that can be used as guides in the design process because their relative values are correct. And more the designers engage themselves in that endeavor, more they will learn about building energy efficiency and their collaboration with energy consumption simulation specialists will become more fruitful.

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PREPARING BIM MODEL FOR ENERGY CONSUMPTION SIMULATION

Marko S. Jarić[1], Nikola J. Budimir[1], Igor Svetel[1]*
[1] Innovation Center, Faculty of Mechanical Engineering, University of Belgrade, Kraljice Marije 16, 11000 Belgrade, Serbia
* corresponding author: isvetel@mas.bg.ac.rs

Abstract. *Recently, the BIM technology combined with software energy analysis tools have been promoted as the solution for energy efficient design. The paper investigates if the mentioned technologies provide effortless energy consumption simulation and finds that more development is needed to achieve that goal. By giving a quick overview of the appropriate processes for the most common BIM applications and related energy consumption simulation tools, this paper tries to foster building designers to use energy simulation tools regularly.*
Key words: *Building Information Modeling, BIM, energy analysis, ArchiCAD, Revit, model preparation*

1. INTRODUCTION

The use of computer based building performance simulation in traditional architectural design processes was hindered by the significant time and skill required to create building model for energy simulations. The BIM technology, based on rich information models of buildings containing not only geometric data like traditional CAD models but exhaustive description of all building attributes covering entire lifespan [1], appears as the proper candidate to provide missing models.

The seamless data transfer from BIM applications to energy simulation tools is complicated by the fact that simulation tools use simplified building model that represents only spaces in the building. For that reason, the BIM model needs special preparation to fit the needs of software energy simulation tools.

The paper presents model preparation process for two BIM applications (ArchiCAD and Revit) and accompanied energy simulation tools (EcoDesigner, Energy Analysis Tool, Green Building Studio, Ecotect and Riuska).

2. PROCESS

The ArchiCAD 16 comes with the built-in energy consumption evaluation application - EcoDesigner. Within ArchiCAD 16 it is necessary to create zones in the building, to be able to determine the proper surface and volume facilities required for the whole energy building analysis. From the version 17, the program requires from the user to define energy blocks, a larger building sections with same thermal properties.

In addition to this, it is necessary to include in the "Options" menu the geographical location of the object so that software can adopt automatically the appropriate climate parameters from Strusoft Climate Server or user should enter weather data manually from EnergyPlus simulation software. Finally, before starting energy evaluation software the user need to include appropriate parameters for heat generation and fuel prices.

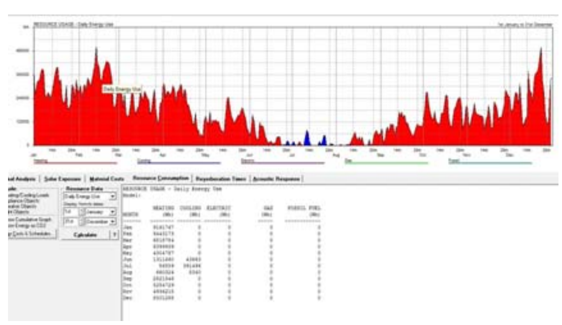

Figure 1. Report from Ecotect Analysis software

To start analysis in the Ecotect software the user also needs to make building zoning in the ArchiCAD application and then save the energy model using the gbXML [3] format. Upon importing data in the Ecotect application it is necessary to define thermal performances, material costs, solar exposure, etc.

using built-in tools. Based on all that data the application generates evaluation report (Figure 1).

The process of analyzing energy consumption of the building in Revit 2013 is carried out in several stages. After the geometrical model of the building is finished it is necessary to include all of the characteristics of the building elements. This is primarily related to the characteristics of the floor, the walls, ground, mesh, elements of heating system, air conditioning, elements of electric system, plumbing, furniture, etc.

Conducting energy analysis of object in Revit 2013 is performed using tools that are in the main menu "Analysis". This analyzer provides the capabilities to perform static, dynamic, thermal and electrical performance of the formed object. In the first stage of the analysis the zoning of the object is first carried out using the option “Zone” in the main menu. After that, using the “Space” option in the menu the space properties of each object will be determined. This way the object is fully defined in terms of the layout and dimensions of all work areas and volumes.

The actual simulation starts by selecting the option “Energy Analysis” in the menu “Analysis” and then by selecting option “Energy settings”. Using this option the user defines the object type and its location, makes the choice of the analysis level, selects building infiltration class, the type of the structure, the type of the report for the analyzes, etc. After completing this phase user should selected the “Heating and Cooling Loads” function from menu. By starting this application the user is presented with the view containing rough image of the object with zones in the left side of the window and data of the object which is to be analyzed on the right side. By selecting the option “Calculate” in this window the actual simulation starts.

Depending on the chosen geographical location the application automatically takes data on weather conditions from the Web Service, and produces a report on the necessary forces for heating/cooling facility, together with its maximum values, while depending on the detail of the report the data may be related to the entire object or for every single predefined entity.

The process of analyzing the performance of the object in Green Building Studio web software is also carried out in several stages. There process differs depending on whether the model is created in the ArchiCAD or Revit application.

The process of preparing the model created in ArchiCAD 16 for the Green Building Studio's requires third party gbXML export utility. The process of zoning required by the export utility differs from that required by the built-in energy evaluating tool software and already established zones can not be used. The process can be obtained manually following instructions, or by using a plug-in that automates the process. Under the “Design extras” option in the “Design” tab in the main menu there is the “Place zones” tab that activates the plug-in. The utility works in the separate window that enables definition of the appropriate zones in the object. To define the interior surfaces the option “Place Zones in Rooms” is selected which enables adoption of categories inside of the building, as well as their visibility in the site. A similar operation is carried out to define the building's external areas and their visibility by selecting option “Place Zones to Exterior”. To fully define the area of the object it is also necessary to check if the area relates to the whole model or to the current level, and to select option “ignore small gaps”. After the completion of this process all parts of the object are defined and within of each section a table is featured giving basic information related to this unit. This information includes the names of units, its category, area and height. If we want to change some of the characteristics of particular entity the left mouse click should be performed on the related table followed by right click to open the properties window in which the parameters can be changed. Thus prepared model is ready for further analysis. From the top menu a “File” tab in main menu is selected and under option “Save as the” option to export the model as gbXML file is selected. Thus formed file is imported to the Green Building Studio software for further analysis.

The process of object analysis in the Green Building Studio program is conducted in following steps. Upon opening main application window the option “My projects” from the main menu is selected followed by the selection of the option “Create a New Project” from the menu box. The next step is the selection of options which requires entering of data related to the object in 3 steps. In the first stage the Project name, Building type, Schedule, and Project Type are defined. Second phase includes the location of the object, Time zone, Currency and Weather station. The third stage involves input of the Data Access Preference, Contact Preference and Autodesk Green Building Studio Web Service. Upon completing these steps a message that the new project is created appears.

Further procedure involves selecting an option “Continue to Application” after which the window is opened with the menu box with the following options Run list, Run charts, Project Defaults, “Project Details”, “Project Members”, “Utility Information”, and “Weather Station”. In this menu the user can perform further adjustments of the project in terms of project participants, weather station, details of connecting to schedule zone in the facility, the data related to water and sanitation facility as well as data related to energy prices. After defining all possible building features it is possible to choose the “Run list” option from the “Run” menu in order to import the gbXML file.

It is necessary to note that the building model created in either of the analyzed BIM applications must be fully defined; otherwise the DOE 2.2 [5, 2] engine blocks its analysis. Care must be taken that all materials within an object and their characteristics are defined entirely. Also, it should be ensured that each roof object is defined in a proper way, because this feature often leads to failure of importing the gbXML model in the Green Building Studio.
On the other hand, process of preparation models from Revit to Green Building Studio is same as the already mentioned process for Revit's built-in energy evaluation tool.
After successfully importing gbXML file a “Heating and Cooling Loads” option is selected. From this procedure the drop-down menu opens in which the option “Export” is selected and then the file extension is selected which is in this case is gbXML. Upon choosing the extension the working window opens in which the left side view shows the zoned property and the right side shows the basic characteristics of the building. There, the user can choose whether he/she wants presentation of the general or of the detailed characteristics of the building. Upon selecting “Next” option in the lower part of the window the “Save” dialog box opens enabling the file to be saved using the gbXML file format which fully completes the process of preparing the object for the analysis in Green Building Studio software.
Preparation of building model for the energy analysis in Riuska software is similar to the one already described for the Green Building Studio. The process in ArchiCAD 16 is same as the model preparation process for analysis in EcoDesigner. After the basic building model is finished all the characteristics necessary to fully define building elements like walls, windows, doors, radiators, pipes, etc. should be included. Zoning process is conducted as is previously described. Upon completion of this operation the object and zones are fully defined which enables export of the building model using the IFC [4] file format. Saving object as IFC is implemented under “Save as” option in the “File” tab of the main menu. In the dialog box the user should select the “General Translator” option. Only thus formed object can be further introduced in Riuska simulation tool.
The process of preparing the object in Revit 2013 for Riuska is quite simple. After completion of model all objects need to be fully defined in terms of the elements that comprise it, with all their characteristics. Next, the option “Export” is selected from the main menu and “IFC 2x3” is selected as the extension option.
The process of energy analysis in Riuska software is conducted in several steps. Upon starting the application, the user chooses option “File” in main menu, and then option “Import building information model” (BIM). That opens an IFC reading method dialog box. Within this window two possibilities are offered: “Import 3D geometry” and “Import only space 2D borders-Walls”. The process continues by selecting first option, and checking “Import also the unknown types of Spaces Boundaries”, and “Use "Merge" method to remove cracks between adjacent internal walls” sub options. After that, the actual IFC file is selected.
Next, the new window titled “New Case simulation” opens that asks the user to give the name of the new object to be simulated and provide specific information for the object that was previously analyzed.
After the model is imported into the program the window opens requiring the user to provide further settings that are necessary for energy analysis simulation. In the left part of the window there is an option for entering location of the object and the menu “Space groups” containing two commands “Building” and “System”. In the command “Building” there is the option “Storeys” and within it sub option “Level” that enables the user to define size and level of object or any part to be analyzed.
On the other hand, in the command “System” there is an option “Air conditioning space groups” that enables the user to define settings related to heating energy, cooling energy, HVAC system, lighting energy, equipment electricity and other necessary equipment for the distribution and consumption of energy for object. When the user finishes all the required settings on the right of working window he/she selects the option “Calculate” after which the program provides appropriate results (Figure 2).

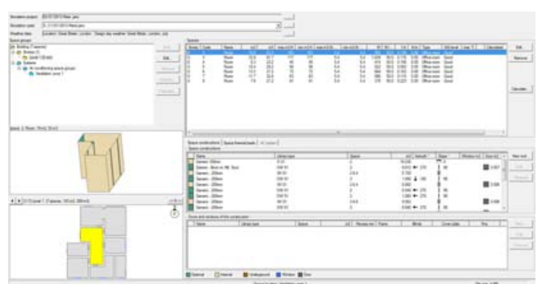
Figure 2. Report from Riuska software

3. CONCLUSIONS
Most software vendors advertise their energy consumption simulation tools as easy to use additions to existing BIM applications that enables designers to get appropriate results on the click of the button.
The paper shows that this process is not so straight forward and that even within same BIM application different simulation tools requires separate processes. This fact still hinders the use of software energy simulation tools in everyday architectural practice. On the other hand, if the designers withhold from the use of those tools no progress will be achieved toward better software applications. By

giving a quick overview of the appropriate processes for the most common BIM applications and related energy consumption simulation tools, this paper tries to foster building designers to use energy simulation tools regularly.

4. ACKNOWLEDGEMENT

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Session

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OPTIMAL SALE NUMBER OF KIND FOR SPECIALIZED SHOP WITH INCREASING DEMAND

Hui-Ming Teng[1], Ping-Hui Hsu[2]
[1]Department of Business Administration, Chihlee Institute of Technology, New Taipei, Taiwan, R.O.C
[2]Department of Business Administration, De Lin Institute of Technology, New Taipei, Taiwan, R.O.C.

Abstract. *The marketing policy for the retailers is influenced by sale number of product kind. In this study, we consider selling more kind of product to promote business. Selling a variety of product is needed to offer larger warehouse, inventory and ordering costs. An algorithm is developed to derive a replenishment cycle and sale kind of item such that the total unit time profit is maximized. A numerical analysis is presented.*

Key words: *Marketing policy; Product kind; Warehouse*

1. INTRODUCTION

Development of marketing strategy is the way to survive in a competitive environment. Owing to business competition and capital limitation, many retailers are beginning to be trafficking in department stores into specialty products. For example, tire stores, battery shop, shoe shop, for sale the only one merchandise store. Another example, automotive peripheral products shop including tires, battery,…etc., pet supply store for trafficking of a variety of relative goods. In terms of consumer behavior, multi-commodity trafficking stores are more attractive to consumer. However, retailers selling a variety of goods need to offer larger warehouse, inventory and ordering costs (Each kind of commodity must be individually ordered). So faced with conflict of increasing demand and escalating costs, how to tradeoff in commodities is a very practical problem.

There has been much work regarding the marketing and inventory problem. By acquiring and analyzing information regarding customers and competitors, marketing can be viewed an external-focused functional area that determines “what” kind of products (or services) a company should provide through “which” channel at “what” price (Tang, 2010). Marketing through internet has become an indispensable pipeline, however, entity display still make customers feel relieved.

Perspectives for a theory of marketing are outlined. Both the so-called marketing and broadened marketing concepts are inadequate conceptualizations of the marketing process. A theory of marketing should be formulated at the macro rather than the micro level and emphasize the positive rather than the normative problem-solving dimensions of the subject matter (Arndt, 1980). The householder concept, including mastering the material world and the resulting spiritual growth, stresses the importance of action, also a criterion for success in business (Barnett, 1985). Chesbrough (2010) explored the barriers to business model innovation, which previous academic research has identified as including conflicts with existing assets and business models, as well as cognition in understanding these barriers. Since product display usually induces customers’ desire to purchase, the retailer makes more order so that extra products can be displayed on the shelf. Teng et al. (2011) considered a two-echelon inventory system with returns and shortage backordering, and examined a situation when stock increases will result in more consumption. Chan et al. (2012) reflected the most recent advances on green industrial marketing, green/sustainable supply chains and their interplay in green industrial branding, and to explore future research directions. Peters et al.(2013) offered a platform for the exploration, comparison, application, and consideration of ontological choice and its implications in industrial marketing research. Dennis et al. (2014) investigated tacit knowledge exchange between sales and marketing and its ability to enhance marketing success (i.e., marketing program innovativeness, relative efficiency, and relative effectiveness). Royle and Laing specify (2014) specified any digital marketing skills gaps encountered by professionals working in communication industries. They found that a lack of specific technical skills; a need for best practice guidance on evaluation metrics, and a lack of intelligent future proofing for dynamic technological change and development are skills gaps currently challenging the communication industry. However, none of the above researches consider marketing with displaying more kind of product. This study considers selling more number of product kind to promote business. The aim is to determine the optimal number of product kind and replenishment cycle so that the total unit time profit is maximized.

2. ASSUMPTIONS AND NOTATION

In this section, the following notation is used throughout this paper.

- T the replenishment cycle length
- N total kind of item
- n selling kind of item
- r unit profit per sold unit
- $H(n)$ inventory holding cost per unit time including warehouse cost, which is function of selling kind;

$$H(n) = h(1 - b + \frac{bn}{N}), 0 \le b \le 1, \quad 1 \le n \le N.$$

Where h, b are constants, that means the unit inventory holding cost is increasing function of selling kind

- C ordering cost per replenishment cycle
- c_o ordering cost per kind of item per replenishment cycle
- TC total unit time cost
- $T\pi$ total unit time profit

In developing the model, the following assumptions are made:

1. Customer's demand is assumed as the average of individual demand of item. The demand rate is deterministic, stationary, and uniform through time.
2. Customer's demand follows a deterministic function $D(n)$ of kind n such that:

$$D(n) = d(1 - a + \frac{an}{N}), 0 \le a \le 1, \quad 1 \le n \le N.$$

Where d, a are constants. This means that the customer's demand increases when the kind of item increase.

3. The replenishment is instantaneous.
4. No shortages are allowed.
5. The capacity of the warehouse is unlimited.

(3)

(4)

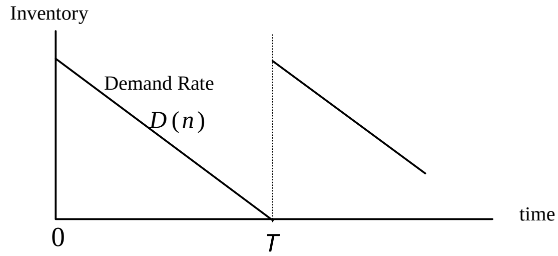

FIGURE 1. Customer's demand

3. MODELING AND ANALYSIS

In this section, we consider selling more kind of product to promote business. The supplier of multi-commodity trafficking store sells n kind of item. It is assumed that the total kind of item are N and the customer's demand follows a deterministic function $D(n)$ of kind n such that:

$$D(n) = d(1 - a + \frac{an}{N}), 0 \le a \le 1, \quad 1 \le n \le N \ ,$$

where d, a are constants. This means that the customer's demand increases when the kind of item increase. While selling a variety of product is needed to offer larger warehouse, inventory, and ordering costs. This study tries to maximize the total unit time profit by determining (1) the replenishment cycle and (2) sale kind of item. A graphical representation of this inventory system is depicted in Figure 1.

If the total unit time cost is TC, then

$$TC(T,n) = \frac{1}{T} \text{ [ordering cost + inventory holding cost]}$$

$$= \frac{1}{T}[C + nc_o + \frac{D(n)H(n)T^2}{2}]. \quad (1)$$

The total unit time profit is

$$T\pi(T,n) = \text{ [unit time sales revenue- total unit time cost]}$$

$$= \frac{1}{T}[rD(n)T] - \frac{1}{T}[C + nc_o + \frac{D(n)H(n)T^2}{2}]. \quad (2)$$

Three cases are considered, that is, Case 1: when T is fixed and n is variable; Case 2: when n is fixed and T is variable, and Case 3: when both T and n are variables.

3.1 Case 1: when T is fixed and n is variable

Given that $T = T_o$, and denoting $T\pi_1(n) = T\pi(T_o, n)$, one has

$$\frac{d}{dn}T\pi_1(n) = \frac{rda}{N} - \frac{c_o}{T_o} - \frac{da(1 - b + \frac{bn}{N})T_o h}{2N} \quad (3)$$

$$\frac{d^2}{dn^2}T\pi_1(n) = \frac{-dabT_o h}{N^2} < 0. \quad (4)$$

That means $T\pi_1(n)$ is concave. By setting

$\frac{d}{dn}T\pi_1(n)=0$. The optimal selling kind of item is as follows:

$$n^*=\frac{(2rdaT_o-2c_oN-adT_o{}^2h+2dabT_o{}^2h-bdT_o{}^2h)N}{2dabT_o{}^2h}. \quad (5)$$

3.2 Case 2: when *n* is fixed and *T* is variable

Given that $n=n_o$, and denoting $T\pi_2(T)=T\pi(T,n_o)$, one has

$$\frac{d}{dT}T\pi_2(T)=\frac{C+n_oc_o}{T}-\frac{dh(1-a+\frac{an_o}{N})(1-b+\frac{bn_o}{N})}{2} \quad (6)$$

$$\frac{d^2}{dT^2}T\pi_2(T)=\frac{-2(C+n_oc_o)}{T^3}<0. \quad (7)$$

That means $T\pi_2(T)$ is concave. By setting $\frac{d}{dT}T\pi_2(T)=0$. The optimal replenishment cycle is as follows:

$$T^*=\sqrt{\frac{2(C+n_oc_o)}{dh(N^2-bN^2+bn_oN-aN^2+abN^2-2abn_oN+an_oN+abn_o{}^2)}}N. \quad (8)$$

3.3 Case 3: when both *T* and *n* are variables

$$\frac{\partial^2}{\partial T^2}T\pi(T,n)=\frac{-2(C+nc_o)}{T^3} \quad (9)$$

$$\frac{\partial^2}{\partial n^2}T\pi(T,n)=\frac{-dabTh}{N^2}. \quad (10)$$

$$\frac{\partial^2}{\partial T\partial n}T\pi(T,n)=\frac{2c_oN^2-dhaT^2N+2dhabT^2N-2dhabnT^2-dhbT^2N}{2N^2T^2}. \quad (11)$$

To show the concavity of $T\pi(T,n)$, the positivity is needed. Let $H(T,n)$ be the Hessian matrix of $T\pi(T,n)$:

$$H(T,n)=\frac{\partial^2}{\partial T^2}T\pi(T,n)*\frac{\partial^2}{\partial n^2}T\pi(T,n)-[\frac{\partial^2}{\partial T\partial n}T\pi(T,n)]^2. \quad (12)$$

From (9), (10), and (11), by using mathematical software MAPLE to calculate (11), it is too complicated to prove the positivity of $H(T,n)$. The illustrative example is to be presented to show the concavity of $T\pi(T,n)$ and derive the optimal solution of (T,n).

4. NUMERICAL EXAMPLE

The proposed model can be illustrated with the following numerical example.

Example 1. Let *N*=100, *d*=1000, *r*=2, *h*=2, *C*=80, c_o =1.5, *a*=1/3, *b*=1/2.

Case 1: When *T* is fixed and *n* is variable. Given that *T*=0.35, from (5), the optimal number of product kind is n^* =54, and $T\pi_1{}^*$ =$1005.

Case 2: When *n* is fixed and *T* is variable. Given that *n*=10, from (8), the optimal replenishment cycle is T^* =0.497 year, and $T\pi_2{}^*$ =$1018.

Case 3: When both *T* and *n* are variables(5)

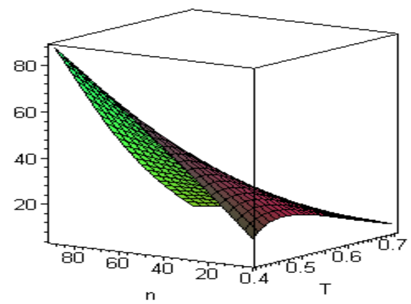

FIGURE 2. The graph of the Hessian matrix function of $T\pi(T,n)$ on [0.4, 0.7]×[1, 90].

Figure 2 (Using software Maple) shows the graph of the Hessian matrix function of $T\pi(T,n)$ on [0.4, 0.7]× [1, 90]. That means Hessian matrix of $T\pi(T,n)$ on [0.4, 0.7] × [1, 90] is positive. A graphical representation showing the concave function $T\pi$ is given in Figure 3. The optimal solution is derived by setting both $\frac{\partial}{\partial T}T\pi(T,n)=0$ and $\frac{\partial}{\partial n}T\pi(T,n)=0$. The optimal number of product kind is n^* =71, the optimal replenishment cycle is T^* =0.492 year. The optimal total unit time profit is $T\pi^*$ =$1048.

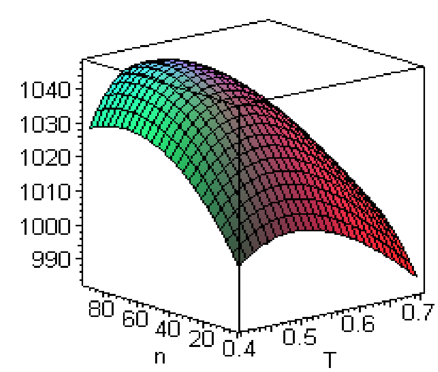

FIGURE 3. The graph of $T\pi(T,n)$ on [0.4, 0.7]×[1, 90].

5. CONCLUSION

This paper proposes and analyzes the optimal number of product kind and replenishment cycle so that the total unit time profit is maximized. The closed form of optimal solution is derived as another variable is fixed. The graphical illustration for concavity is presented when both *T* and *n* are variables. Further research can be done to consider limited warehouse and capital.

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AN APPROACH TO DETERMINE OPTIMAL NUMBER OF CONTAINERS FOR CARGO STACKING IN FUNCTION OF TRANSPORTATION COST

Radoslav Rajkovic[1], Nenad Zrnic[2], Đorđe Stakic[3], Aleksandar Sedmak[2], Snežana Kirin[1]
[1]Innovation Center, Faculty of Mechanical Engineering, University of Belgrade, Serbia
[2]Faculty of Mechanical Engineering, University of Belgrade, Serbia
[3]Faculty of Mathematics, University of Belgrade, Serbia

Abstract. *Contrary to conventional transportation systems in which different modes of transportation operate in an independent manner, container transport aims at integrating various modes and services of transportation to improve the efficiency of the whole distribution process with clear task to define the final price of the product.This paper develops mathematical model to minimize transport cost in container transport through proper "stuffing", using optimal number of containers,depending on different dimensions and weight of cargo.The analysis of this modelwould be helpful for the study of intermodal transport systemsand enables consignee to achieve market competitiveness.*
Key words: *Container transport, Transportation cost, Mathematical model.*

1.INTRODUCTION

In one of its most widely accepted meanings, intermodal freight transportations refer to amultimodal chain of container-transportation services. This chain usually links the initial shipper to the final consignee of the container (socalled door-to-door service) and takes place over long distances. Transportation is often provided byseveral carriers. Aclassical example of an intercontinental intermodal chain is given in,[1].

Containerized intermodal transportation supports a significant part of the international movement of goods and container-related transportation activities have grown remarkably over the last 10 years and the trend does not show any sign of slowing down, [8].

Determination of cargo weight and volume is one of the crucial information when selecting the type of container and whose information the buyer of the goods must always specify to the appropriate forwarding agency how they organize transport making booking for appropriate type of container.

The developed mathematical model in this paper, programmed in C and MATLAB, offers a possibility of determining optimal solutions, choosing the optimal routes in terms of concurrent minimization of the observed transport costs. The model provides a possibility of selection of cargo volume and weight, based on which a number of required containers, transported from the port of consignor to the consignee, are determined.

The remaining part of the paper is organized as follows: Section 2 presents the literature review; Section 3 describes the methodology which is suggested in this work; Section 4 reports and analyzes the results of the mathematical model and illustrates how the model could be used. Finally, Section 5 is focused on conclusions and future developments.

2. BACKGROUND

One of the most important tasks in the transportation of containers is the integration of container networks into a single network using different modes of transport. Studying literature data it was concluded that a small number of researchers investigated at the same time see and land legs together.

The main goal of Newman,A. M. and Yano, C. A. [6], was to minimize operating costs, including a fixed charge for each train, variable transportation and handling costs for each container and yard storage costs, while meeting on-time delivery requirements.

Francesetti D. C. [2], presented andanalyzedthe costs of shipping containers, clearly showing that Genoa and Trieste are favourable solutions.

A multimodal transportation problem considered by Kim et al. [5], was the problem of determining the transportation flow, i.e. volume of container cargoes, and the transportation mode in each trade route, for the objective of minimizing the sum of shipping and inland transportation costs.

Similar investigations a next year was made by Infante et al. [4]. It focused on an intermodal freight transport service in which containers represent the moved loading units. In particular, it deals with the advantages of combining sea and road transportation – sea for transferring large quantities over long distances, road for collecting and distributing over short or medium distances.

Han et al. [3], considered the problem of determining transportation quantity and mode in transporting international cargoes between Myanmar and her trading countries, especially focusing on the countries in South East Asia to check the extent of using short sea shipping, and inland transportation. The objective of theirs paper is to minimize transportation costs by mode between cargo origin and destination, subject to the maximum cargo volumes being handled at each seaport.

Payman, J. and Robert, C. L., [7] introduced an analytical models for predicting the allocation to ports and transportation channels of containerized goods imported from Asia to the USA. The first model, termed the Long-Run Model, is a large mixed integer non-linear programming model, and a set of heuristics to solve that. The objective is to minimize the total costs for transportation and handling, pipeline inventory, and safety-stock inventories.

3. METHODOLOGY

This paper examines transportation of goods from one part of the world to another. All cargo of different volume and weight is transported in containers by ship, assumed to originate from a major loading point far away. Depending on different dimensions and weight of shipments, the type of container in which goods are loaded is selected. This paper considers three different types of container: 20′ container, 40′ container, 40′ high-cube container (Table 1).

Table 1. Weights and dimensions of some common types of containers

	20′ container	**40′ container**	**40′ high-cube container**
internal volume	33,1 cbm	67,5 cbm	75,3 cbm
maximum gross weight	30.400 kg	30.400 kg	30.848 kg
empty weight	2.200 kg	3.800 kg	3.900 kg
net load	28.200 kg	26.600 kg	26.580 kg

The considered network includes three categories of nodes: origin port (port of loading), gateway ports (ports of discharge) and destination (place of delivery), and two categories of links, maritime and inland. The first one represents maritime transfers from origin port to gateway ports and the second the inland component of the distribution, in which containers are routed from gateways to final destination by road, rail and barge.

The main goal of this mathematical model is to minimize the sum of shipping and inland transportation costs for three different types of containers. The transport cost was considered for each of the most commonly used types of containers in the container transport, and is based on the Free On Board - FOB term. Total cost includes local costs in the port of discharge, customs clearance and handling costs. During inland transport it was used different modes of transport, and because of more appropriate comparisons of the costs of rail and barge with truck, it was included also handling costs at the terminals and final delivery to users by truck (local delivery).

This section presents the model formulation and corresponding explanations are given as follows:

N - set of nodes, let N = S ∪ E ∪ B, while S stands for origin port, E stands for gateway ports stands for place of delivery

A - set of arcs connecting an origin to a gateway (first-leg arcs)

C - set of arcs connecting gateways to place of delivery (second-leg arcs)

t_{ij} - binary cost variable representing containers flow on first-leg arc, operator i to gateway j, $t_{ij} \in \{0,1\}$

l_{jk} - binary cost variable representing containers flow on second-leg arc, gateway j, mode of transport k, $l_{jk} \in \{0,1\}$

i - number of operator, $i \in \{1,\dots,6\}$

j - number of port, $j \in \{1,\dots,5\}$

t - type of container, $t \in \{1,\dots,3\}$

k - mode of transport, $k \in \{1,\dots,3\}$

CSE_{ijt} - transportation cost on first-leg arcs (expressed in \$)

EX - exchange rate (€ / \$)

CPC_{ijt} - port cost (expressed in €)

CEB_{jkt} - transportation cost on second-leg arcs (expressed in €)

Objective functions:

Min cost =

$$\Big(\sum_{(i,j)\in A}\big(CSE_{ij}\frac{1}{EX}+CPC_{ij}\big)*t_{ij}+\sum_{(j,k)\in C}CEB_{jk}*l_{kj}\Big) \quad (1)$$

Constraints:

$$\sum_{(i,j)\in A} t_{ij} = 1 \quad (2)$$

$$\sum_{(j,k)\in C} l_{jk} = 1 \quad (3)$$

$$\sum_{(i,j)\in A} t_{ij} = \sum_{(j,k)\in C} l_{jk},\ \forall j \quad (4)$$

Corresponding Explanations:
The objective function (1) minimizes total cost of container import flow through the transport network. They include transport cost on the first leg-arc (ocean costs), port cost and transport cost on the second leg-arc (cost of using inland vehicles - truck, rail and barge. Constraints (2) and (3) define a single best solution for cost from a group of ordered pairs on the maritime and inland part. Constraint (4) selects the same port for the first and second leg-arc and defines one route from origin to place of delivery regarding transportation cost.

4. RESULTS

As a case study it was developed mathematical model which minimize transportation costs of container import from Shanghai to Belgrade. Optimization model was programmed in C and MATLAB and simulations were performed on an Intel Core i7-3612 QM 2.1 GHz computer. We use original input data regarding first half of 2014. Table 2 represents simulation results of different type of cargo (different volume and weight) while figure 1 represents optimal transport routes for each type of container:

Table 2. Simulation results

Simulation	Volume (cbm)	Weight (t)	20 dv	40 dv	40 hq	Total cost (EUR)
1	200	200	8	0	0	12752
2	500	100	1	2	5	18949
3	1000	500	4	18	0	50836
4	5000	1000	1	0	71	177887
5	10000	5000	2	203	0	504598

Optimal transportation cost between Shanghai and Belgrade per each container (20 DV, 40 DV, 40 HQ) are respectively 1594 €, 2470 €, 2483 € using see and land legs together.

5. CONCLUSIONS

This paper analyzes the supply chain network with primary focus on import of containers from Shanghai to Belgrade through selected Mediterranean ports, observing the six world's largest container operators (Maersk Line, Mediterranean Shipping Company, CMA CGM, Evergreen Line, China Ocean Shipping Company and Hapag-Lioyd) with theirs different type of services.
The main goal of this research is to provide an optimal route with lowest transportation cost of different type and number of container from Shanghai to Belgrade depending on different weight and volume of cargo.

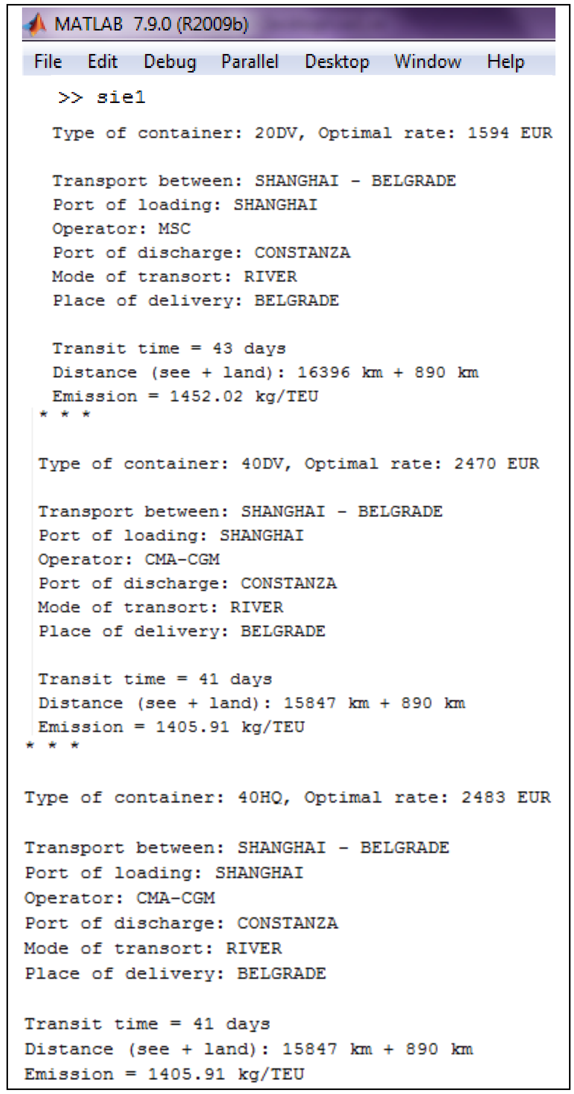

Figure 1. *Optimal transport routes for each type of container*

Mathematical model give us possibility to get reliable data of the minimal cost on the observed route per each type of container. Computational results shows that the lowest transportation costs between Shanghai and Belgrade, per each type of containers are reached using barge (river transport) on hinterland.
A mathematical model has also a practical use in determining the optimal route. Using this model it can be generate competitive bids in transport organization. Appropriate forwarding agency can provide these bids to its customers and constantly it can inspect the most optimal routes depending on the selected criteria.
Further research is needed, because this research is recited only part of the problem. It can be extended in the future and can be imported with a lot of new nodes and new objectives such as transit time and emissions.

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IMPROVEMENT OF MATERIAL FLOW IN SYSTEM FOR MANUFACTURING OF COOLING AND COOKING DEVICES

Nemanja Sremčev, Đorđe Lazarević, Ilija Ćosić, Milovan Lazarević, Aleksandar Rikalović
Department of Industrial Engineering and Management, Faculty of Technical Sciences, University of Novi Sad, Serbia

Abstract.*The paper describes transformation of material flow in a system for manufacturing of cooling and cooking devices. Group methodology is used for moulding an optimal production system layout. Based on production flow analysis and the incidence matrix, groups of products and work units are formed.*
Keywords: *group approach, cellular manufacturing,production flow analysis (PFA).*

1. INTRODUCTION

Production of cooling and cooking devices is conducted in a system which consists of thirty six work stations. Complexity of a material flows, in the analysed case, is vast – more than one hundred and eighteen, with lots of backflows.Efficiencyof such a system is low and its structure has to change. Group approach is introduced through method II of PFA methodology[2]. Production flow analysis is conducted and work units are designed.

This paper is organized in four sections. Second section describes methodology and its benefits. Third section is divided into two parts, first analyses condition of a production process, second shows solution to analysed problems. Fourth section presents conclusion.

2.LITERATURE PREVIEW

Group technology is a manufacturing technique in which target grouped machines (producing parts or products with similar characteristics) are organized into work units (cells) [11][2]. Each of these work units is specified for a family or group of parts.

There are two ways of introducing group approach, depending on the analysis of system/environment relationship, analysis of the production programme and product's characteristics analysis [8].Analysis of a production program will result with a coding system that has the purpose of processing part attributes and to store their classification codes for module and group design[5]. Second method for introducing group approach is by conducting production flow analysis (PFA) [3].

Introducing group technology changes the way a company operates [4]. In production systems based on group approach, group of parts follow the same procedures of production: same machines, order of operation, require relatively proportional time requirements on operations and share setup time of the machines[7][10].The objective of group technology is to form small organizational units (cells or working units) which complete all the set of products or components which they make, through one or a few major processing stages and are equipped with all the machines and other processing equipment they need to do so [3].

Production flow analysis (PFA) is used as a tool for planning a revitalization of a system that is process based to a product organization and to plan its layout from process to product layout [2][10]. The partsthat are classified and grouped into families produce a much more tractable database [9]. In production systems based on group approach time of production cycle is shorter and machine setup times for each individual part/product are avoided [7].In general, GT simplifies and standardizes. The approach to simplify, standardize, and internalizethrough repetition produces efficiency [1][6].

3. CASE STUDY

Analysis of material flow in a system for cooling and cooking devices manufacturing

In this case, twelve types of devices are observed. Most of them are cooling devices, but twenty percent of the production programis cooking devices. Each type of device is produced in between fifty and a hundred varieties. In the production plant it has been noticed one hundred and eighteen different material flows between thirty-six workplaces and three warehouses (Figure 1).

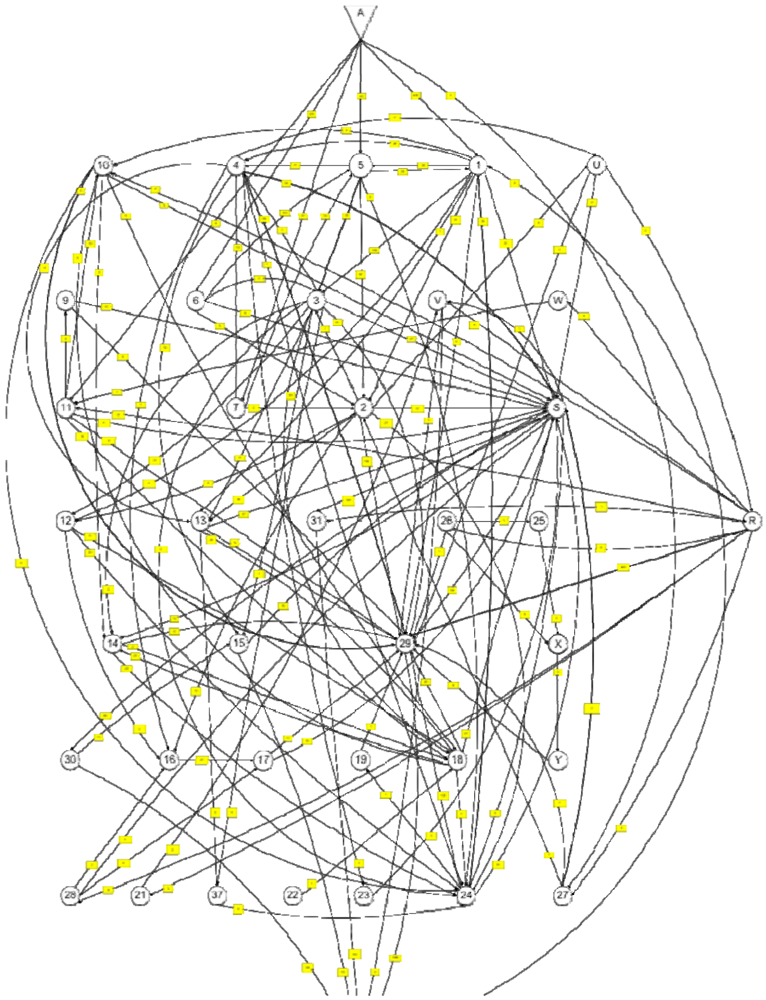
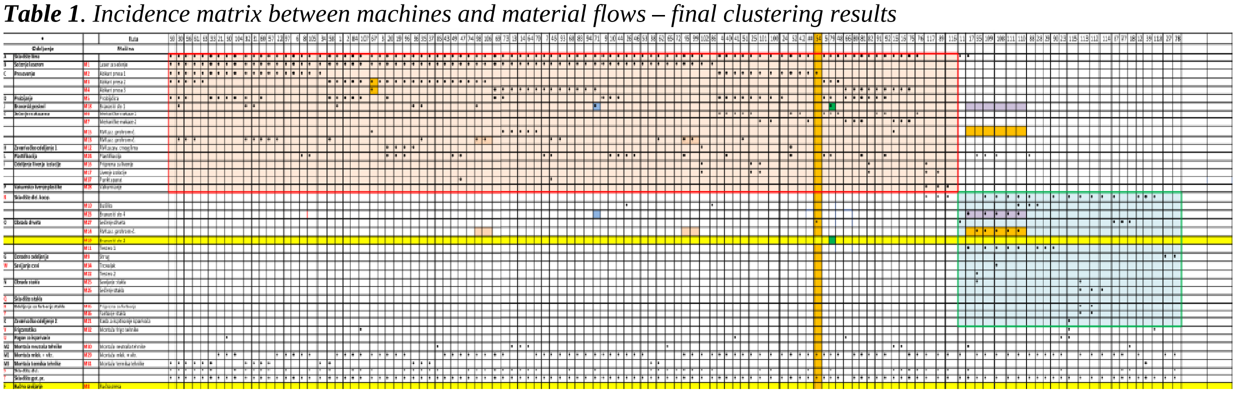


Figure 1.*Analysis of materials flows*

Figure 1 shows the main disadvantages of work organization in production of such complex production programme, and illustrates why it is necessary to change the approach to material flow managing. The figure uses a flow network to show workplace processing (thirty-six workplaces and three warehouses–marked with the letters R, S and T). This primary network is very complicated, which leads to a complicated flow of information and such systems is extremely difficult to manage. The product flow analysis and other indicators show us that there is a need for reengineering and revitalization of manufacturing structure.

Table 1*. Incidence matrix between machines and material flows – final clustering results*



The basic technique of group analysis (PFA analysis) is the resolution of a matrix. Normally in such a matrix the machines will be listed in type number sequence, parts in part number sequence, and the association of machines and parts will appear to be random. It is always possible to find a solution for division into groups and families by reordering the sequence in which parts are listed and reordering the sequence in which machines are listed. Some machine types, which are specific by type, will be required in more than one group, and will be shared. The reordering of columns and rows leads to the solution - two work units in production (marked with red and green square in the Table 1), and one work unit for assembly.

Forming of groups and work units

Based on the obtained information from incidence matrix and by grouping machines that perform the same or similar operations, work units are designed (Figure 2), and a new spatial structure of the factory is suggested (Figure 3).

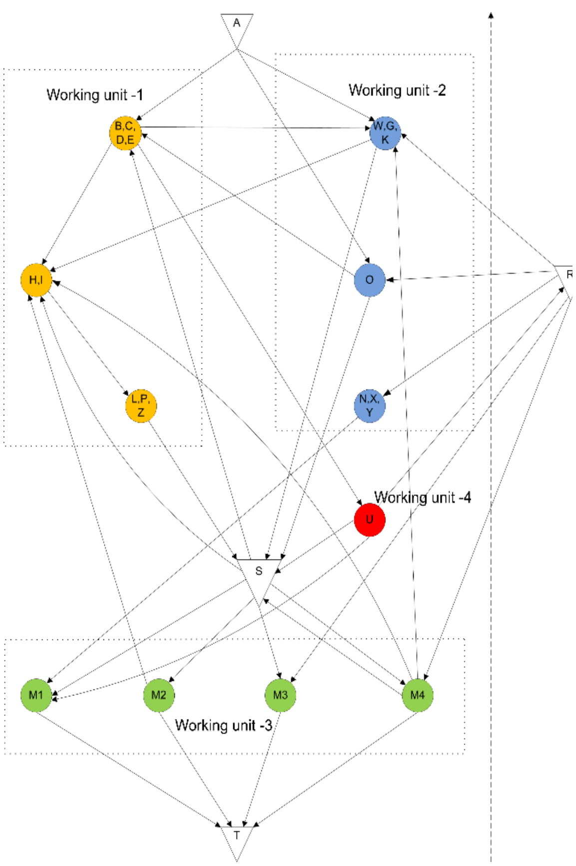


***Figure 2.** Analysis of materials flows – simplified system*

The first working unit consists of machines for punching, slitting and cutting of sheet metal. The second work unit consists of machines for turning, drilling, milling and welding, and the third work unit consists of workplaces for assembly (Figure 2). The fourth working unit has already been designed and is not included in this analysis.

This analysis do not consider a department that deals with the production of evaporators (right side of the production hall – Figure 3), because the PFA for that department is done earlier, and revitalization is conducted. In accordance with the production hall that already exists, proposal for a new spatial structure of the plant is given (Figure 3). Workplaces which are numbered with 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, are the first working unit, workplaces which are numbered with 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, are the second working unit, and workplaces which are numbered 24, 25, 26, 27 are third working unit. Warehouses are numbered with 28, 29, and 30.

4. CONCLUSION

Process organization is obsolete, and it has to be replaced by product organization. The paper presents example of transformation from process layout to product layout by using group methodology. PFA is the best technique for planning the change from process organization to product organization. It is desirable to use one of just in time (JIT) single cycle methods of production control to obtain the full advantage of group technology. Downside of PFA analysis is that there is a segment of machines and parts that cannot be included into the formed groups and work units. For those machines and parts, material flow will still be complex, no matter how good the spatial structure is, but number of them will be almost imperceptible. Advantages are:reducedmaterialhandlingandtransittime, reducedsetuptime, and reducedwork-in-process inventory.

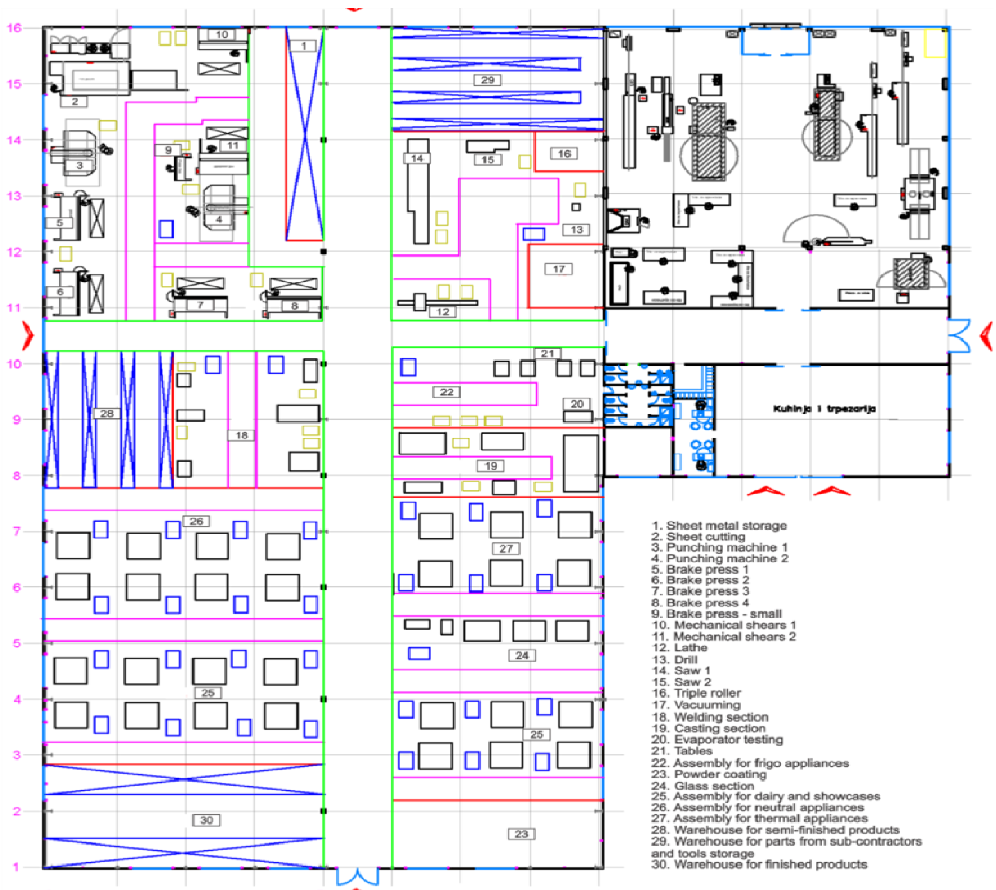


Figure 3*. Proposed spatial structure of the factory*

5. ACKNOWLEDGEMENT

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INFLUENCE OF XYLAN ON NANOCELLULOSE (NFC) SUSPENSION RHEOLOGY AND AEROGEL MORPHOLOGY

Katarina Dimic-Misic[1], Patrick Gane[1, 2], Tatiana Budtova[3],Christophe Pradille[4], Herbert Sixta [1],Lovikka Ville[1], Thad Maloney[1]

[1]School of Chemical Technology, Department of Forest Products Technology, Aalto University, 00076 Aalto, Helsinki, Finland
[2]Omya International AG, Baslerstrasse 42, CH-4665 Oftringen, Switzerland
[3]CEMEF, Mines Paris Tech, Centre for Material Forming, 06904 Sophia Antipolis cedex, France
4 Mat Xper, 19 Traverse du Barri, 06560, Sophia Antipolis, France

Abstract.*Alkaline washed nanofibrillated cellulose (NFC) samples, obtained via TEMPO-mediation of hardwood Kraft pulp, with different amount of retained xylan were prepared to study the influence of xylan on the water retaining properties of NFC suspensions and on the morphology of dry porous materials derived therefrom by freeze drying. Comparing suspension rheology and dynamic dewatering properties and the morphological and mechanical properties it could be shown that reducing xylan content on NFC results in a weakening gel structure of nanocellulose suspensions and an increase in the mechanical properties of their derived aerogels. Interstitial retained moisture during drying, therefore, leads to weaker interfacial fibrillar bonds*.

Keywords: *nanocellulose, aerogels, rheology, xylan content, water sorption, fibrillar interactions*

1. INTRODUCTION

The potential of NFC materials has been demonstrated with applications, such as reinforcing composites, transparent gas-barrier films [1, 2], medical diagnostics, electronics, cosmetics, aerogels and flame-resistant materials [1-5]. More recently, NFC utilisation in cellulosic aerogel production has been reported [6-8].

Xylan is a hemicellulose abundantly present in hardwoods, where it attaches to cellulose nanofibrils and is present in the cell wall of wood. It has been shown that xylan plays also an important role in the stability of NFC gels [9]. Xylan is located typically on the fibril surfaces and therefore it stabilises the dispersion of NFC both sterically as well as electrically [10],whereas, chemically carboxylated pure cellulose nanomaterials, such as cellulose nanocrystals (CNC) and NFC, are stabilised only electrically, which leads to the solution property dependency on the stability of the gel [10]. This difference could influence significantly the gel-network properties of NFC, which, in both cases, involves trapped and sorbed water.

Flow and dewatering properties of NFC suspensions are important in respect to processability, as they are strongly shear thinning gel-like materials and their viscosity and viscoelasticity properties are concentration and pre-treatment dependent [11, 12]. The swelling radius of a nanocellulose particle is directly related to the charge density caused by the hydroxyl groups, which are in contact with individual water molecules [17]. NFC gels are non-Newtonian fluids, highly dependent on flow conditions, and the increase of shear rate enhances both the aggregation and fragmentation of such complex colloid systems which result in flow curves that have high shear thinning and thixotropic behaviour [18, 19]. Since NFC gels are stabilised with water binding gelation, tuning the gelation mechanism via altering xylan content will have a strong effect on their rheological and dewatering properties.

Aerogels are typically prepared from solvent swollen gels, i.e. percolative networks within a solvent medium, where it is essential that uncontrolled collapse and shrinkage of thelater network can be suppressed as the solvent is removed. The most widely used technique for the solvent removal is supercritical CO_2 ($scCO_2$)drying or freeze drying. Both $scCO_2$-drying and freeze drying limit shrinkage during the drying process, and the volume fraction of the solid phase in the dry state is similar to that in the wet state. This leads to the characteristic features of aerogels, such as low apparent density, high specific surface area and porosity, as well as low heat conductivity, which makes aerogels useful as catalystsupports, drug delivery vehicles, the basis for novel electrical and magnetic materials, thermal insulators, or as sorbents for oil spills [9].

To investigate dependence of xylan content and consistency on aerogels compressibility, we prepared NFC hydrogels with highest amount of xylan in four different consistencies (1.5 %, 2.4 % and 7.0%) and correspondingly NFC gels with varying amount of xylan at two different consistencies (1.5 % and 4.0%).

2. METHODOLOGY

Never dried laboratory bleached kraft birch pulp (kappa number 0.96) was used as the raw material for the TEMPO-mediated NFC. TEMPO (Sigma Aldrich (St Louis, USA)) was used as catalyst. 13 % NaOCl solution (Merck (Darmstadt, Germany)) was the primary oxidant during the TEMPO-oxidation. 22 g of ortho-boric acid (VWR (Leuven, Belgium)) and 1.8 g of NaOH pellets (VWR (Leuven, Belgium)) were diluted to 2000 cm^3 of distilled water to prepare a borate buffer (pH8.3) in situ. 1 M NaOH (Merck (Darmstadt, Germany)), 1 M HCl (Merck (Darmstadt, Germany)), Büchi reactor (volume 1.6 dm^3), and Metrohm 718 Stat Titrino titrator with pH adjustment were used during the pulp oxidations. All water used in the work was ion-exchanged.

2.1*Alkali treatment of bleached pulps*

Alkaline treatment was applied to the washed birch pulps at room temperature (RT). First, a 0.8 M NaOH solution together with water was added to the pulp to obtain the desired alkalinity and pulp consistency of 5 %. The pulp suspension was then stirred with a mechanical stirrer throughout the reaction time. After the 15 min reaction time, the pulp was washed immediately with deionised water to pH 10-11 and the pH of the suspension was measured with a pH meter (Mettler Toledo). Finally, the pulp was manually pressed to a dry matter content of approximately 20%.

2.2*Preparation and analyses of NFC-TEMPO suspensions*

Radical TEMPO was mixed with NaOCl at a stoichiometrically excess amount in a water solution. The pH level of the solution was adjusted to 7.5 with sulphuric acid. The solution vessel was closed and the solution was mixed until the radical TEMPO was dissolved and converted to its oxidised form due to the formation of HOCl from added NaOCl. The prepared solution was used as a catalyst in the TEMPO-mediated birch pulp oxidation.

The xylan content of the starting birch pulp was reduced with an alkali treatment prior to the TEMPO-mediated oxidation and resulting pulp characterisation. Although alkali treatment is known to change the end product structural and strength-forming properties, the level of alkali treatment was controlled so as not to convert the cellulose I into a cellulose II form in order to minimise any such effects.Then the pulp suspensions were homogenised ready for analysing the resultant NFC gels.

The pulp and the activated TEMPO solution (0.05 mmol TEMPO g^{-1} pulp) were mixed extensively in a closed vessel. Then water and the pulp were added into a Büchi reactor (continuous mixing, temperature 25 °C, volume of pulp solution 1.2 dm^3). 2.4 mmol of NaOCl g^{-1} pulp was added to the Büchi reactor by a pump to adjust the pH level to 9. After the initial addition of NaOCl, the pH of the suspension was kept at 9 with 1 M NaOH additions with an automatic titrator. The oxidation rate was followed by an active chlorine titration until all HOCl from the suspension was consumed.

For rheological measurements 1.5% suspensionsof each sample NFC were used. For aerogel preparation,hydrogels were made at 1.5%, 2%,4 % and 7% consistency for NFC samples without alkaline pretreatment (1,2), and 1.5% and 4% consistency for NFC with alkaline pre-treatment, in order to evaluate the effect of consistency on density and mechanical properties of the resulting aerogels.

2.3*Conversion of residual aldehydes to carboxylates by chlorous acid*

The oxidised pulp suspension at 1 % consistency was adjusted to pH 3 with 1 M HCl. $NaClO_2$ was added to the suspension (1 mM final concentration),forming the acid salt of chlorous acid, and the suspension was mixed in the Büchi reactor for 2 hours at 50 °C. Finally, the pulp was extensively washed with deionised water.

2.4*Surface charge andagglomerate size*

To help characterise the different NFC samples, the charge of the fibrillated cellulose preparedvia different routes (zeta potential (ζ)) was determined by a Zeta-sizer (Malvern Instruments Ltd.). The particle size of the flocculated NFC agglomerates was measured with dynamic light scattering (DLS), using thephoton correlation spectroscopic technique on the same instrument. Prior to measuring the ensemble defined particle size, the samples were diluted with de-ionised water to a solid content of 0.01 %. The scattering volume equivalent diameter (d_{sv}) and ζ are reported as an average of at least five runs. In the case where the density of a material is constant throughout its size distribution, the volume and weight determined size distribution are identical.

2.5*Fluidisation of TEMPO-oxidised pulp*

The studied TEMPO-oxidised pulp was diluted with water (1.5 % solids) prior to adjusting to pH 9. Then the slurry was homogenised once in a Microfluidics M110P fluidizer through a chamber nozzle pair with diameters of 200 µm and 100 µm at a constant pressure of 1000 bar.

2.6*Rheology and dynamic dewatering/immobilisation*

The viscoelastic rheological investigations were performed at 23 °C with an Anton Paar 300 (Anton Paar Germany GmbH, Hellmuth-Hirth-Strasse 6, 73760 Ostfildern-Scharnhausen, Germany) oscillatory constant stress/strain and variable shear rheometer [21]. Different types of rheological measurements were performed including viscoelastic measurements, stability and recovery tests (3ITT) and steady state flow with increasing shear rate [12], as well as recording the dynamical change in rheological parameters under dewatering using the immobilisation cell (IMC). To prevent evaporation of the water medium during rheological measurements, a layer of silicone oil was spread over the surface of the sample in contact with the air. All rheological measurements were repeated five times including a pre-shear protocol, and for the calculation of rheological parameters, average values of five measurements are used and quoted with their standard deviation [15, 16].

For the oscillatory measurements a parallel plate geometry with a serrated bottom and upper plate (PP25) was chosen, with diameter of 25 mm, and the gap between upper and bottom plate being set at 1 mm [15, 16]. The pre-shear protocol was applied with an angular frequency ofω = 10 (rad)s^{-1} and strain amplitude γ = 0.01 % for 3 min, followed by a rest time of 10 min [16]. The linear viscoelastic range of the sample (LVE) was obtained from an amplitude sweep oscillatory test using constant angular frequency (ω = 1 (rad)s^{-1}) with varying strain amplitude (γ = 0.01 - 500 %). Dynamic moduli, G' and G'', and complex viscosity (η*) of the NFC gels were measured as a function of angular frequency (ω) using a downward scaling frequency range (ω = 100- 0.01 (rad)s^{-1}) in frequency sweep oscillatory tests, with a logarithmic spread of data point intervals.Flow curves of NFC gels were measured in a downward shear rate $\dot{\gamma}$ = 1000 – 0.01 s^{-1} with a logarithmic spread of data point duration ranging from 1 to 100 s [12].

Dynamic dewatering measurement was conducted using the same Physica MCR 300 rheometer with IMC accessory as licensed from BASF-AG [15, 16, 64, 71, 72]. A Whatman nucleopore membrane, with the pore size of 0.2 µm, placed on the filter. The upper plate is then lowered into contact with sample [63].NFC suspensions were pre-sheared within the LVE for 20 s, and then the dewatering in DSO proceeded. Determination of immobilisation time, $t_{imm,}$ was calculated as the second zero of damping factor (tan δ)[15].

2.7 *Apparent swelling by WRV measurements*

The swelling of the NFC was determined with a modified version of the solute exclusion test [20]. Two different probe molecules were used in the measurement in order to measure swelling at the interparticle and intraparticle levels. To determine the non-swollen state, 2 x 10^6 Dalton dextran (T2000 from Pharmacosmos) was used for blocking interparticle level swelling. A 5 000 Dalton dextran (T5 from Pharmacosmos) with a Stokes diameter of 3.2 nm was used to block selectively the intraparticle swelling of the NFC. Comparison of the blocked samples with the water-sorbed samples provided a measure of the apparent swelling properties in water.

The network swelling of the nanocellulose was evaluated with a modified water retention value test (WRV ISO/DIS 23714), in order to suit the measurements of gel-like NFC. Due to the difficulty in observing NFC alone as the whole structure change is extremely strong, a dilution with untreated pulp was used as a mix component. The fibre matrix helps in dispersing and filtering the NFC during centrifugation. In the measurement, 5 % NFC was added to a sample of the Birch Kraft bale pulp. The entire sample was measured and the proportional contribution of the NFC was calculated. Samples were measured in duplicate, with agreement between replicate measurements better than ±0.1 cm^3 g^{-1}. Swelling measurements were made under conditions of low conductivity, 15-45 µScm^{-1}, pH 7.5-8.0 and carboxyl groups neutralised in the Na^+ form. Using this methodology, the measurement will more closely reflect the water trapped within the fine scale morphological features of the NFC. A detailed description of the method is provided elsewhere [15, 16].

2.8*Preparation of Aerogel Membranes*

In order to make NFCfibrils well dispersed, the hydrogel was magnetically stirred for 1 day before use. The specially prepared hollow plastic cylindrical shaped moulds with dimensions about 1.8 – 2.0 cm height and 2 cm diameter, were designed to make NFC gels self-standing structures, Fig.1. Samples were placed in a Cryothec Freeze dryer with the temperature of the cool trap being -80 °C and an end pressure of -40 mTorr.Due to the vacuum pumping action, the sample quickly cools below the freezing point of water by the induced evaporation of liquid water in the form of vapour, and thereafter the water is removed from the frozen state by sublimation[11]. After complete water removalwhitesponge-like aerogels with a very low density are obtained.

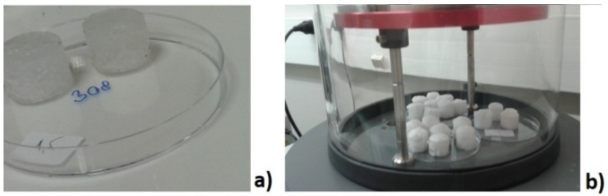

Fig.1 Preparation of NFC aerogels from hydrogels: a)plastic cylindrical moulds withholes were made to hold low and high consistency hydrogels, and b) enabling formation of self-standing structures of aerogels for freeze drying.

2.9*Scanning electron microscopy*

Scanning electron microscopy (SEM) imaging was performed using A PHILIPS XL 30 on samples covered with gold, under vacuum at the acceleration voltage of 15 kV for 1 min.The specimens were made directly from breaking the cylinder mould into two parts and using fresh fracture surfaces in order to investigate the aerogel inner surface.

Densities of the aerogels were calculated by weighing the samples and measuring the volumes.

2.10*Nitrogen-adsorption-desorption measurements*

The specific surface areas were determinated by nitrogen adsorption carried out in a Coulter Omnisorp 100CX at the temperature of liquid nitrogen. Before measurements the samples were dried at the temperature of 100 °C until the vacuum of 1×10^{-5} Torr was reached. Both adsorption and desorption isotherms were measured and the surface area was determined from the adsorption curve by the Brunauer–Emmet–Teller (BET) method. The mesopore diameter distributions were determined from desorption isotherms by the Barret–Joyner–Halenda (BJH) method assuming open cylindrical pores[29]. The limit of accuracy is 1%.

2.11*Mechanical testing*

Uniaxial compression tests were carried out on a tensile testing machine Zwick (Zwick GmbH, Germany) Z 2.5 equipped with a 2.0 load cell according to ISO 604 with the testing speed of 1mmmin^{-1} and a preload of 1N. Teflon plates were mounted on the compression tools in order to minimise the friction. Strains were calculated as a ratio of displacement of the machine plates over nominal height of a sample. All samples were conditioned for at least 72 h prior to testing in a controlled environment (23 °C, 50% RH) according to ISO291. At least 5 samples of each formulation were tested. The error in compression modulus was 20%. Relative compression modulus E_{rel} was calculated as a ratio of the absolute compression modulus and density of the sample in gm^{-3} allowing suppression of the influence of sample density on the mechanical properties of a composite. The Poissonratio was calculated as a negative ratio of transverse to axial strain. The strains were measured from images taken using a fixed optical camera during testing.

3. RESULTS AND DISCUSSION

3.1*Removal of Xylan and TEMPO-mediated Oxidation*

Alkalitreatment of bleached birch pulp was conducted at room temperature at 5 % pulp consistency for 15 min which is sufficient reaction time due to the fast xylan removal which was earlier reported to take place immediately (e.g. 1 min) after NaOH is exposed to the pulp [29]. The xylan content decreased linearly as a function of NaOH concentration from 25.2 % to 7.3 % (NaOH concentration varied between 0 – 2 M, as presented in Table1. The removal of xylan correlates with increasing alkali concentration of alkali treatment with birch pulp correspondingly to earlier study [26, 27,29]

Table 1TEMPO-mediated pulp oxidations of alkalitreated (AT) and reference bleached birch pulps and description of NFC with different alkali treatment.

Sample name	Ref.	AT/0.75	AT/1	AT/1.5	AT/2	BC
Alkali treatment / mmol dm^{-3} NaOH	0	0.75	1.0	1.5	2.0	N.A.
Xylan content after alkali treatment / %	25.2	19.9	15.3	10.6	7.3	N.A.
Reaction time of TEMPO oxidation /min	220	132	80	51	28	N.A.
Carboxylate content /mmol g^{-1} pulp	0.89	0.90	0.93	0.85	0.90	0
Carboxylate + aldehyde content /mmol g^{-1} pulp	0.97	1.03	1.06	1.11	1.17	N.A.

Reaction time of TEMPO-mediated oxidation reduces with the decreasing xylan content of pulp. Increased reactivity of alkali treated cellulose is proposed to be dependent onthe content of dissolved xylan as well as on the alkali-induced swelling of the fibre wall [29]. Reaction times are higher compared with earlier reported results under similar conditions [29]. However, in this case the reference pulp contains higher xylan content (25.2 %) compared withthe corresponding reference pulp (22.4 %) reported earlier [29].

The fibrillar structure of NFC-gels produced from xylan extracted (alkali washed) TEMPO-oxidised pulps was studied with atomic force microscopy (AFM). The AFM images were recorded from the dried NFC-gel samples without any fractionation having been applied in order to maintain the actual fibrillar structure of the produced NFC gel. The AFM images revealed clearly that all pulps were fibrillated effectively down to the individual fibril scale, when excluding observed large fibril flocs.

The AFM imaging was utilised also for measuring the fibril dimensions in the produced NFC-gels. The AFM technique gives only values relevant to theprobe *z*-direction motion due to the image artefacts related to the AFM technique [2, 11].

Table 2 Measured thicknesses for fibril dimensions with AFM. AW denotes the alkali washed samples with alkali concentration 0.75-2.0 mol NaOH dm^{-3}. BC denotes bacterial cellulose sample.

Sample name	Ref	AW/0.75	AW/1.0	AW/1.5	AW/2.0	BC
Thickness of fibril (nm)	4.0 ± 1.1	3.4 ± 0.8	3.6 ± 0.5	2.9 ± 0.4	3.1 ± 0.6	0.5 ± 0.1

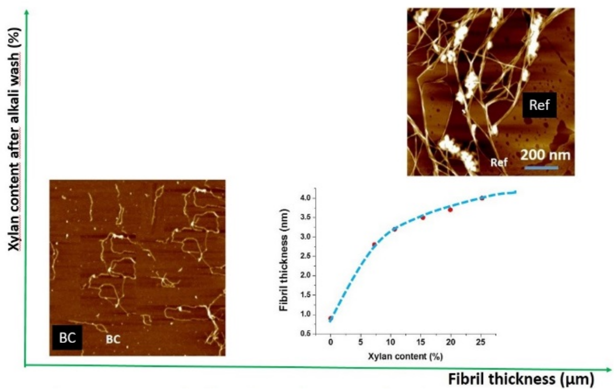

Fig 2. NFC fibril thickness as a function of xylan content

3.2 *Swelling and water retention (WR)of NFC*

A thorough description of the swelling of an NFC gel should include both the water trapped within the interstitial fibrillary matrix and within each fibril. The network swelling of the NFC increases strongly with xylan content. The xylan appears to stabilise the NFC network sterically thus immobilising water in the interstitial spaces. Interestingly, the xylan content, dominates over the increase in charge in the TEMPO oxidised series as the acid content increased from 0.97 to 1.17 $mmolg^{-1}$ through the series, while the network swelling decreased from 14.3 to 6.0 $cm^3 g^{-1}$. Other factors being equal, increasing surface charge will increase swelling

.

Table 3 Particle and network swelling as a function of xylan and COOH content, showing the strong effect of xylan hemicellulose on trapping the water within the nanofibrillar matrix.

NFC suspension	**Particle swelling** 3.2 nm dextran probe/ cm^3g^{-1}	**Network swelling** 54.0 nm dextran probe/ cm^3g^{-1}	**WRV** / g_{water} g^{-1}_{NFC}	**Filtrate amount during static dewatering** ÅA GWR/ gm^{-2}
Ref	2.7	14.3	10.8	404.2
AW/0.75	2.8	13.7	9.6	620.4
AW/1	2.2	11.4	N.A.	621.2
AW/1.5	1.7	8.6	10.3	724.1
AW/2	1.9	6.0	5.5	1 903.6
BC	0.5	3.2	N.A.	8 643.4

3.3 *Rheology*

Oscillatory measurements presented in Figs.3a) and b) were used to characterise the difference of microstructure of nanocellulose suspensions throughout the LVE domain[1, 12, 14, 15].The first observation we make from Fig.3a) is that there is an obvious difference between samples regarding the xylan content, as two distinct groups of *G´* and *G´´* can be distinguished. The upper one with nanofibrillar celluloses contains high and medium amounts of xylan, respectively, i.e. Ref, AW/0.75, AW/1 and AW/1.5, with γ_c at 0.2 %. The second group shows lower values of "wavy" shaped *G´*and *G´´* for nanofibrillar cellulose suspensions having drastically reduced xylan content, AW/2, and no xylan, BC. The longer LVE[16] for nanofibrillar cellulose suspensions in the firstgroup is explained by the stronger gel-like structure build between the more swollen fibrils with higher carboxylic content on their surface, [12, 16],showing different agglomeration mechanisms between those two distinguished groups. Similarly, difference in strength of nanocellulose gel is observable from frequency sweep measurements, Fig 3b), expressed as independence of $G'$and G'' from frequency for small frequencies and increase for higher frequencies, respectively again, according to the distinguished grouping of suspensions regarding xylan content. The elastic behaviour of the samples predominates over viscous, with rigidity increase with frequency being more pronounced for nanofibrillar cellulose of the second group (AW2 and BC), also explained as strain hardening, possibly due to increasing friction within less swollen nanocelluloses at higher frequencies [27, 13, 15, 16].

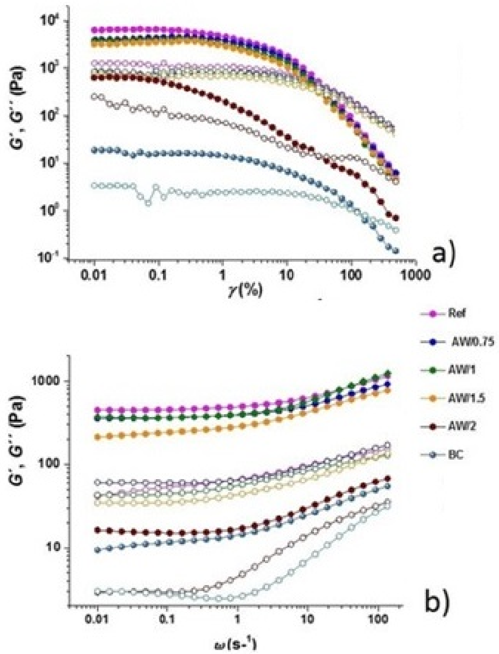

Fig. 3 Viscoelastic measurements for NFC suspensions: a) amplitude sweep for a range of strain (γ = 0.01-500 %) at constant angular frequency of 1 (rad)s^{-1}, b) frequency sweep (0.1-100 (rad)s^{-1}) at constant strain of 0.1 %.Elastic modulus (G') are presented with open symbols, loss modulus (G'') with closed symbols.

The immobilisation curves in Fig.4 display a clear difference in the rate and nature of immobilisation in relation to partial/total removal of xylan in the suspension matrix. The increase of elasticity (G') of the structure, and can be traced through the difference in moduli (G' and G''), which is more pronounced for the samples which have xylan remaining in suspensions, in contrast to those without xylan [21]there follows a decrease, probably due to smaller, less swollen and more mobile, gel-liberated nanocellulose particles. We see that, (i) with reducing amount of xylan there is an obvious difference in dynamic of development of viscoelastic moduli (G' and G'') and the suspensions with larger xylan content immobilise as gel (G'>G''), which is opposite for the other, low-xylan content group. After initial dewatering, bound water in the second group, leaves the suspension, which results in elasticity decrease after immobilisation.

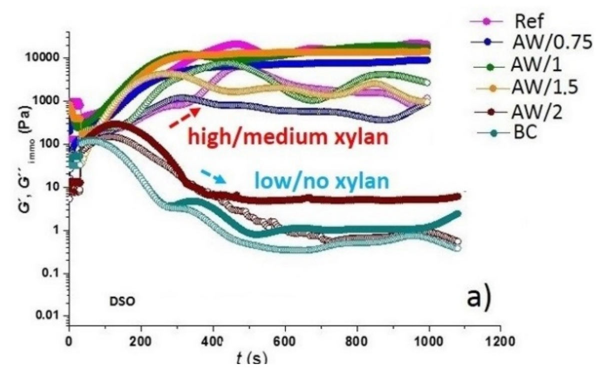

Fig. 4 Determination of nanocellulose suspension dewatering using dynamic dewatering (IMC) in DSO mode as a function of dewatering time, showing the change of the amount of entrapped gel water within the filter cake upon immobilisation.

As the presence of xylan affects the nature of immobilisationwe highlight the grouping of nanofibrillar cellulose suspensions giving correlation between swelling as seen in Fig. 3 and its influence on dewatering as seen in Fig. 4, indicating that by reducing xylan structure there is a lower level of gel-water trapping, which naturally reduces elasticity within the suspension.

3.4*Aerogels*

Instead of traditionally used supercritical CO_2 drying, which includes solvent exchange, here we used afreeze drying method to remove water directly from the aqueous gel, as described earlier by Pääkko [11] where moulds with hydrogels samples were placed in a vacuum oven without any preceding freezing.Due to the vacuum pumping action, the samples quickly cool below thefreezing point of water, and afterwards water is removed by sublimation. It has been demonstrated that such gels have very low porosity and a layered sheet structure with micropores and mesopores. Using this method part of the water is evaporated already from the liquid state during the initial state of pumping.Theremaining part of the water is sublimated from the frozen state. Fig. 5 presents the SEM images from the sponge-like aerogels, which have very high porosity ~ 98%[11, 12].The specific BET surface area was in range 9-11 m^2g^{-1}. When aerogel structure is formed from the sheet-like skeleton, the sheets are inter-connected by fibrillar joint networks and are able to deform readily [12].

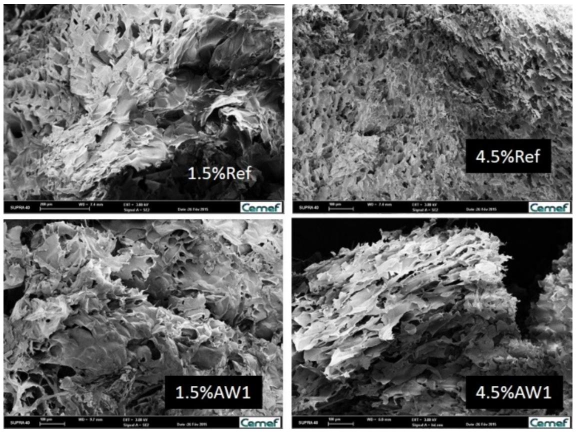

Fig5. SEM images from aerogels as a function of solids content.

Representative compression stress-strain curves for Ref samples, for all four different consistencies, are presented in Fig. 6a). For higher consistencies, 4 % and 7%, it is evident that a linear increase in stress as a function of strainis followed by a plastic deformation region and then a sharp increase upon densification of the porous structure. The stress-strain curve shows that the stiffness of aerogels increases with increase in consistency. The dependence of compressive modulus as a function of density, presented in Fig. 6b), reveals that, as seen in Fig. 6a), density (solids content) has a strong influence on the compressive moduli of the aerogels, while elasticity is higher as the xylan content decreases, as seen for all samples at both 1.5 % and 4 %.

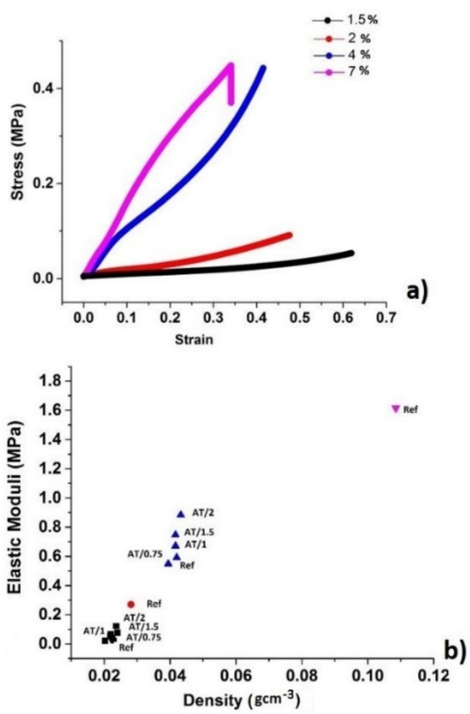

Fig. 6 Compression stress-strain curve for freeze-dried aerogels: a) made from Ref samples, and b) dependence of elastic (compression) moduli on density for all samples.

The lower amount of xylan in the aerogel network results in higher compressive modulus due to the evident influence on the nanocellulose network, which has swollen xylan bundles between nano-fibrils. Image analysis of compressed aerogels, Fig. 7, viewed from the beginning of compression through the end compression (last of four images) of 7 %.

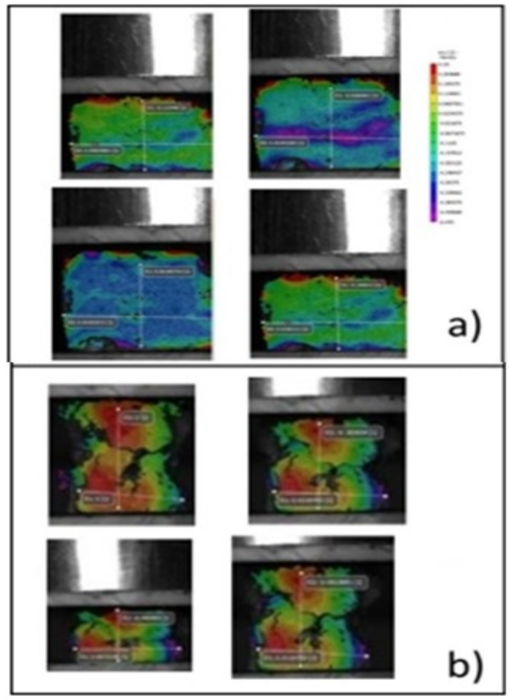

Fig 7. Stress distribution images of compressibility of Ref samples at a) 7.0%, and b) 1.5% consistency.

4. CONCLUSIONS

In the present work, the role of xylan on the water binding properties of NFC gels is investigated through the rheological and dynamic dewatering behaviour of nanocellulose gels with varying xylan content. The xylan is water binding polysaccharide and is attached to fibrils, surviving the TEMPO-oxidation, unless it is removed by alkaline pre-treatment. The effect of xylan on the amount of immobilised water within NFC gels is correlated through the different strengths of the gels, as the mechanical structure of water-interlocking aggregates of xylan is preventing structure collapse upon dynamic dewatering. The role of xylan removal on the strength of NFC aerogels is seen through the increase of compression moduli with decrease of xylan content, which is in turn is consistency dependent.

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RHEOLOGICAL BEHAVIOUR OF SONOCHEMICALLY PREPARED BACTERIAL CELLULOSE AQUEOUS DISPERSIONS

Dimitrios Tsalagkas[1], Katarina Dimic-Misic[2], Patrick Gane[2], Orlando J Rojas [2], Thaddeus Maloney[2], Levente Csoka[1]
[1]Institute of Wood Based Materials and Technologies, University of West Hungary, Hungary
[2]School of Chemical Technology,Department of Forest Products Technology, Aalto University, Finland

Abstract.*Bacterial cellulose (BC) is an environmentally-friendly polymeric material that has high purity, high crystallinity, a high degree of polymerisation, high tensile strength and strong biological adaptability,all of whichproperties make it interesting for various applications. Two different approaches in purifying BC are demonstrated, water and alkaline methods, and in the alkaline case followed by ultrasoundtreatment. The different approaches in BC purification and sonochemical processingare shown to affect drastically the morphology of the BC fibrils, as seen from films by optical methods. Rheological investigation shows that there is a difference in manifestation of particle shape/crystallinity response and that sonicated samples show a rheological behaviour similar to that of liquid crystals in bothlinear and non-linear regimes. This opens up new possibilities for novel application of BCin the preparation of self-oriented composite materials.*
Keywords*:microbial cellulose, ultrasound, liquid crystals, aligned composites, self-assembly*

1. INTRODUCTION

Bacterial cellulose (BC)is being used in a broad range of fields, includingbiomedical and smart material applications, rheological modifiers in food, cosmetics and chemical products, foams, aerogels, and as reinforcement in a range of polymer matrices. Novel industrial applications of nanofibrillar cellulose (NFC), of which BC can be considered a subset, include production of electrically conductive all-polymer batteries, magnetic nanopaper, additive in paper coatings, and in the cellulose nanocrystal form (CNC) as transparent films for electronic display applications[9, 17]. The rheological behaviour and structure of complex materials define the nature of their mechanical properties[3, 7]. This is more apparent withbio-polymeric materials, whose unique combination of mechanical properties derives from an architectural design that spans from nanoscale to macroscopicdimensions [13,17].

Macromolecules, in particular cellulose, control the intricate nano and microstructures of biocomposites, which can be probed rheologically in the process toward achieving functional material design concepts. By application of shear structuration conditions, BC suspensions can be tuned, making it possible to create controlled structure orientation and, thus, opening up new possibilities with clear industrial application potential in products and processes[6].

Polymer liquid crystals form a class of materials whose molecular structure and macro-scale arrangement are very diverse. The rheology of liquid crystals composed of small molecules has been already described by many authors [1,9, 11, 14]. Important aspects in related phenomena take into account anisotropy, where the viscosity along the direction is different from the viscosity perpendicular thereto [14]. Polymer liquid crystals all possess the usual characteristics of polymers, since they are composed of long chains that lead to a complex viscoelastic behaviour [2, 4, 5, 6]. Yet, their intrinsic orientation also makes them follow theconstraints of that orientation in relation to the direction and of elasticity due to its distortion [5].

The influence of the orientation leads to a set of six viscosity coefficients (a Newtonian fluid only has one) [14]. The rheology of nematic liquid crystals provides a very rich behaviour in respect to their viscosity. Entropic elasticity components originating from the polymer, as well as anisotropic viscosities and elasticity of distortion of the direction originating from its intrinsic orientation, are characteristics of thisnematicmesophaseorder [6, 10, 11, 15].

Rheological behaviour of cellulose suspensions could influence the properties of final dried films [16].The main reason for enthusiasm in obtaining liquid crystalline order within suspensions is that,once dewatered, these materials have excellent mechanical properties due to very high levels of molecular orientation in the solid phase [8, 11, 14].
The aim of this work is to determine the rheological behaviour of alkaline purified, sonochemically treated BC aqueous dispersions prior to their solvent evaporative drying process to obtain BC films.

2. MATERIALS AND METHODS

2.1*BC aqueous dispersions*

BC was purchased from a commercially available product, nata de coco gel cubes, distributed by PT Cocomas, Indonesia [9, 13, 17]. BC aqueous dispersions were prepared as reported by Tsalagkas *et al*. [17]. Briefly, BC was washed and soaked in distilled water until neutral pH (5-7) to remove the citric acid and other components added to nata de coco syrup. Then, a portion of the water purified BC was alkaline treated to remove bacterial cell debris and other soluble polysaccharides existing in nata de coco. Purification treatment was conducted by warming water purified nata de coco cubes in 0.01 M NaOH at 70 ℃ for 2h under continuous stirring and rinsed at neutral pH.Subsequently, both water and alkaline purified nata de coco cubes wereblended, poured into silicone trays and dried at 50 ºC. After drying, BC films were cut and redispersed (0.1% w/w immersed in 80 cm^3 distilledwater). Water purified BC aqueous dispersions (W BC) were used as control. Alkaline treated BC dispersions were further submitted to ultrasonication (US BC). Sonication was directly applied at low frequency (20 kHz) in a cold water bath for 30 min using an ultrasonic probe (25 Wcm^{-2}).

Characterization of samples

The crystallinity was recorded with X-ray diffraction patterns at room temperature in the 5-80 °C 2Θ angle using an MDP Pro Panalyticaldiffractometer equipped with Xcelerator linear detector.
FE-SEM micrographs were obtained using a Zeiss ULTRA Plus (Oberjochen, Germany) instrument at an acceleration voltages of 1 and 2 kV. The suspensions were filtered through a gilded PC membrane and dried for 1 h at room temperature. All samples were coated with a highly conductive film of gold by Bal-Tec SCD 500.
Transmission electron microscopy (TEM) was applied in a morphological study conducted using a JEOL JEM 2100 at 100Kv. BC samples for TEM were sonicated for 1 min at ambient temperature, at 80 W. Then, a drop of diluted supernatant containing dispersed BC was deposited onto carbon-coated Cu grids, following removal of excess liquid by a piece of filter paper. Finally, the samples were dried at room temperature.
Zeta potential, ζ, of W BC and US BC aqueous dispersions were determined with a Zetasizer Nano ZS90 (Malvern Instruments) at room temperature. Smoluchowski's approximation was used to convert the electrophoretic mobility into aζ potential value.

2.2*Rheological measurements*

The rheological characterisations were performed using an Anton Paar 300 (Anton Paar Germany GmbH) equipped with a bob and cup geometry, with an operating gap of 1 mm.For oscillatory measurements,a pre-shear protocol was applied at angular frequencyω = 10 rad.s^{-1} and strain amplitude, γ = 0.01 % for 100 s, followed by a rest time of a further 100 s. The linear viscoelastic range of the sample (LVE) was obtained from an amplitude sweep oscillatory test using constant angular frequency (ω = 1 rad.s^{-1}) with varying strain amplitude (γ = 0.01 - 500 %). Dynamic moduli, G' and G'', and complex viscosity (η*) of BC dispersions were measured as a function of angular frequency (ω) over a downward frequency range (ω = 100 - 0.01 rad.s^{-1}) in frequency sweep oscillatory tests, with logarithmic spread of data points.Hysteresis of steady state flow measurements was obtained with a pre-shear protocol of 10 s^{-1} for 2 min and rest time of 2 min. In addition toη* (ω), also steady state flow curves as a function of shear rate $\dot{\gamma}$ were used to investigate differences in flow behaviour between W BC and US BC. Hysteresis of flow curves were measured in downward and upwardshear rate sweeps$\dot{\gamma}$= 1000-0.01 s^{-1} and 0.01 – 1000s^{-1} with logarithmic spread of data point duration from 1 to 100 s.Structure recovery measurements were performed with the 3ITT test, consisting of three intervals: oscillation/rotation/oscillation. Once again a pre-shear protocol was applied at$\dot{\gamma}$= 10 s^{-1} for 20 s and rest time of 2 min. In the first interval of oscillation, the test was performed at constant angular frequency ω = 10 rad.$s^{-1}$and constant direct strain (DSO) strain γ = 0.01%, which has a value in the linear viscoelastic range (LVE) determined previously by an amplitude sweep test. During the second interval, a deformation was applied to the sample under a rotational regime with a medium to high shear rate of 500 s^{-1}.
Each type of measurement was performed five times, including the pre-shear protocol, and an average value with deviation was calculated.

3. RESULTS AND DISCUSSION

Crystallinity index (Cr. I) and maximum degradation temperature (T_{dmax}) values of dried, alkaline purified, sonochemically treated BC films were found to be around 78 % and 374 ºC, respectively [17]. ζpotential values of W BC and US BC were measured anionic at -35.9 ±3.14 and -21.8 ±1.05 mV, respectively.
FE-SEM and TEM images presented in Fig.1 displayed differences in the homogeneity, transparency, size and number of aggregated BC microfibrils after ultrasound treatment [17].

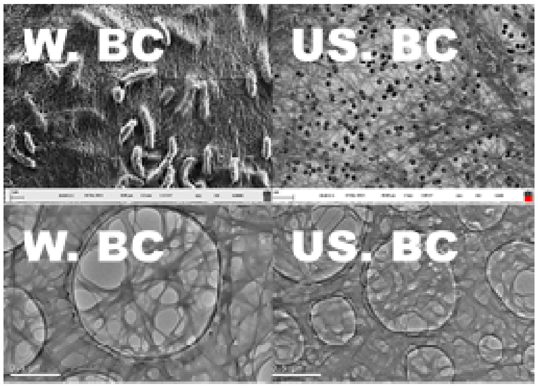

Fig. 1 FE-SEM and TEM images of W. BC and US. BC aqueous dispersions.

Once the linear region was specified with an amplitude sweep oscillatory rheological measurements, a frequency sweep was used to characterise the material's linear viscoelastic response to small amplitude deformations [3,7]. Results from oscillatory measurements are presented in Fig. 2a-band reveal that both BC suspensions, being at very low solid content range of 0.1%, are like those of a low aggregated liquid crystalline form [2, 9, 14]. The cross-over point of *G´* and *G´´* is at lower strain rates for US than for W samples, probably due to re-ordering of the liquid crystalline structure. Fig. 2bshows the frequency sweep measurement, which reveals a behaviour of *G´* typical for liquid crystals, with a cross-overlapping of *G´*and *G´´* occurring two times, at distinct values of *ω*. *G´´* is seen to increase with increasing frequency, which is typical for low aggregated networks, as presented schematically in Fig. 3.The liquid crystalline nature of the BC suspensions and the associated observed presence of change in orientation during flow, is obvious from the curves presented in Fig. 4. This is demonstrated by the presence of two distinct hysteresis loops, defining*bistability*,typical for liquid crystals [10, 14, 15]. Evident also is the distinct difference between the two BC treatments, i.e. between (i) greater shear thinning and (ii)larger hysteresis loops each in the case of the US samples, indicating structuration during shear flow [5, 10, 11]. This bistability is also present in the W BC samples, but to a lesser extent, as, due to the lower energy less dispersing pre-treatment of water washing (W), the rods are not as free to move as in the case when they were alkali washed and sonicated (US).

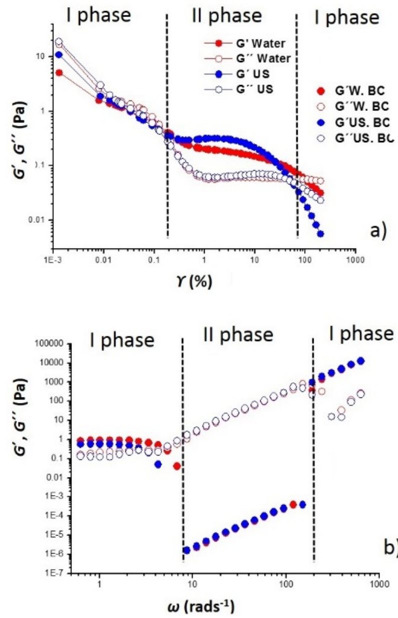

Fig 2Viscoelastic measurements for US BC and W BC suspensions at 0.1 % solids content: a) amplitude sweep, b) frequency sweep. Elastic modulus (*G´*) closed symbols, loss modulus (*G´´*) open symbols.

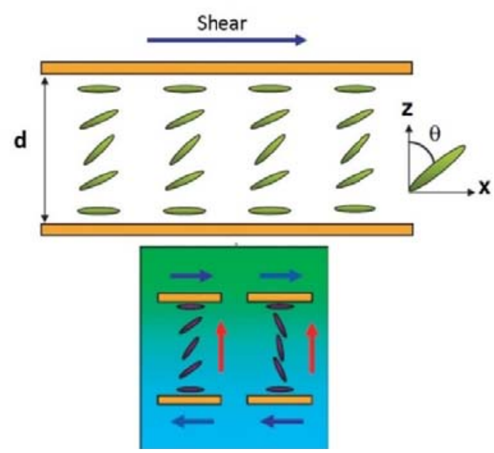

Fig. 3 Schematics of the behaviour of crystalline BC rods that show *bistability* in orientationwhen subjected to shear flow, similar to liquid crystals [11].

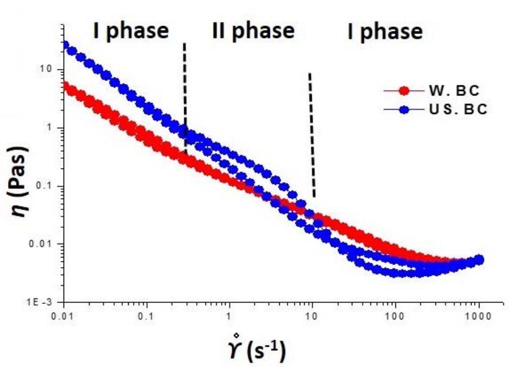

Fig. 4 Dynamic viscosity *η*for US BC and W Csuspensions at 0.1 % solids content as a function of shear rate. Two hysteresisloops are present in the flow

curves of both samples, with the US.BC samples having more pronounced hysteresis loops and greater shear thinning behaviour.

Structure recovery thixotropic 3ITT tests reveal the break-up of elastic structure during the middle high shear interval, as presented in Fig.5. The recovery path of liquid crystalline structures is seen through the overshooting character of G', and the slow recovery towards the initial value ofG'_0 [14]. Overshoot is higher for the US BC samples, which correlates well with data in Figs. 3 and 4. The structure recovery 3ITT measurements also indicate the faster recovery of the liquid crystalline structure in the US BC case,after the high shear field, due to the easier orientation of the better dispersed crystalline rods and the potential energy well "spring effect" typical for liquid crystal structures[1, 2, 14] .

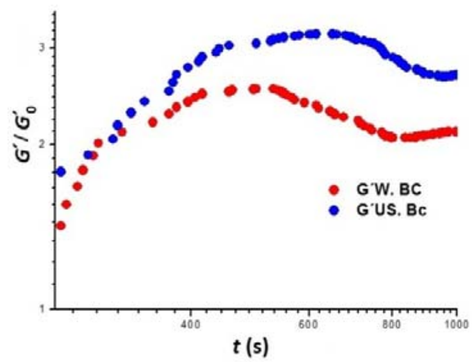

Fig.5 Elastic modulus (G') during the third interval in the oscillation – shear- oscillation protocol of the 3ITT experiment, and the normalised elastic modulus (G'/G'_0).

4. CONCLUSIONS

The BC aqueous dispersions tested showed to be highly crystalline bio-polymers, which after being treateddisplayed a complex and richrheological behaviour, by borrowing their viscosity and entropic elasticity characteristics from polymers and their anisotropic viscosity, as well as elastic distortion, from liquid crystals. Alkaline purification increased the surface charge and removed BC debris contamination. The following ultrasound mechanical treatment, fibrillated and restructuredthe aggregated BC microfibrils, enhanced further dispersion, and increased the freedom of movement of the rod-like particles, such that they could readily develop a liquid crystalline behaviour.

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FLOW CHARACTERISTICS OF INK-JET INKS USED FOR FUNCTIONAL PRINTING

Dimic-Misic Katarina[1], Alp Karakoc[1],Merve Ozkan[1],Syed Ghufran Hashmi[2],Tuomo Salo[1],Patrick Gane[1,3]Thad Maloney[1], Jouni Paltakari[1]
[1]Department of Forest Products TechnologyAalto University School of Chemical Technology
[2]New Energy Technologies Group, Department of Applied Physics, Aalto University, FI-00076 Aalto (Espoo), Finland
[3] Omya International AG, CH-4665 Oftringen, Switzerland

Abstract. *The rheology-related effects of nozzle clogging in inkjet printing can seriously affect ink ejection rate and result in irregular droplet trajectory, resulting in poor printing results.In this study three different inkjet inks, used for functional printed electronics with a Dimatix materials inkjet printer, are investigated rheologically. In connection with rheological observation a novel method of inkjet trajectory image analysis gives insight into the irregularity of directional deviation due to clogging of nozzles of the printerIt is found that the rheological behaviour has a profound effect in the printing regime, which directly has an effect on ink-droplet trajectory and contact characteristic with the substrate.*

Keywords: *inkjet printing, rheology of inkjet inks, nozzle clogging, ink droplet trajectory.*

1. INTRODUCTION

Inkjet printing (IP) is a versatile, non-contact, highspeed and precise patterning technique which decreases the manufacturing costs of printable devices by minimising the waste and process time [3, 5]. Commercialisation of many research technologies on numerous substrates can only be realised by such an economic, ecologically-friendlyand high throughput method[5]. Although especially drop-on-demand (DoD) IP is a very competitive mass production method it poses some limitations preventing it to be a standard part of the manufacturing lines especially due to the crucial ink requirements [5, 6]. The DoD process starts with an impulse applied to the nozzle of the printer and a drop is formed within the limitations given by the nature of the ink and properties of the printer, followed by the ejection from the nozzle. The droplet, in some cases with undesirable 'satellite drops', travels between the printing orifice and the substrate [2]. Ideally, the satellite-free and round-shaped drop needs to follow a straight trajectory with a controlled velocity. Clogging of nozzles in inkjet printing is the most disruptive phenomenon in the sensitive operation of ink-jet printing, affecting print quality in several ways. Partial clogging can change the flow pattern and print out uniformity, and the internal property and quality of ejected ink can be seriously compromised, not least by a contamination derived from a clogging build-up breaking off and entering the ejected drop. While researchers have intensively used IP technology in the manufacture of many printed electronic devices, such as thin-film transistors (TFT), solar interactive dyes and respective electrolytes, and organic light emitting diodes (OLED), there are still problems present related to unevenness of prints, that are a result of nozzle choking, an effect of fast solvent evaporation and complex rheological behaviour of the IP inks [20].

Various types of IP inks have been developed with low viscosity solvents in order to increase performance ofthe print out, especially when used for electronic device applications. Reduction of fluidity of the inks through evaporation and gelation is important to prevent leakage and avoid undesirable contact with solvents, especially when sealing materials are present. In addition, too high an increase in viscosity of the IP ink used for printing electronics upon gelation leads to dilatant behaviour, and can furthermore lead to undesirable clogging of the IP nozzles [7,8].

In order to obtain high performance jetting of the functional IP inks used for Dimatix printer, optimised parameters define the desirable physical properties for the jetting of inks used for printed electronics: viscosity (η ~ 10-12 mPa.s), surface tension (σ ~ 28-42 x 10^{-3} Nm^{-1}), boiling point (more than 100° C), density (more than 1 gcm^{-3}), pH value (4-9).

Using rheological evaluation of the three different IP-functional inks used for functional printing of electronic devices, discussed in this paper, in respect to their viscosity dependence over a broad shear rate range and their structure recovery, it is possible to correlate their flow parameters with the print out performance. Measuring ejected trajectory from a cleanDimatix nozzle, and a same nozzle after printing has been performed for a few days, we can observe that clogging of the nozzle due to the observed complex rheological behaviour results in a change in ejected trajectory[11-14].

2. EXPERIMENTAL METHODS

2.1 Characterisation of Inks

Three types of organic solvents were used for production of functional printing IP inks, aimed for printing electronics:L-D (low-dilatant), M-D (medium dilatant) and H-D(high dilatant), respectively. The respective solvents had different boiling temperatures of 285 ºC, 164 ºC and 82 ºC.

The surface tension of L-D, M-D and L-D exhibited surface tension values ofσ = 40 $mN.m^{-1}$, 27 $mN.m^{-1}$, 24 $mN.m^{-1}$, as measured using an optical surface tension meter (CAM 200 from KSV instruments) in pendant drop mode, respectively.

The viscosity behaviour is a complex phenomenon, which is presented in detail below.

2.2 Inkjet Printing Process

A piezoelectric, laboratory scale DoD materials inkjet printer (Dimatix 2831-DMP) [14, 17, 20] was used to test the printability of the inks. The DMP employs a disposable cartridge which is made of chemically resistant polypropylene silicone and silicon dioxide. The cartridge is composed of 2 main components: jetting and storage units. Following a filtering step, and (for some cases) degassing, around 2 cm^3 liquid is filled into the polypropylene bag in the printer storage unit with the help of a special syringe with a blunt tip needle and the two units were attached together. The regular cleaning cycles can be run before, during and after the printing process with contact made with a cleaning pad to maintain or improve the printing performance. The cleaning cycle consists of three actions: blotting, purging and jetting having adjustable order and time lengths [14].The substrate is placed on a special platen having equally spaced holes which provides vacuum to keep the substrate in the desired position. The platen temperature can be raised to 60-70°C.The ink is jetted upon an impulse applied to the jetting module of the cartridge, which is attached to the storage unit. In the jetting module 16 nozzles are embedded in a single row and each nozzle has a channel-type connection to the ink storage unit. The straightforward and flexible processability of printers that operate at relatively low frequency, 1-20 kHz, makes inkjet printing easier and more popular when small amounts of expensive inks are employed [5-8]. The main limiting factors for such an operatingcondition are the fast evaporation of the solvent, resulting in choking of the nozzles, and increase in the viscosity [14, 20].

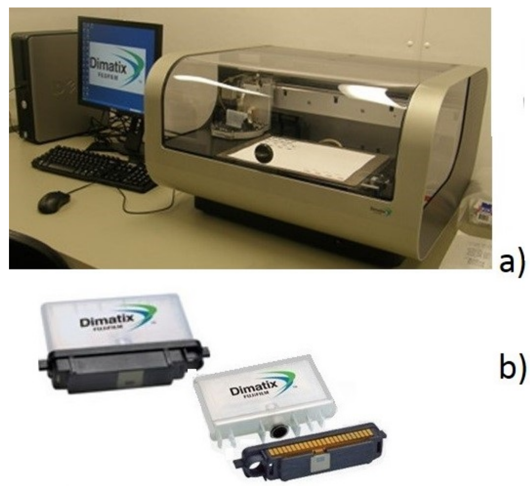

Fig.1. Fujifilm’s Dimatixmaterials printer DMP-2831 and its print head parts: a)DoD inkjet printer, which allows the user to deposit fluid materials on an A4 sized substrate using piezo-based inkjet cartridge, and b) the cartridge consisting of storage unit and jetting (printing) head.

2.3 Rheometry

Rheological measurements were made to characterise the viscoelastic properties of the inks in different temperature and shear ranges.

2.3.1 *Linear and non-linear behaviour*

The viscoelastic rheological investigations were performed at 23 °C by means of an Anton Paar 300 (Anton Paar Austria GmbH) oscillatory constant stress/strain and variable shear rheometer. For rheological measurements of inks, an upper serrated plate-plate geometry PP-25 was selected, while the bottom plate was smooth, in order to reduce any potential wall-slip effect, gap was set to 0.5 mm. In order to avoid any memory-effect from previous deformations all samples were pre-sheared under oscillation at an angular frequency (ω) of 10 $rad.s^{-1}$ and strain deformation (γ) of 0.01 % for 10 min, followed by a rest stationary state time of 15 min. To prevent evaporation of the water medium, a layer of silicone oil was spread around the boundary of the sample in the geometry in contact with the air - a common procedure [2, 19]. To perform the frequency sweep test, the linear viscoelastic range of the sample (LVE) was obtained from an amplitude sweep using constant angular frequency (ω = 1 s^{-1}) with varying strain amplitude in the range γ = 0.01 - 100 %. The influence of frequency on the variation of complex viscosity (η*), which is within the LVE range, was evaluated for angular frequency in the range ω = 0.1 - 100 rad.s^{-1}. Response of the dynamic viscosity (η) to shear rate was measured over the shear rate range $\dot{\gamma}$ = 0.01 – 1 000 s^{-1} applying a logarithmic data collection duration from 500 - 1 s.

2.3.2 *Recovery and dilatancymeasurements*

Structure recovery measurements were performed with the three interval test (3ITT test). To evaluate the evolution of η after high shear stress, the 3ITT rotational test was performed consisting of a step-wise shear rate test with three defined intervals of applied shear. During the first and third intervals, the sample was sheared at a low shear rate of 0.1 s^{-1}, following the second interval during which high shear, $\dot{\gamma}$ = 500 s^{-1}. For evaluation of the tendency to dilatant behaviour, another 3ITT test was performed where in the second interval shear rate was linearly increased from 1 to 500 s^{-1}, recording the dynamic viscosity (η) response.

2.3.3 *Droplet Trajectory determination: regular and irregular ejection*

To investigate the influence of the rheological properties on the droplet trajectory, image processing was implemented to distinguish between the difference in droplet formation and trajectory Fig. 2a), at first when the nozzle was clean at the initial stage of printing, and Fig. 2b) when time has passed and the nozzle opening was choked leading to irregular ink ejection which changed droplet trajectory, as presented in Fig. 2c).Complex rheological behaviour may result also in lower performance as a function of the firing (jetting) frequency, drop velocity and drop formation under deformation, creating irregular droplets or spherical drops of insufficient volume. The change in trajectory after drop formation was evaluated for the case where the nozzle was initially clean and after using the same nozzle for a few days, due to the effect of the complex rheological behaviour and deposition of ink on the edge of nozzles, including unwanted evaporation.

3.1 *Rheological analysis*

For successful printing of IP inks, due to their fast evaporation at high temperatures, thermal and rheological stability under jetting are important [12, 13], especially when considering fast evaporation of solvent at the nozzle-air contact. For this reason, when engineering functional printing inks, used, for example, for printing electronics with a relatively low colloidal volume fraction [16,18], the tuning of rheological behaviour is very important in tailoring ink viscosity and drying kinetics. Fig. 2a)-b) shows clearly that the complex and dynamic shear response behaviour as a function of shear rate is different to that of the complex response as a function of frequency, with the complex viscosity (η*) being much higher than the dynamic viscosity (η), with both η* and η revealing shear thinning properties at the lower energy input state but dilatant behaviour for successive alternate conditions of higher frequency [17, 20]. Both η* complex viscosity and η dynamic viscosity, Fig. 2a)-b), for ink L-D reveal more stable flow curves that ink M-D and H-D, which exhibited instability in both η* and η attributed to viscoelastic fluctuations and dilatancy, respectively.

The example functional IP inks have shear thinning rheological behaviour, but since the solvent evaporates during the printing process their viscosity changes through the duration of use, depending on the process conditions [8-10]. As presented in Fig. 3a)-b) the inks eventually display dilatant behaviour, and therefore it is important to define the degree of viscosity increase after the high shear period. However, as presented in Fig. 3a), viscosity increase resulting from the high shear rate interval is lowest for the L-D ink, which is important when considering that dilatant behaviour leads to clogging for nozzles and a related decrease in printing performance [20]. Fig. 3a) shows a typical plot of viscosity at low shear rates, but as shear rate increases in the second 3ITT interval, viscosity decreases and then stays constant. When the shear force is decreased again, the viscosity increases again, as this is typical for thixotropic behaviour [2, 19]. Fig. 3b) shows the viscosity of inks when the shear rate is linearly increased between 0.1 - 500 s^{-1}.

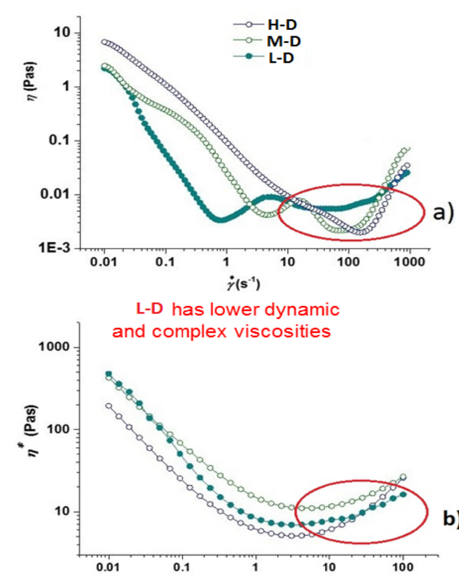

Fig.2. Rheological behaviour of inks: a) steady state

flow curve for dynamic viscosity (η), b) viscoelastic response expressed through complex viscosity (η*) showing increase at higher frequencies, being lowest from L-D.

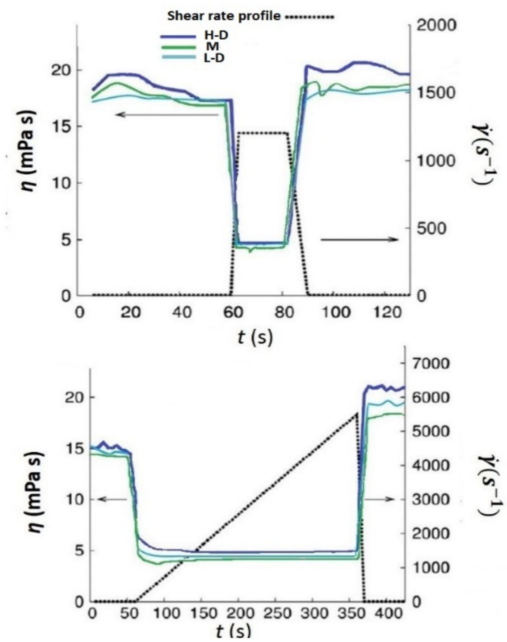

Fig. 3. Response of η in 3ITTfor the example functional inks: a) step wise constant shear rate, and b) a linearly increasing shear rate showing dilatant behaviour of inks.

The more stable response of the L-D ink can explain its good printability, whilst, on the contrary, the poor performance of the remaining inks can be explained as clogging of the nozzle cause by increased elasticity and dilatant viscosity accompanied with faster solvent evaporation, as presented in Table 1, where the dynamic viscosity is normalised to the equilibrium low shear viscosity η^0.

Characteristic Property	H-D	M-D	L-D
η @ 10 s^{-1} (mPa.s)	7.8	8.2	10
η @ 100 s^{-1} (mPa.s)	2.4	3.4	9
η @ 1 000 s^{-1} (mPa.s)	58	62	24
η / η^0 after 3ITT, ($\dot{\gamma} = const$ (%))	34	27	5
η / η^0 after 3ITT, ($\dot{\gamma}$ linear increase (%)	37	29	7

Table 1. Rheological parameters of the three functional inksobtained from flow curves and structure recovery tests.

The IP-ink printing performance was tested on Xerox paper for the clarity of information, as shown in Fig. 4a)-c). With paper as substrate it is clearly possible to see the difference between the ideal dot shape when it comes in contact with substrate "single spherical droplet size before spreading" and dot printouts in respect to the solvent used for each ink[13, 16]. Once the deposits of the ink are formed at the nozzle they tend to clog the inkjet print head due to further attractive build-up and reduced velocity of flow, which in turn reduces print performance further and even requires frequent replacement of the ink supply channel.

The spreading of the ink shown in Fig. 4 is primarily a function of ink-paper interaction during the absorption phase of drying. However, asymmetry of the droplet, and the presence of satellites when observed relates to the jetting performance.

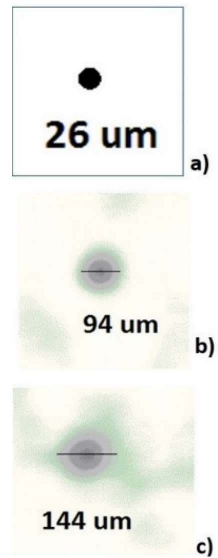

Fig. 4. Functional IP inks printed on Xerox paper: a) "single spherical droplet", b) spreading of ink solvent on paper causing uneven concentration within the ink matrix, c) extreme spreading of ink due to uneven distribution of solvent and ink particles on the substrate.

3.2 *Droplet trajectory*

In order to study the impact of rheology on the clogging of the nozzle and the effect it has on ink trajectory, in drop trajectory evaluation was carried using image processing from the images taken during the jetting process of M-D ink. In the current study, one cycle of the inkjet printing was taken into account, video frames of which images were extracted for one single nozzle and shown in Fig. 5a)-c). Thereafter, extracted frames were digitised to form a binary image so as to obtain foreground and background pixel data as seen in Fig. 5a). To determine the binary threshold, the Otsu method was used, which minimises the combined spread of foreground and background pixels [11].

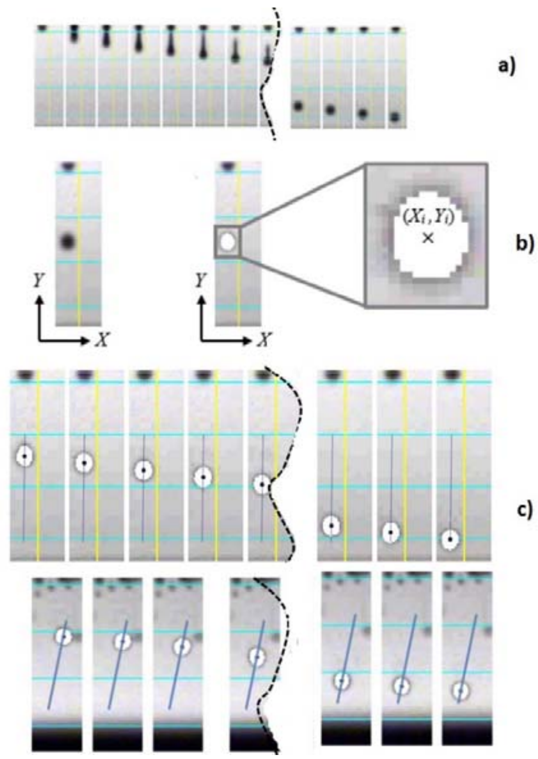

Fig.5. Droplet ejection during the inkjet printingprocess: a)image processing from original image to binary image with white coloured foreground pixels, b) schematic representation of the droplet centroid, and c) droplet centroids ejected from a clean nozzle following a linear trajectory compared withdroplet centroids from a nozzle that has been used for a few days.

Following the binary conversion, morphological analysis was performed to define the droplet centroid coordinates for the i^{th} frame as

$$\left(X_i, Y_i\right) = \left(\frac{\sum_{j=1}^{n} x_j}{n}, \frac{\sum_{j=1}^{n} y_j}{n} \right), \tag{1}$$

where(x_j, y_j) are the coordinates of the j^{th}foreground pixel and n is the total number of foreground pixels inside the investigated droplet in Fig. 5c).

The droplet trajectory is followed using the centroid data for each consecutive frame in Eq. (1). For this purpose, the data were fitted to a first order polynomialto investigate whether the droplet follows a linear trajectory. Here, Y coordinate data are simply taken to be dependent on the X coordinate data. For the linear drop trajectory the fitted polynomial,

$$Y = 74.16\, X \text{-} 720.11 \tag{2}$$

with angular difference $\theta_{\text{ref}} = 0.77^{\circ}$ was calculated. This trajectory was hence used as reference for further computations. The deviated drop trajectory the fitted polynomial was

$$Y = 4.91X \text{-} 29.77 \tag{3}$$

with angular difference $\Delta\theta = \left|\theta - \theta_{\text{ref}}\right| = 10.74^{\circ}$, which is giving significant difference in position where dot actually consolidates

3. CONCLUSIONS

Three differentIP inks for functional printing on electronic devices were fabricated from different organic solvents, with different physical properties. Their dilatant rheological behaviour was found to have a deleterious effect on printing performance, and further cause clogging of the inkjet nozzles, which resulted in a change of ejected ink droplet trajectory. For the first time, deviation angle of ink trajectory has been measured using image processing. By careful tailoring of solvent used for preparation of ink deleterious dilatant behaviour of inks can be reduced,and soprovides potential for further development of DoD-IP processes for functional printing.

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FOOD PRODUCT SHELF-LIFE PREDICTION

Vule Reljić[1], Laslo Tarjan[1], Stevan Stankovski[1], Milovan Lazarević[1], Gordana Ostojić[1]
[1]Faculty of Technical Sciences, University of Novi Sad, Serbia (vushe90@hotmail.com, laci@uns.ac.rs, stevan@uns.ac.rs, laza@uns.ac.rs, goca@uns.ac.rs)

Abstract. *The paper shows analysis of how to detect diseases of tomato leaf, caused by leaf miner, or mechanical damage to the leaves and fruit of tomatoes, and how to predict the shelf-life of fresh tomatoes, that are to be used in dishes. In order to, as accurate as possible, determine shelf-life, all information, that covers the entire life cycle of product, in this case tomatoes, as well as products intended for human consumption, must be available. This information can be also used to inform consumers if the food product becomes unusable.*

Key words: *tomato, shelf-life, disease, damage, leaf, fruit.*

1. INTRODUCTION

For different types of products there is a finite length of time, after production, in which product retain a required level of quality under stated conditions of storage. This period of time is short for: chemical, medical, cosmetic and food products. In case of food products the required level of quality is conditioned by organoleptic and safety properties.

Time period in which food preserves all this properties is generally defined as the shelf-life. Shelf-life can be calculated by measuring the amount of degradation that occurs during the food aging process.

In order to better calculate and in some cases predict shelf-life of most importance is to track and trace food product during its life cycle. For each food product, it is necessary to record data starting from the stage of raw products farming, through food processing, transport, warehousing, to retailing and reaching the end consumer [12]. This data together with data about storage [3] conditions will help improving product's shelf-life prediction.

Temperature is one of the most important parameters of quality control and food freshness is almost an exclusive function of time and temperature. Thus the temperature is becoming an important function for perishable food and visibility and traceability is especially important in its cold chains [14].

Recently, a number of researches are focused on shelf-life. In the paper [4] analyzes the changes in the shelf-life of tomatoes placed in the warehouse using a sensor system for detecting odours. The application of wireless sensor networks for monitoring of food products in the cold chain logistics is represented in paper [7].

Another important parameter that can affect shortening of shelf-life is early detection and elimination of diseases of fruits and vegetables in order to get a good quality yield and to reduce production and economic losses [9]. If the disease is detected in early stage, timely treatment could initially suppress its spread, and also completely remove it. It is clear that the presence of the disease influences the predicted shelf-life and maintaining the freshness of fruit and vegetables. On the other hand, mechanical damage that may occur during transport also affects shelf-life. In this case it is advisable to detect damage and alert consumers about the change in the shelf-life.

Disease or leaf damage, or fruit and plants can be detected using different methods e.g. various spectroscopic methods (near infrared spectroscopy, magnetic resonance spectroscopy), fluorescence imaging and others [1, 5, 13].

The paper shows analysis of how to detect diseases of tomato leaf, caused by leaf miner, or mechanical damage to the leaves and fruit of tomatoes, and how to predict the shelf-life of fresh tomatoes, that are to be used in dishes.

2. METHODOLOGY

In order to as accurate as possible predict the shelf-life of a food product, it is necessary to use adequate mathematical model and to collect the data of interest.

There are several mathematical models, but kinetic model is used in most cases [11].

$$K = K_0 \cdot e^{\frac{-E_a}{R \cdot T}} \quad (1)$$

$$A_{t_0} = A_0 - K \cdot t_0 \quad (2)$$

$$\ln A_{t_1} = \ln A_0 - K \cdot t_1, \quad (3)$$

where K is called a rate constant depending on temperature, product and packaging characteristics; K_0 is a pre-exponential factor, integration constant; R is the gas constant in [J/K*mol], and equal to 8.3141; T is an absolute temperature in K (273 + °C); E_a is an activation energy in [J/mol], the minimum energy that a system must have for reaction to start; A_0 is initial concentration of reactant; A_{t_0} , A_{t_1} concentration of reactant in t_0, (storage time before treatment of product) t_1 (storage time after treatment of product) [day].

The (1) represents Arrhenius plot often used to analyze the effect of temperature on the rates of chemical reactions. Equations (2) and (3) are equations that describe chemical reactions of zero and first order.

Concentration of reactant can be measured, while the values K and E_a are estimated on the basis of linear regression analysis. Product shelf-life can be determined with equations (4) and (5), which derives from previous equations:

$$t_0 = \frac{A_{t_0} - A_0}{K_0 \cdot e^{\frac{-E_a}{R \cdot T}}} \quad (4)$$

$$t_1 = \frac{\ln A_{t_1} - \ln A_0}{A_0 \cdot e^{\frac{-E_a}{R \cdot T}}} \quad (5)$$

t_0 and t_1 are determined in number of [day].

Several elements like: firmness, elasticity or viscosity, moisture content, level of decomposition degree of wilt, the presence of soluble solids, the presence of some significant acids and others, have great influence on the food product shelf-life. All these parameters can be measured using appropriate instruments. For firmness, elasticity or viscosity testing e.g. dedicated instruments can be used (Fig. 1.) [2].

Parameter values are collected in pre-defined time intervals and these measurements are done in the following manner: the product is stored at several temperatures until it becomes unusable and the dependence of the influential elements, for example, firmness, elasticity or viscosity, temperature and time elapsed are determined.

Figure 1. Food Rheology Tester [2]

Since there are many parameters that affect the product shelf-life, only most important must be chosen. Sensory estimation can also help in choosing these parameters. This estimation includes evaluation of the: quality, color, taste, smell, and other characteristics of the product which is done in the same time intervals when making measurements and data collection.

After that, it is observed, based on the Pearson correlation coefficient, which parameters show the highest correlation. For calculating the Pearson coefficient the software [10] can be used. The parameters of interest are selected if the value of the Pearson coefficient is greater than 0.9 (or less than -0.9, if it is a negative correlation).

When the parameters, which influence the shelf-life, are chosen and when their value is measured, then values of the K_0 and E_a for selected fruits and vegetables are estimated, using linear regression analysis.

For conducting experiments it is necessary to prepare several crates (at least 5) with fresh tomato fruit. Each crate should be stored at different temperature and monitored until the moment when it fruit becomes unusable for human consumption. Meanwhile, in a pre-defined time intervals, would be measured data of importance about which were discussed in the previous paragraphs, on randomly selected samples (minimum 10 pieces).

Following the procedures described above, K and E_a for tomatoes would be determined. Based on the obtained values of the K and E_a shelf-life can be calculated according to equations (4) and (5).

Based on data obtained in this way it is possible to monitor the state of the tomato in any stock or any retailer only by monitoring room temperature where the tomato is. This data can be gathered using a temperature sensor placed in the corresponding sensor assembly. This information would be forwarded to the server through communication network (e.g., wireless). In this case server is used to control entire database and for forwarding the information about changing the shelf-life of products to the retailers.

For detection of disease and plants damage, whose symptoms are visible or not, a variety of spectroscopic and other methods, can be used [9]. One of them is near infrared spectroscopy (NIR). This method can be used for detection of tomato leaf miner and mechanical damage to the leaf, or the fruit of tomatoes.

Leaf miner is small fly whose body length is between 1.5 mm and 2.3 mm and can be differently colored. The larvae, which cause damage to the leaf by feeding on leaf tissue, do not have legs and a distinct head. On infected leaves arise typical corridors - mines, which are visible from the face and the surface of leaf (Fig. 2). Additional damage on leaves is caused by female pests. This damage is in the form of bright spots, which are caused because supplementary feeding or laying eggs [8].

Figure 2. Leaf of tomato pestilent by leaf miner [6].

A slowdown of growth and development of plant, and thus reduce production and economic losses are the results of this damage.
NIR can be used for detection of leaf miner and mechanical damage because it includes part of approximately between 0.8 microns and 2.5 microns of the electromagnetic spectrum and may arouse harmonic vibrations. The most commonly used element for this technique is spectrometer with Fourier transformation.
For conducting experiments it is necessary to collect a number of healthy leaves and fruits of tomatoes, as well as mechanically damaged, and the leaves that are infected with leaf miner. The leaves and fruit of tomatoes should be illuminated by the spectroscope at appropriate intervals (every 3 nm). The process is repeated for more than 10 times. Since the leaf miner and mechanical damage are visible from the face and the surface of leaf, all measurements should be made firstly on face side and then on back side of the leaf. All data collected from the spectrometer can be transferred to a computer via analog-to-digital converter, where the appropriate calculations will be performed. Collected data is placed in a separate file, which can be initiated only with appropriate software package that spectrometer producers supplied with the device. This procedure is then followed with appropriate statistical analysis of the data and adoption of the appropriate conclusions.

3. RESULTS

It is very important to know food product shelf-life and stick to it in order to avoid food poisoning. Therefore it is required to enabling tracking and tracing product during its life cycle, through all stages.
In the early stages of production, it is possible to use spectroscopic methods to detect the disease, if any, and to remove it. In addition, it is possible to detect mechanical damage of leaves and fruit, which can occur at any stage of the product life cycle. Of course, it should be noted that spectroscopy is not the only method for the detection of plant diseases. There are many others. One of them, used in the paper [5] implies fluorescence imaging and image processing using CCD (Eng. Coupled Charge Device) devices. In this research it is shown that the detection of disease can be very quickly achieved (only 50 hours after putting pest in the leaf), but a large number of images is needed.
It is also very important to take care of food product freshness, and it is important to keep it to a pre-defined temperature. Only in this case, prescribed shelf life is valid. What is characteristic is that the temperature, at which the product is kept throughout its life cycle, is constantly changing (depending on whether the product is in stock, transport, or retail). Therefore, it is necessary to constantly monitor temperature changes and predict new shelf-life. This can be achieved using sensor networks and promptly sending data to the appropriate server. It should be noted that this method is not the only one for predicting shelf-life. In the paper [4] a shelf-life prediction of tomatoes is made using the sensor system for the detection of odors, but the results were not satisfactory.
Methodology described in this paper helps eliminating any possibility of food poisoning consumers, a thus the main objective has been met.

4. CONCLUSIONS

One of the most important things in the food industry is the tracking and tracing product during its life cycle. Tracking must be done in order to avoid putting harmless food on the market. Tracing is done in case of contamination. Then tracking information can help detecting where the contamination took place during process. In this paper it is shown a concept how can be possible to track life cycle of the tomato – from farming products, till using it for nutrition, or, until it becomes unusable for human consumption. In order to set this concept two experiments are shown.
In the first experiment a detection of tomato leaf miner, using the spectroscope, during plant growth is done in order to prevent or completely remove miner. This spectroscope can also be used to detect mechanical damage to the leaf and fruit of the tomato, which is used in the food industry. It is clear that all damage, whether caused by the presence of pests, or otherwise can substantially affect the shelf life of tomatoes.
The second experiment involves monitoring the life cycle of tomato and shelf-life prediction, depending on the appropriate conditions, such as, for example, the storage temperature for tomato. Results show that shelf-life is very variable and it depends on the storage temperature, temperature during transportation and temperature in retail.
Methodology presented in paper gives a novel approach which combines food product (plant) monitoring through all stages of its life cycle, and timely provision of information, about changing of product shelf-life, to consumer in order to enable using only fresh food product for nutrition.

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RECOMMENDATION FOR A NEW MODEL OF THE MAINTENANCE SYSTEM OF TURBINE AND HYDROMECHANICAL EQUIPMENT AT THE HYDRO POWER PLANT DJERDAP 1

Arsić Miodrag[1a], Srđan Bošnjak[2], Mladen Mladenović[1], Nebojša Milovanović[1], Zoran Savić[1]

[1]Institute for materials testing, Bulevar vojvode Mišića 43 Belgrade, miodrag.arsic@institutims.rs
[2]Faculty of Mechanical Engineering, Kraljice Marije 16, Belgrade, sbosnjak@mas.bg.ac.rs

Abstract. *Turbine and hydro mechanical equipment at hydro power plant 'Djerdap 1' is subjected to service conditions that lead to degradation of material of components and structures. Taking into account the rate of occurrence of failures (damages, accidents) and experience gained through long-term performing of tests it was established that main causes of material degradation are fatigue, corrosion, erosion and cavitation. Results of performed tests and researches carried out in order to identify the causes of material degradation, damaging and fracture of components and structures of turbine and hydro mechanical equipment during the rehabilitation of the hydro power plant 'Djerdap 1' showed that material degradation, damages and fractures occur due to the simultaneous influence of a large number of technological, metallurgical, structural and exploitational factors and that convenient structural solutions which would ensure mechanical reliability of components and structural integrity could be achieved only through absolute knowledge of their behaviour under various regimes of operation. On the basis of those results new system for maintenance of components and structures of turbine and hydro mechanical equipment was recommended.*

Keywords. *Hydro power plant, turbine equipment, hydro mechanical equipment, maintenance system model*

INTRODUCTION

Vertical Kaplan turbines, manufactured in Russia and with nominal power of 200 MW, have been installed in 6 hydroelectric generating units at hydro power plant 'Djerdap 1' [1]. Hydroelectric generating sets are being projected for the service life of 40 years due to structural solutions and limited possibilities of performing periodic inspections and state analyses.

Results of performed state analyses and researches that referred to determination of the cause of material degradation, damaging and fracture of components and structures of turbine and hydro mechanical equipment during the rehabilitation of hydroelectric generating sets A4, A5 and A6 at hydro power plant 'Djerdap 1' [2-6] showed that material degradation, damaging and fractures occurred due to the simultaneous influence of a large number of technological, metallurgical, structural and exploitational factors and that convenient structural solutions, which would ensure mechanical safety of components and integrity of structures, could be achieved only through absolute knowledge regarding their behaviour in various operating regimes. Basic components of the vertical Kaplan turbine are shown in figure 1.

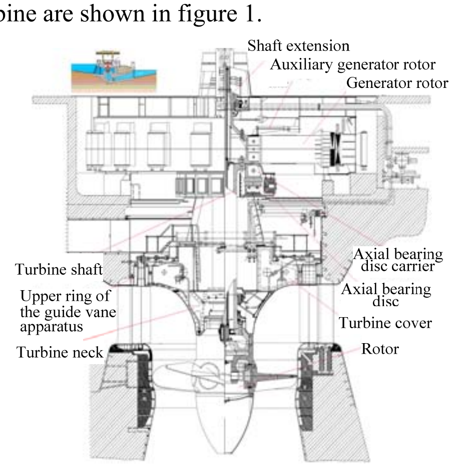

Figure 1. Appearance of the vertical Kaplan turbine

TECHNICAL DIAGNOSTICS USED DURING THE REHABILITATION OF HYDRO POWER PLANTS

Gradual degradation of parent material and/or deformation of components and structures of turbine and hydro mechanical equipment occurs during the service life of hydro power plants, therefore the diagnostic measurements and tests are being carried out only when the accelerated failure of components and structures due to flaws that occur during the manufacturing, assembly and service, as well as during the planned rehabilitation of hydro power plants [2-6], happens. Technical diagnostics during the rehabilitation of hydro power plants has to be based on 3 principles:

– Scope of testing and measurements have to be based on the history of use of turbine and hydro mechanical equipment,

– tests and measurements have to be carried out in compliance with specified procedures, through the use of adequate equipment and qualified personnel,

– results of tests and measurements need to be shown in such a way that the conclusions comprise the exploitation of manufacturing technical systems and a team of experts with suitable experience and knowledge from various professional and scientific areas. Properly executed technical diagnostics prevents sudden failure of components and structures of turbine and hydro mechanical equipment from happening, as well as rational technical and economical exploitation and safe working conditions for employees. It is very hard to analyse large production systems, such as hydroelectric generating sets at HPP 'Djerdap 1', due to the complexity of their structure, operating conditions and a large number of components and structures of turbine and hydro mechanical equipment. In such cases it is suitable to use FTA (Fault Tree Analysis), figure 2 [5]. For the analysis of modes and effects of failures, a method of qualitative and quantitative reliability analysis of components and structures of turbine and hydro mechanical equipment in all phases of service life and preventive analysis for all potential modes of failure of hydro mechanical generating set elements and their influences, FMEA (Failure Mode and Effect Analysis) is being used, figure 3. On the basis of performed researches regarding the failure and cause of malfunction of components and structures of turbine and hydro mechanical equipment at hydro power plant 'Djerdap 1' through the use of Fault Tree Analysis and Failure Mode and Effect Analysis [5], as well as indicators of reliability obtained on the basis of analysis of collected data for realistic conditions of service, optimum setting of the system for continual diagnostification of turbine and hydromechanical equipment based on the application of PLC-PC coupling could be carried out accurately.

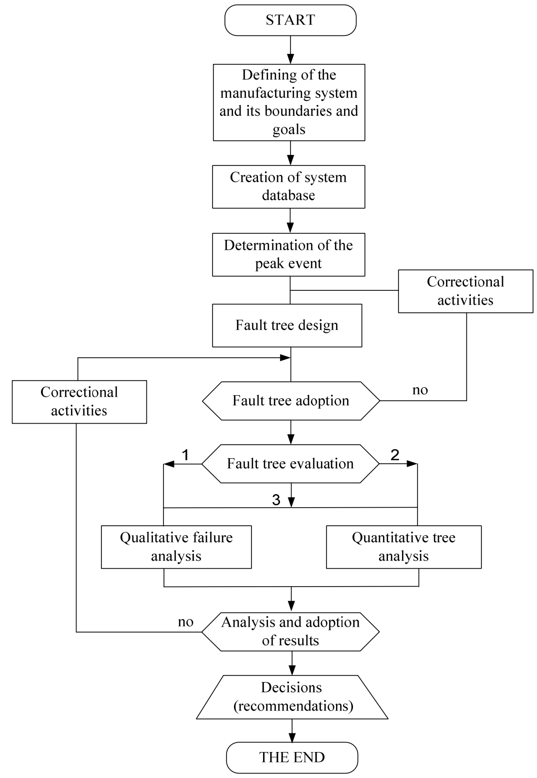

Figure 2. Fault Tree Analysis, block diagram

Figure 4 shows the schematical appearance of the configuration of the system for continual management, monitoring and diagnostification of the vertical Kaplan turbine through all system levels. It can be seen that it is possible to directly connect operational interface and hand-held programmer to the PLC [7]. Hand-held programmer has a numerical keyboard with light indicators for status marking and operator terminal which, with better models, can define up to 200 numerical and variable messages. Operator interface has the alphanumeric display with the functional keyboard and displays values of process variables, statuses, alarms and messages, logs that refer to system flaws and those defined by the user’s program with the moment of creation and parameters predetermined by name or address.

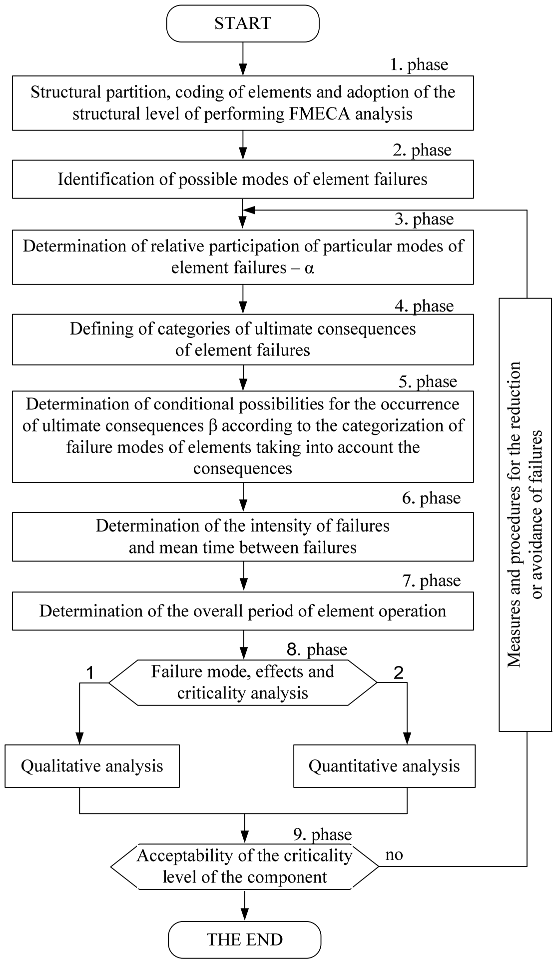

Figure 3. Failure Mode, Effects and Criticality Analysis, block diagram

DATABASES

Data on loads, properties of parent material and welded joints, technology of their creation, technical and physical characteristics of recorded fractures and prescribed measures of damage and failure prevention are being imported into suitable databases. Organization of the maintenance system of turbine and hydromechanical equipment at hydro power plant ’Djerdap 1’ depends primarily on the nominal power, type and structure of the turbine, number of employees, experience of experts and suitable databases that refer to maintenance and previous inspections.

On the basis of realized researches [2] and many years’ experience of authors regarding the maintenance of complex systems, the proposition of a new model of maintenance system for hydro power plant ’Djerdap 1’ was made, figure 5.

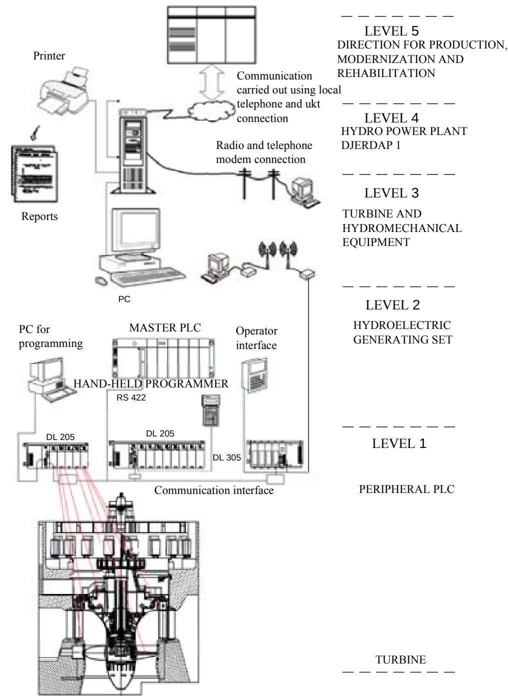

Figure 4. Appearance of the configuration of the system for management, monitoring and diagnostification of a turbine

CONCLUSION

Realized researches offer great possibilities in wide-ranging analyses performed in order to define behaviour of components and structures of turbine and hydromechanical equipment at hydro power plant 'Djerdap 1'. The goal of these analyses is to determine the cause of material degradation and failures of components and structures due to variations of a large number of influential factors, in order to get safer components and structures or to reduce undesirable effects to acceptable values, or in other words to realize suitable structural solutions.

A fast and reliable solution for the realization of convenient structural solutions regarding the components and structures could be achieved solely through the creation of databases and bases for the development of computer programs. The accompanying software packages would enable more efficient use of databases, analyses of particular influential factors, improvement of techniques, possibilities for fracture prevention and considering alternative solutions in all phases of design and development of components and structures of turbine and hydromechanical equipment. The above-mentioned would enable the development of the expert system for prevention of failure of turbine and hydromechanical equipment at hydro power plant ’Djerdap 1’.

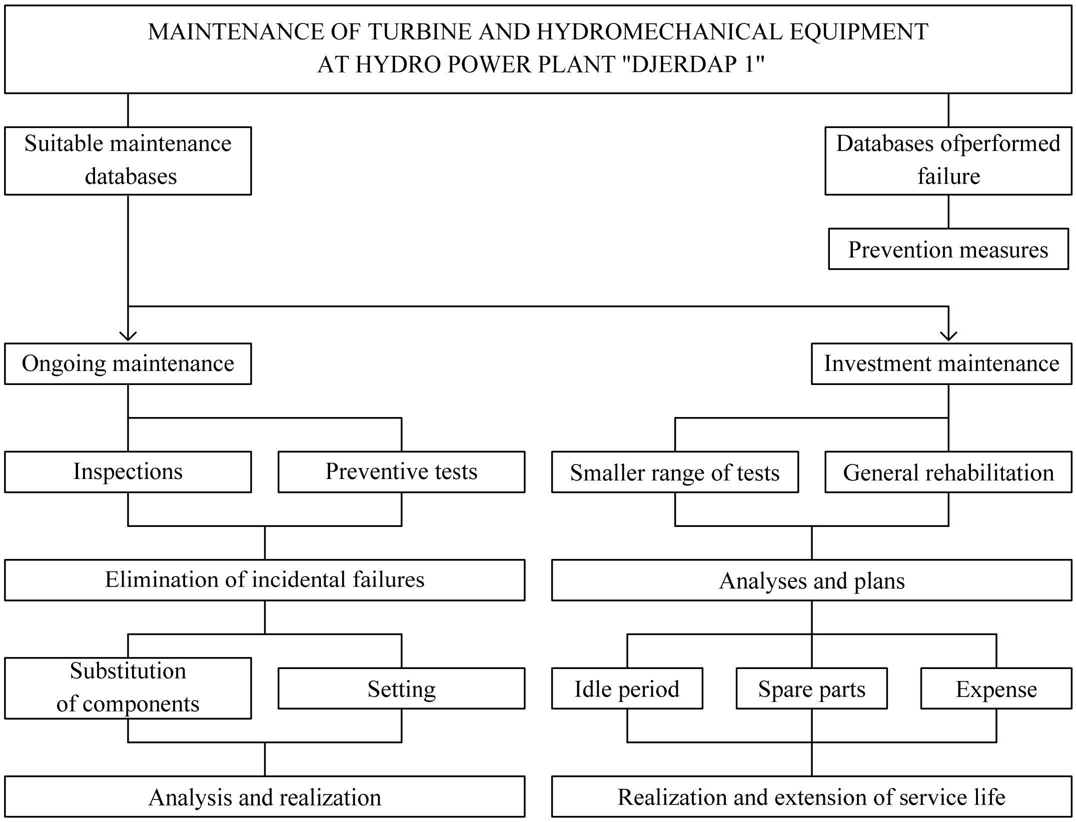

Figure 5. New model of the maintenance system for turbine and hydromechanical equipment at HPP 'Djerdap1'

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CALCULATING GEOMETRIC PARAMETERS OF THE SEMI-ROLLED STRAIGHT PAN GEAR

Vladimir N. Syzrantsev[1], Kseniya.V. Syzrantseva[2], Andrey A. Pazyak[3]
[1]Doc. Sc. (Engineering), Professor, Honorary worker of science of the Russian Federation, the chief of department «Machinery and equipment of oil and gas industry»;
[2]Cand. Sc. (Engineering), assoc. professor, department «Cybernetic systems»;
[3]Postgraduate, teaching assistant, department «Machinery and equipment of oil and gas industry»
Tyumen State Oil and Gas University, Tyumen, Russian Federation

Abstract. *To recover high-viscosity oil using progressive cavity pumps it is necessary to apply reduction gear boxes with the gear ratio of 7-30 located in the wellbore between the motor and the pump. Currently used planetary reduction gear boxes with the required gear ratio are hard to manufacture, have a low performance coefficient and do not possess the desired reliability.*

To improve the reliability of progressive cavity pumps when recovering high-viscosity oil we can use a coaxial reduction gear box with a pan precess gear.

The work describes the geometry of a semi-rolled straight pan gear. The given method of cutting pinion and gearwheel teeth significantly simplifies its manufacture technology. Multiple teeth in contact allow for the required gear load capacity and reduction gear box reliability.

Based on the developed geometry reduction gear boxes were manufactured with the gear ratio of 10-21 for progressive cavity pumps to recover high-viscosity oil.

Key words. *Coaxial reduction gear box, semi-rolled pan gear, straight teeth*

INTRODUCTION

Coaxial reduction gear boxes [1, 2, 3], developed on the basis of the pan precess gear, allow creating compact drives for oil and gas machinery that have a high performance coefficient (about 0.9), low starting torque, which is crucial for drive operation under severe operation conditions, and a wide range of gear ratios (10-65 and more). Currently, the most fully researched pan gears are those with double concavo-convex teeth [4, 5]. The process of cutting such teeth is not only labor-intensive, but also incredibly complex. It requires four re-settings of the gear-cutting machine, as each tooth side is cut separately. In the given work we discuss the semi-rolled straight pan gear with a simplified procedure of manufacturing its gearwheel teeth. Despite the absence of contact in the gear of interest, due to multiple teeth meshing, it is commercially viable when producing high-load drives operating under conditions of low shaft speeds and short-term work modes.

Figure 1. Coaxial reduction gear box with gear ratio $i = 20$

Figure 2. Pipion with double-concavo teeth

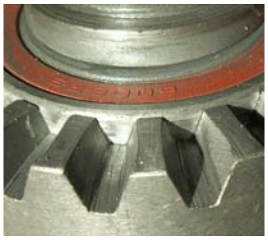

Figure 3. Gearwheel with double-convex teeth

SHAPING GEAR TOOTH

Figure 4 shows the gear diagram. Cutting of the gearwheel tooth cavity is done by a tool with a straight-line cutting edge. During such treatment the gearwheel remains fixed. Prior to cutting each of the following tooth cavity, the gearwheel rotates at an angle divisible by the tooth pitch angle, i.e. a method of singular division is realized. As tools we can use cutters (cutting on a gear shaping machine without rolling), end-mill type cutters or side mills (cutting on a milling machine with a turntable).

From the described method of cutting it follows that the gearwheel tooth flank is a plane. The reference tooth surface is a plane that goes through the tooth reference point M parallel to the plane $x_2 o_2 y_2$ (perpendicular to the axis z_2). The coordinate system $S_2(x_2, y_2, z_2)$ is firmly connected to the gearwheel. The gearwheel tooth flank in the coordinate system $S_p(x_p, y_p, z_p)$, which axis y_p is directed along the normal towards the tooth surface, is a plane and in this system of coordinates its equation is:

$$x_p = u\,;\, y_p = 0\,;\, z_p = h\,, \tag{1}$$

where u - a linear coordinate along the gearwheel tooth length, h - a linear coordinate along the gearwheel tooth profile.

Let us express the radius vector $\overline{r}_p$ of the gearwheel tooth surface (plane) in the coordinate system $S_p(x_p, y_p, z_p)$ as a row matrix $\widetilde{r}_p = \left\| x_p; y_p; z_p; 1 \right\|$, the elements of which are coordinates x_p, y_p, z_p, and the radius vector of the gearwheel tooth surface $\overline{r}_2$ in the system $S_2(x_2, y_2, z_2)$, - as a row matrix $\widetilde{r}_2 = \left\| x_2; y_2; z_2; 1 \right\|$, the elements of which are coordinates x_2, y_2, z_2. Then the gearwheel tooth surface in the system $S_2(x_2, y_2, z_2)$ is described as the dependence:

$$\widetilde{r}_2 = \widetilde{A}_{2p} \cdot \widetilde{r}_p\,, \tag{2}$$

where $\widetilde{A}_{2p}$ - the fourth order matrix [5, 6], determining the transition from the coordinate system S_p to the system S_2.

Uncovering the expression (2) we get:

$$\left.\begin{aligned} x_2 &= u \cdot \cos\theta_{f2} - h \cdot \sin\theta_{f2} \cdot \cos\alpha_n - r_2 \\ y_2 &= -h \cdot \sin\alpha_n + t \\ z_2 &= u \cdot \sin\theta_{f2} + h \cdot \cos\theta_{f2} \cdot \cos\alpha_n \end{aligned}\right\} \tag{3}$$

where θ_{f2} - the decrement angle; α_n - the pressure angle; r_2 - the mean cone distance; t - a half of the tooth thickness.

In the studied semi-rolled pan gear the gearwheel tooth surface is an envelope in a one-parameter movement of the gearwheel tooth surface. The generating surface is a straight gearwheel tooth flank (plane). Let us refer to Figure 4, which demonstrates the coordinate system $S_2(x_2, y_2, z_2)$, firmly connected to the gearwheel, and the coordinate system $S_1(x_1, y_1, z_1)$, firmly connected to the pinion during gearwheel tooth shaping.

When cutting teeth, due to the machine kinematics, when the wheel tooth rotates along its axis at an angle φ_2 the workpiece rotates along its axis at an angle φ_1, connected to the angle φ_2 by the dependence:

$$\varphi_1 = \varphi_2 \cdot i\,, \qquad i = z_2^* / z_1^* \tag{4}$$

where i - the gear ratio of the machine roll, z_2^* - a number of gearwheel teeth, z_1^* - a number of pinion teeth.

Coordinates of the current point of the gearwheel tooth surface (1) are determined by two independent parameters: u and h, that is $\widetilde{r}_2 = \widetilde{r}_2(u, h)$. Due to the above-mentioned rolling motion when shaping the pinion tooth surface, the relative motion matrix $\widetilde{A}_{12}$ is a function of φ_1: $\widetilde{A}_{12} = \widetilde{A}_{12}(\varphi_1)$. The radius vector $\overline{r}_1$ of the pinion tooth surface in the coordinate system $S_1(x_1, y_1, z_1)$ (Figure 4), in matrix form is expressed as:

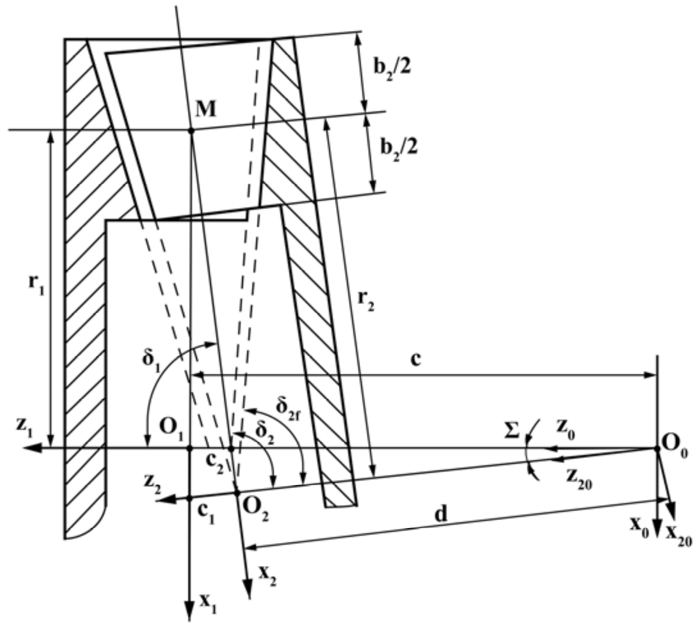

Figure 4. Design scheme of a semi-rolled pan gear and scheme for calculating transition from the coordinate system S_2 to the system S_1.

$$\widetilde{r}_1 = \widetilde{A}_{12} \cdot \widetilde{r}_2 , \tag{5}$$

where $\widetilde{r}_1 = \|x_1, y_1, z_1, 1\|$ - a row matrix, composed of coordinate projection of the radius vector $\overline{r_1}$ of the pinion tooth surface.

Uncovering (5), we get:

$$\widetilde{r}_1(u,h,\varphi_1) = \widetilde{A}_{12}(\varphi_1)\widetilde{r}_2(u,h) . \tag{6}$$

As the surface can have only two independent parameters, for mathematical description of the pinion tooth surface it is necessary to establish an additional connection between parameters φ_1, u and h. In the theory of tooth meshing [6] such connection is referred to as a meshing equation:

$$f(u,h,\varphi_1) = 0 . \tag{7}$$

If the meshing equation is known, the pinion tooth surface, as a family envelope of the gearwheel tooth surface, is described as follows[6, 7]:

$$\widetilde{r}_1(u,h,\varphi_1) = \widetilde{A}_{12}(\varphi_1)\widetilde{r}_2(u,h) ;$$
$$f(u,h,\varphi_1) = 0 . \tag{8}$$

To determine the meshing equation, in the given paper we used the method suggested in [7]. As a result, the dependences determining the pinion tooth surface have the form:

$$x_1 = A_1 \cdot \cos\varphi_1 + B_1 \cdot \sin\varphi_1 ;$$
$$y_1 = -A_1 \cdot \sin\varphi_1 + B_1 \cdot \cos\varphi_1 ; \tag{9}$$
$$z_1 = \sin\Sigma \cdot (f_3 \cdot \sin\varphi_2 - f_1 \cdot \cos\varphi_2) +$$
$$+ \cos\Sigma \cdot (f_2 + d) - c$$
$$\varphi_2 = \arcsin\left[-C_\varphi (\sqrt{A_\varphi^2 + B_\varphi^2})^{-1} \right] - \xi ;$$

where r_1 - the mean cone distance of the pinion; Σ - the shaft angle in the gear.

$$f_1 = u \cdot \cos\theta_{f2} - h \cdot \sin\theta_{f2} \cdot \cos\alpha - r_2 ;$$
$$f_2 = u \cdot \sin\theta_{f2} + h \cdot \cos\theta_{f2} \cdot \cos\alpha ;$$
$$f_3 = t - h \cdot \sin\alpha ;$$
$$c = r_1 \cdot (i - \cos\Sigma) \cdot (\sin\Sigma)^{-1} ;$$
$$d = r_1 \cdot (i \cdot \cos\Sigma - 1) \cdot (\sin\Sigma)^{-1} ;$$
$$A_1 = \cos\Sigma \cdot (f_1 \cdot \cos\varphi_2 - f_3 \cdot \sin\varphi_2) +$$
$$+ \sin\Sigma \cdot (f_2 + d) ;$$
$$B_1 = f_3 \cdot \sin\varphi_2 - f_1 \cdot \cos\varphi_2 ;$$
$$A_\varphi = \sin\alpha \cdot \sin\Sigma \cdot$$
$$\cdot (u + d \cdot \sin\theta_{f2} - r_2 \cdot \cos\theta_{f2}) ;$$
$$B_\varphi = -\sin\Sigma \cdot (f_2 \cdot \cos\alpha -$$
$$- f_3 \cdot \sin\alpha \cdot \cos\theta_{f2} + d \cdot \cos\alpha) ;$$
$$C_\varphi = (i^{-1} - \cos\Sigma) \cdot$$
$$\cdot (f_1 \cdot \cos\alpha + f_3 \cdot \sin\theta_{f2} \cdot \cos\alpha) .$$

These formulas enable us, on the one hand, to perform the analysis of the pinion flank shaping, and, on the other hand, to study the nature of meshing pinion and gearwheel teeth in a semi-rolled pan gear, which is matching according to the way it shapes pinion teeth.

ANALYSIS OF THE GEOMETRIC CHARACTERISTICS OF GEAR TEETH MESHING

Based on dependences (9) in MathCad software a program was developed to study the position and nature of contact lines in teeth meshing of the semi-rolled pan gear. To illustrate the program operation, for a number of fixed values of the pinion rotation angle (φ_1=-0,172; -0,115; -0,057; 0,0; 0,088; 0,177; 0,265) Figure 5 shows its surface contact lines with the gearwheel tooth surface of a semi-rolled pan gear, with the parameters: z_1^*=64; z_2^*=65; Σ=2°; mean normal module m_n=5,0 mm; tooth height ratio h_a^*=1; radial clearance ratio c_o=0,5; face width b_2=25 mm; gearwheel pitch angle δ_2=90°.

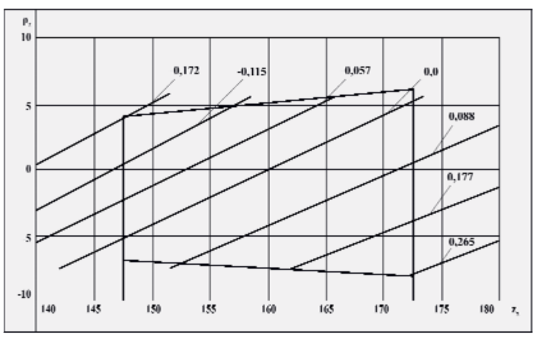

Figure 5. Momentary contact lines on the pinion tooth surface

In the studied semi-rolled gear a change in angle φ_1 from $\varphi_{1\min} = -0{,}172$ to $\varphi_{1\max} = 0{,}265$ corresponds to a maximum tooth meshing phase. Considering the value of the tooth pitch angle on the pinion ($t_1 = 2 \cdot \pi / z_1^* = 0{,}09817$), we determine that $(-\varphi_{1\min} + \varphi_{1\max}) / t_1 = 4{,}45$ tooth pairs are simultaneously in contact in the gear.

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HEAT BALANCE OF LOSSES IN PLANETARY GEAR DRIVES

Predrag Živković
Faculty of Technical Sciences, Kosovska Mitrovica, jomine@sbb.rs

Abstract: *Planetary gear drives have extremely high specific caring capacity. Great energy is being transmitted per gear drive mass unit. A part of this energy which is by friction being transferred to thermal energy, is heating the gear drive components. With prolonged intensive work, the quantity of released heat can be more significance greater than of the emitted one in surrounding. This article treats two issues. The one is concerning producing balance between mechanical losses and released heat. The estimate outcomes of the released heat are put in balance with the mechanical energy losses. The other issues is concerning solutions that can provide heat balance at the prolonged stationary gear work.*

Key words: *planetary gear drives,efficiency, mechanical energy losses*

1. INTRODUCTION

The energy consumed to overcome the frictional resistance at the hips pair of teeth and friction in the bearings, is converted into heat. As a result, the temperature of the oil, shafts, gears and bearings is increased. This heat, through the oil and the inner surface of the housing is transferred to the exterior surface, which increases to the temperature level of the outer surface of the housing. If the carried out heat is less than the energy converted to heat during work, there is an increase of the operating temperature rang of the gear. Calculation of the oil temperature in the planetary gears housing, is mainly based on a calculation of the oil temperature and the heat distribution in components, which are used for gear with parallel shafts. For planetary gear these models are not applicable without further corrections. Experimental determination of mechanical power losses and distribution of power losses per component of the planetary gear, procedure and method of this calculation are discussed in the paper [2]. In order to stabilize the temperature, it is necessary to achieve thermal balance, ie. that the amount of released heat through the outer surface of the housing is equal to produced.

2. STARTING POINTS OF CALCULATION

To establish the heat balance and to determine the temperature of the oil in the housing of the planetary gear, it is necessary to define the method and place, ie. components in which the mechanical energy is converted into heat and how that heat is removed from the outer surface of the housing.
Graphical view of the energy balance is given in figure 1.

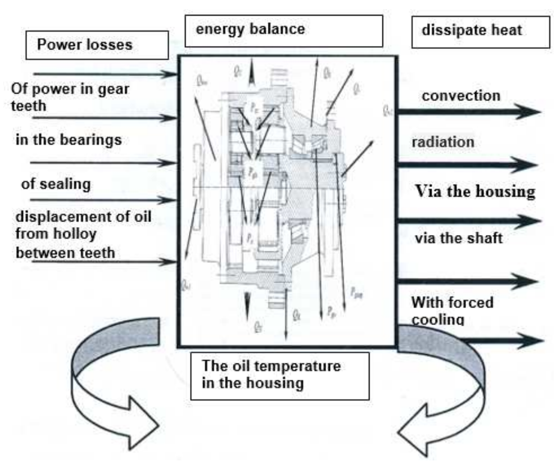

Figure 1. Energy balance in planetary gears drive

Power losses in the components of the planetary gear unit and the resulting heat dissipation through the various components, is shown in Figure 2 [1].

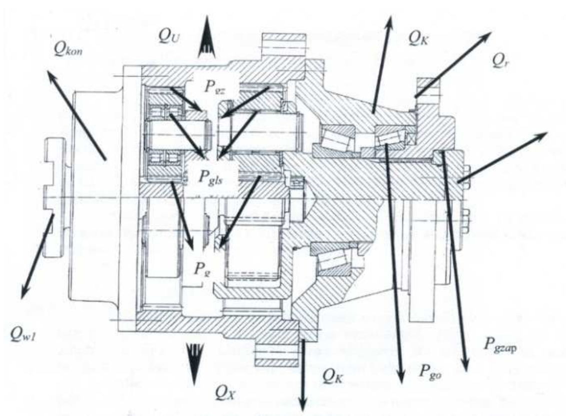

Figure 2. Power losses and heat dissipation of planetary gears

***Q_{W1}** and **Q_{W2}**- conduction of heat through the shaft, Qr - radiation of heat, **Q_K**-heat discharged by convection, Q_{kon} - heat discharged by construction,QU - heat discharged by circulation of oil, Qx - the remaining heat, Pgz -power loss due to gear coupling, Pglz – power loss in satellite bearings, Pgol – power loss in the remaining bearings, Pgzap – power loss due to sealing*

The required amount of heat for the establishment heat balance, which is discharged via the casing can be represented by Eq.

$$P_{gz}+P_{gzap}+P_{gL}+P_{graspulja}=Q_K+Q_R+Q_W+Q_{Kon}+Q_{Pvent}+Q_{ost}$$

In which is:

Q_K- the amount of heat which is supplied by natural convection,

Q_R- The amount of heat that is discharged by radiation,

Q_w- The amount of heat that is discharged through the implementation of the output shafts,

Q_{kon}- the amount of heat supplied to the implementation of the design of the underframe through,

Q_{Pvent}- the amount of heat which is supplied by a forced draft,

Q_{ost}- the amount of heat which is carried out by other methods,

The power loss that is converted into heat, leads to the occurrence of high oil temperature in the gear. The excess heat is transmitted through oil to the internal components of the gear and to the inner surface of the housing. By conducting the external surface of the housing allows the emitted into the external environment. The amount of heat absorbed by the inner swivel parts which pass through the inner surface of the housing depends on the coefficient of thermal conductivity of oil and coefficient of the thermal conductivity material internal rotating components and materials of the case.

The method for determining the coefficient of thermal capacity of oil, for known speed of oil flow inside the housing, which can be applied in the development of forms of housing, with the knowledge of flow conditions, is given in paper [1].

3. CALCULATION METHOD

Depending on the balance between power losses and derived heat, the temperature of the oil will be changed. Total power losses are the sum of the losses of the coupling teeth, mixing oil displacement and the bursting of oil from the space between teeth, losses in the bearings and sealing compounds on the input and output shaft. The relative distribution of these losses, changes with the change of extensive speed of gears. For smaller extensive speed, power losses perforation are higher, compared to the total losses. For large voluminous speed, with the higher level of oil in the housing, power losses perforation decline compared with losses of mixing, extrusion and bursting oil. For the calculation of heat that is transferred from the gear in the environment, it is necessary to define the outer surface of the housing and to determine the effects of devices for forced heat dissipation.

The distribution and dissipation losses per components, removal of heat from the housing and oil temperature of planetary gears are difficult to describe with mathematical equations. That complicates the specificity of the geometry of the components and their movement. Establishing a dependency between losses and distribution losses per component, it is possible to achieve only by experimental bench.

Two-stage planetary gear, which was the test subject, is declared with characteristics: overall gear ratio 42, 23000 Nm torque output, the input speed is 1108 min^{-1} [1]. During tests in laboratory conditions, the ambient temperature indoors was 20^o (±) 2^oC. The testing lasted 8 hours a day. Before the start of the test table on which were placed transmissions, gear oil temperature was equal to the ambient temperature. During the tests the temperature of the housing was measured, by which it is determined that the housing temperature reached a value of 90^o degrees. In order to maintain steady operating temperature during the test gear cooling is performed by forced air flow with the help of the fan. This ensures a steady state.

For practical application, a procedure for calculating the heat balance of power of planetary gears is made. Started from the known sizes and ambient temperature of 20^o degrees, and the temperature of the external surface of the housing 90^o degrees. Based on the known temperature of the casing and the measured power losses, the difference between the temperatures of the inner and outer surface is determined. It was used to calculate the temperature of the oil, with the knowledge of the value of the coefficient of thermal conductivity of the oil. To calculate the thermal emission from the housing, the housing surface was calculated:

Outer surface of the housing A_{SPK} = 0,665 m^2, inner surface A_{upk} = 0,373 m^2, and is equivalent to the thickness of the wall housing δ_{ek}=0,0334 m.

For calculating the thermal emission from the housing of the elaborated method the Funck's equation was applied[1,2].

$$Q_{kod} = Q_{w1} + Q_{w2} + \sum_{j}^{n} Q_j = f(\vartheta_{oil}, v_{airvelocity})$$

Q_{kod} – total discharged heat from the housing,

Q_{w1} and Q_{w2} – heat discharged through the inner and outer shaft,

$\sum_j^n Q_j$ – total heat discharged through the housing,

ϑ_{oil} – oil temperature°C,

$v_{airvelocity}$– air velocity,

Using the calculation method of amount of heat $Q_{kod} = K \cdot A_{SPK} \cdot (\vartheta_{oil} - \vartheta_{vazolonine})$ kW, which is given through the housing for different conditions of air velocity and oil temperature in the gear

$\vartheta_{oil} = \frac{Q_{os}}{\alpha_{oil} \cdot A_{UPK}} + \vartheta_{uk}$°C ,

where:

α_{oil}– coefficient of heat crossing from the oil to the interior of the housing in kW/m^{2}K [3].

A computation of coefficients of heat crossing, with air flowing around the housing, was used $K = \frac{1}{\frac{1}{\alpha_{oil}} + \frac{1}{\gamma_{mk}} + \frac{1}{\alpha_{airvelocity}}}$, with application of the calculated difference of inner and outer surface temperatures of the housing $\boldsymbol{\Delta\vartheta = \vartheta_{uk} - \vartheta_{sk}}$, with equation $(\boldsymbol{\vartheta_{uk} - \vartheta_{sk}},) = \frac{Q_{os} \cdot \delta_{ek}}{\gamma_{mk} \cdot A_{UPK}}$°C,

where:

Q_{os} – discharged heat,

δ_{ek} – equivalent wall thickness of the housing,

γ_{mk} – coefficient of heat conduction for the housing material – steel,

This has established a correlation between the mechanical transmission losses and dissolution rate of heat over the surface of the gear housing, with natural and forced air circulation environment, in order to ensure the heat balance during long-term stationary work.

4. THE CALCULATION RESULTS

Table 1 shows the power losses obtained by measuring the on test rig, screening methods and thermal budget.

By comparing the results of measurements of power loss and results of thermal calculation, a good match of results was obtained. A very good balance between power loss, heating and cooling gear was established. In models for calculating power losses based on the work of the friction force of the coupled gear teeth, a serious correction should be applied because of inaccurate and unacceptable results.

Table 1. Power loss in planetary gear

Power losses measured on the testring kW	total power loss in planetary gear		
	2,227		
Power losses obtained by orientational calculation kW	orientational calculation		approximate calculation
	6,905		5,105
Power losses obtained by thermal calculation kW	for air velocity of 1.25 m/s	for air velociy of 3 m/s	for air velociy of 5 m/s
	1,516	2,122	2,454

5. CONCLUSION

Because of the high degree of compactness, in continuous operation of planetary gear, the amount of heat discharged is larger than that heat can be emitted into the environment through the housing. In this regard, a balance between power losses and heat discharge is established solutions that provide heat balance during long-term stationary work are provided.In addition, we obtained the following results:

- Developed a method and procedure of calculating the amount of heat that is released through the outer surface of the housing, and the temperature of the oil in the gear housing.
- Established a correlation between the mechanical losses and the amount of heat that is emitted into the environment. Numerical results are well matched with the test results.

ACKNOWLEDGEMENT

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INFLUENCES TAKEN INTO CONSIDERATION DURING CALIBRATION OF CONTACT THERMOMETERS AIMED FOR MEASURING TEMPERATURE OF A SOLID SURFACE

Prof.dr.sc. Nermina Zaimović-Uzunović, mr.sc. Narcisa Jarović-Bajramović, mr.sc. Edin Terzić,
University of Zenica

Abstract. *Measurements, calibrations of contact thermometer have benn conducted on prototype/standard – apparatus for calibration of contact thermometers on solid surface (in following text just prototype). In order to make the calibration obtained result whole an estimation of measurement uncertainty is done.*

The possibility to vary parameter of influence of ambient temperature just above the reference surface is used. This parameter is directly derived from the construction of the prototype.

Key words*: Calibration, contact thermometers, measurement uncertainty.*

1. INTRODUCTION

To be sure in contact thermometer measurement result, each instrument and the sensor has to be checked, calibrated. Calibration is the operation that, under certain conditions, in the first step, defining the relationship between the value of the size with uncertainty of measurement standards and corresponding indications with associated measurement uncertainties, and in a second step, uses this information to establish a relation for obtaining a measurement result from the readings. [1]

Contact thermometers for measuring at solid surface are calibration subject on prototype. Those have their part into contributions during estimation of measurement uncertainty.

Contact thermometers have wide application such as food industry, cooking, and various branches of industry where is needed to measure solid surface temperature. For example coatings based on secretion of resin can not be applied at temperatures below the dew point or the temperature below 5°C. Contact thermometers are used for this purpose as well as in the auto industry and other branches of the paint, where the coatings or layers are applied only after checking the temperature using a contact thermometer. The same also have application in the monitoring of temperature heat pipes, construction and many other purposes.

Contact thermometers are generally calibrated using temperature-controlled hot plate. In such a device, the reference temperature is the one on the upper surface of the metal body, and it is determined by linear extrapolation from the readings of calibrated sensors (probes) that are drawn into the body at different depths and distances from the reference surface. The actual temperature of the reference surface depends largely on the interaction of the sensor to the surface. [3, 4]

2. PROTOTYPE - APPARATUS FOR CALIBRATION OF CONTACT SENSORS FOR MEASURING TEMPERATURE OF SOLID SURFACES

The research focused on measuring the variation of the parameter that can not be ignored, and that came out of the construction characteristics of the prototype. Parameter is related to the impact on the ambient temperature just above the surface and ocured as the result of the number, arrangement and position of the heater in the prototype.

One position of the reference board is when the same is in the "top" position and then practically the reference plate is in height (aligned) with the upper rim of the upper (annular) heater. In this case this heater is heating the reference board around (Fig. 1).

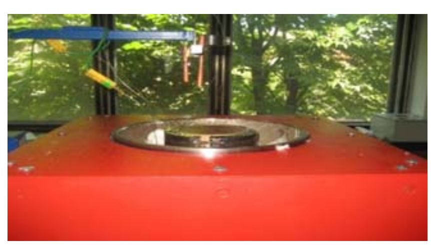

Figure 1. The upper position of the reference body/ plate

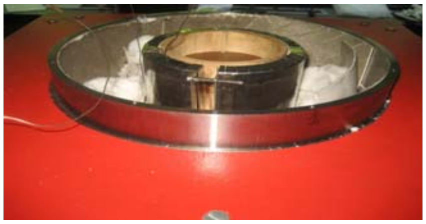

Figure 2. the lower position of the reference body/ plate

The second situation is when the reference plate in the "lower" position and then the lower (the ring, and the middle of the three) heater heats the reference plate around, and the upper heater is in a higher position relative to the reference plate and thus has influence on the ambient temperature, just above the surface of the reference plate (Fig. 2).

This is an important fact because this is a new on a prototype meaning that is one of the improvements of the apparatus. This information is important even more because it would be used to compare the results obtained in one and in the second position of the apparatus at the same temperature calibration points.

re.

The assumption was that the difference of temperature readings read out with a thermometer and the reference board (obtained by extrapolating) and measured at the higher calibration points to be much higher.

The assumption was that the temperature difference would be particularly marked in the case when there was no influence of ambient temperature just above the surface of the reference block or when there is no "preheat" of the reference surface and the contact thermometer.

2.1. Description of prototype

Calibrated thermocouples type K, (Fig. 3.) are located at different distances parallel to the surface of the reference body/ plate. The same thermocouples are connected to a digital thermometer with four channels Chub-E4 (Fig. 3.), in order to monitor the value of the reference temperature within the body, and using these data to extrapolate the temperature of the reference surface. This positioning of the sensors is characteristic in other apparatus, which are developed earlier. Not all the apparatures are using type K thermocouples as sensors.

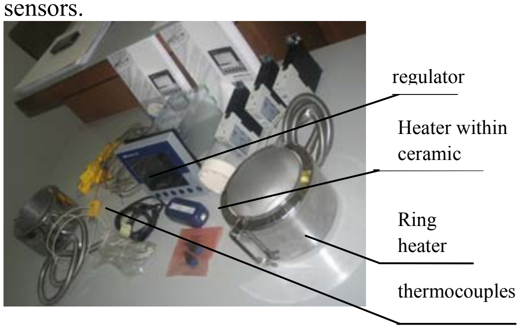

Figure 3. Thermocouples, heaters and regulator that are parts of apparatus

Thermocouple type K (shown in Fig. 3.), were also used for regulating the temperature of the heater and connected to the regulator Imago 500 (Fig. 3.) and thyristor switches manufacturer JUMO, type B 70.9040.0. Everything together makes a system for controlling the temperature of the reference body.

All thermocouples and a digital thermometer are pre-calibrated for the purpose of verification and traceability of the same.

Under the reference body is a heater in ceramics, and other two ring-shaped (Fig. 3.) are around and above or below and around the reference body/ plate.

2.2. Contact thermometers calibration procedure

There is no definined method or a norm for calibration of contact thermometers on a prototype or apparatus of this type. It is possible to give a general idea of how to sort the operations to be performed during calibration. For these reasons, a large part of the procedure performing calibration contact thermometer is taken from Project 635 Thermometry and partly modeled on a bilateral comparison between BNM-LNE (France) i OMH (Hungary).

Calibration procedure:

1. includes the first and finall determination of the surface temperature by extrapolating before applying the sensor ($t_{p\text{-}before}$) at a certain calibration point.
2. Leaning contact thermometer on the surface of the reference blocks for the purpose of obtaining measurements and data read from the thermometer.
3. After removing the contact thermometer (sensor), the surface temperature is once again determined by extrapolating ($t_{p\text{-}after}$). The average surface temperature is determined by extrapolating and define reference temperature (tp), which is the basic value between ($t_{p\text{-}before}$) and ($t_{p\text{-}after}$).
4. So temperature measurements of the reference surface and of the calibration object - contact thermometer (sensor) are performed as described. One cycle of measuring when the reference body is in the "lower" position (Fig. 2.), and another measuring at the same calibration point when the reference surface in the "top" position (Fig.1.).

3. MATHEMATICAL MODEL OF CALCULATING MEASUREMENT UNCERTAINTY

- **Dependence of the temperature sensor (Tc) of the surface temperature (Ts) and ambient temperature (T amb)**
  - $E = t_s - t_p$ (1)

Where:

t_p – surface temperature determined by extrapolation

t_s – read out temperature of sensor
Uncertainty related to deviation E is:

$$u^2(E) = u^2(t_p) + u^2(t_s) \qquad (2)$$

- **Infuence of reference surface temperature (t_p)**

Temperature t_p is determined by method of kstrapolation according to equation:

$$t_p = \frac{(t_{sup}-t_{inf})(e-h_{inf})}{(h_{sup}-h_{inf})} + t_{inf} \qquad (3)$$

Where:
t_{inf}, t_{sup} - Temperature within body (further and closer to reference surface)
h_{inf}, h_{sup} - Vertical position position of opening in the axis of the cylindrical reference surface
e - The thickness of the reference plate (body)
If: $t_{inf} = t_i + c_{i\text{-}cal} + c_{i\text{-}stab} + c_{i\text{-}hom} + c_{i\text{-}drift}$
and $t_{sup} = t_j + c_{j\text{-}cal} + c_{j\text{-}stab} + c_{j\text{-}hom} + c_{j\text{-}drift}$
Than:
t_x - Mean temperature measured by sensor x in reference plate (body),
x = i or j (sensor that is closer or further of reference surface
$c_{x\text{-}stab.}$ - Corrections to the calibration of sensor x
$c_{x\text{-}hom.}$ - Corrections to the inhomogeneity of the temperature around the sensor x
$c_{x\text{-}drift.}$ - Correction relates to the drift of sensor x
h_{sup}, h_{inf} - Vertical position of opening in the axis of the cylindrical reference surface
Measurement uncertainty related to the temperature of the reference surface (specimen) is determined in comparison to the contributions specified in [2].

- **The effect of temperature instruments (t_s)**

Sensor temperature t_s is determined according to:

$$t_s = t_{s\text{-}očit} + c_{rezol.} + c_{amb.} + c_{materijal} + c_{tp\text{-}nazad} + c_{deb.} + c_{pov.} + c_{operat.} \qquad (4)$$

Where:
$t_{s\text{-}očit.}$ – Mean temperature read out of contact thermometer Srednja očitana temperatura kontaktnog senzora
$c_{rezol.}$ – Corection related to instrument resolution
$c_{amb.}$ – Corection related on influence of ambient temperature to measurements during calibration
$c_{materijal}$ - Corection related to thermal conductivity related to the type of material used to construct the reference plate (body)
$c_{tp\text{-}nazad}$ - The correction in relation to changes in the temperature of the reference surface at steady state after redraw of sensor that is calibrated
$c_{deb.}$ - Correction due to differences in the thickness of the material in relation to the reference conditions
$c_{pov.}$ - Correction due to differences of the contact resistance in comparison to the reference conditions
$c_{operat.}$ - Correction in relation to the operator effect
(*) Uncertainties $c_{deb.}$, $c_{pov.}$, $c_{operat.}$ Not currently taken into account.

Based on the specified contributions the measurement uncertainty of sensor is determined according [2].

4. CALIBRATION RESULTS AND EVALUATION OF TOTAL MEASUREMENT UNCERTAINTY at calibration point of 300 °C

Measurements were made at several calibration points and calibration temperature 300 °C is chosen.
A) When the reference surface is in „low“ position.
Table 1: Measurement uncertainty contributions of reference surface at calibration point 300 °C when reference body/ surface is in „low“ position.

Veličina X_i	Procjena x_i	Raspodjela	St.nes $u(x_i)$	Koef.osjet. $\lvert c_i \rvert$	Dopr. $\lvert c_i \cdot u(x_i) \rvert$
t_i	300,57 °C	N	0,04 °C	0,391	0,02
$C_{i\text{-}cal}$	1,67 °C	N	0,42 °C	0,391	0,17
$C_{i\text{-}stab}$	0 °C	P	0,05 °C	0,391	0,02
$C_{i\text{-}hom}$	0 °C	P	0,05 °C	0,391	0,02
$C_{i\text{-}drift}$	0 °C	P	-	0,391	-
t_j	299,65 °C	N	0,03 °C	1,391	0,04
$C_{j\text{-}cal}$	1,67 °C	N	0,42 °C	1,391	0,59
$C_{j\text{-}stab}$	0 °C	P	0,05 °C	1,391	0,07
$C_{j\text{-}hom}$	0 °C	P	0,05 °C	1,391	0,07
$C_{j\text{-}drift}$	0 °C	P	-	1,391	-
e	50,0 mm	N	0,10 mm	0,027 °C/mm	0,01
h_{inf}	2,0 mm	N	0,10 mm	0,028 °C/mm	0,01
h_{sup}	36,5 mm	N	0,10 mm	0,037 °C/mm	0,01
t_p	300,96 °C	/	/	/	**0,63 °C**

Tabela 2: Measurement uncertainty contributions of contact sensor at calibration point 300 °C when reference body/ surface is in „low“ position

Veličina X_i	Procjena x_i	Raspodjela	St.nes $u(x_i)$	Koef.osjet. $\lvert c_i \rvert$	Dopr. $\lvert c_i \cdot u(x_i) \rvert$
$t_{s\text{-}očit}$	299,88 °C	N	0,23 °C	1	0,23 °C
$c_{rezol.}$	0 °C	P	0,33 °C	1	0,33 °C
$c_{amb.}$	0 °C	P	0,11 °C	1	0,11 °C
$c_{materijal.}$	0 °C	P	0,05 °C	1	0,05 °C
$c_{tp\text{-}nazad}$	0 °C	P	0,07 °C	1	0,07 °C
t_s	299,88 °C	/	/	/	**0,43 °C**

$$u^2(E) = u^2(t_k) + u^2(t_p) =$$
$$u(E) = \sqrt{u^2(tk) + u^2(tp)} = 0,76\ °C$$

B) When the reference surface is in „upper“ position

Tabela 3: Measurement uncertainty contributions of reference surface at calibration point 300 °C when reference body/ surface is in „upper“ position

Veličina X_i	Procjena x_i	Raspodjela	St.nes $u(x_i)$	Koef.osjet. $\lvert c_i \rvert$	Dopr. $\lvert c_i \cdot u(x_i) \rvert$
t_i	295,71 °C	N	0,05 °C	0,391	0,02
$C_{i\text{-}cal}$	1,67 °C	N	0,42 °C	0,391	0,17
$C_{i\text{-}stab}$	0 °C	P	0,05 °C	0,391	0,02
$C_{i\text{-}hom}$	0 °C	P	0,05 °C	0,391	0,02
$C_{i\text{-}drift}$	0 °C	P	-	0,391	-
t_j	291,28 °C	N	0,03 °C	1,391	0,04
$C_{j\text{-}cal}$	1,67 °C	N	0,42 °C	1,391	0,59
$C_{j\text{-}stab}$	0 °C	P	0,05 °C	1,391	0,07
$C_{j\text{-}hom}$	0 °C	P	0,05 °C	1,391	0,07
$C_{j\text{-}drift}$	0 °C	P	-	1,391	-
e	50,0 mm	N	0,10 mm	0,129 °C/mm	0,02
h_{inf}	2,0 mm	N	0,10 mm	0,136 °C/mm	0,02
h_{sup}	36,5 mm	N	0,10 mm	0,179 °C/mm	0,02
t_p	291,22 °C	/	/	/	**0,63 °C**

Tabela 4: Measurement uncertainty contributions of contact sensor at calibration point 300 °C when reference body/ surface is in „upper“ position

Veličina X_i	Procjena x_i	Raspodjela	St.nes $u(x_i)$	Koef.osjet. $\lvert c_i \rvert$	Dopr. $\lvert c_i \cdot u(x_i) \rvert$
$t_{s\text{-očit}}$	289,87 °C	N	0,16 °C	1	0,16 °C
$c_{rezol.}$	0 °C	P	0,33 °C	1	0,33 °C
$c_{amb.}$	0 °C	P	0,11 °C	1	0,11 °C
$c_{materijal.}$	0 °C	P	0,24 °C	1	0,24 °C
$c_{tp\text{-nazad}}$	0 °C	P	0,13 °C	1	0,13 °C
t_s	289,87 °C	/	/	/	**0,41 °C**

$u^2(E) = u^2(t_k) + u^2(t_p) =$

$u\,(E) = = 0{,}75\ °C$

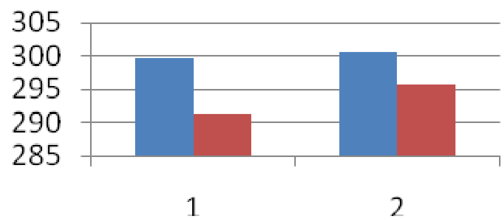

Diagram 1. Showing results of mean values of temperature for Ti and Tj (thermocouples further and closer to the reference surface) used to extrapolate the surface temperature when the reference surface is in „low“ (blue) and in the „upper“ (red) position for in 300 ° C point.

5. CONCLUSIONS

1) The study was conducted in order to establish own procedure for calibration of contact thermometers for measuring temperature of solid surface.
2) In order to clearly define and quantify the contributions to measurement uncertainty when calibrating contact thermometers for temperature measurement of solid surface.
3) The first calibrations using the prototype apparatus - standard for calibration of contact thermometers for temperature measurement of solid surface were performed in terms of preparation for validation of the apparatus itself.

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OPTIMUM DESIGN OF OPEN SECTION THIN-WALLED STRUCTURAL ELEMENTS ACCORDING TO STRESS CONSTRAINT

Nina Anđelić[1], Vesna Milošević-Mitić[1], Taško Maneski[1], Milorad Milovančević[1], Đorđe Đurđević[2]
[1]Faculty of Mechanical Engineering, University of Belgrade, Serbia
[2]Tehnikum Taurunum-College of Applied Engineering Studies in Belgrade, Serbia

Abstract. *The purpose of this work is to present a possible approach to the mass minimization of structural thin-walled open section beams of the proposed shapes (I, Z and U-beam), submitted to the stress constraints and multiple load cases. Lagrange's multipliers method has been used to determine the optimization parameters. The area of the cross-section is used as the objective function, while the stress constraint is introduced and used as the constraint function. Numerical examples are presented to verify the analytically obtained values.*

Key words: *Optimization, thin-walled beams, optimal dimensions, stress constraints, saved mass.*

1. INTRODUCTION

There were a large number of research studies on the behaviour of thin-walled structures. The investigations of the behaviour of thin-walled members with open cross-sections have been carried out extensively since the early works of Timoshenko [13], Vlasov [14], Kollbruner and Hajdin [6], Murray [9], Rhodes et al. [10]. In recent years, there have emerged many studies devoted to the optimization of thin-walled cross-sections. The issue of solving various optimization problems has been discussed in various works and monographs. First of all, Gajewski and Życzkowski [5] provided a review of optimal designing of thin-walled structures; Magnucki and Monczak [7] presented a variational and parametrical optimization of open cross-section of a thin-walled beam subject to bending; Tian and Lu [12] optimized the cold-formed open-channel. There have been many studies dealing with optimization problems, treating the cases where geometric configurations of structures are specified and only the dimensions of structural members and the areas of their cross-sections are determined in order to attain the minimum structural weight or cost [8]. Afterwards, a series of studies have appeared where the optimization problem of various cross-sections, such as the triangular cross-section [11], *I*-section [3, 4], *U*-section [2] or *Z*-section beams [1] is solved by means of the Lagrange multiplier method. The idea of this paper is to develop an approach to the optimization of thin-walled *I*, *Z* and *U* cross-section beams.

2. SUBJECT OF RESEARCHING

Two basic parts can be found in this paper. In the first part, the mathematical model is created and the equations which define the problem are derived. In the second part the obtained system of equations, which defines the optimal relation between the parts of the considered thin-walled cross sections, is analytically solved. The open cross-sections (*I*, *Z* and *U*-beam) are considered as objects of optimization in the paper.

The *I* and *U*-sections of the considered cantilever beam (Fig. 1a, c) with principal centroidal axes X_i ($i = 1, 2$) have the axis of symmetry.

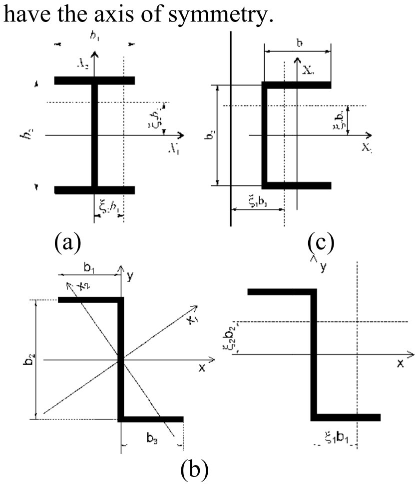

Fig. 1. Cross-section: a) I-beam, b) Z-beam, c) U-beam

The Z-cross-section (Fig. 2b) has the centre and not the axis of symmetry. It is assumed that its flanges have equal widths $b_1 = b_3$, and thicknesses $t_1 = t_3$, and that its web has the width b_2 and thickness t_2.The assumption is that the loads are applied in two longitudinal planes, parallel to the longitudinal centroidal axes at the distances $\xi_i\, b_i$ (i = 1, 2) (Fig. 1). In the case of the *I*-profile (Fig. 1a), the vertical longitudinal plane coincides with the shearing plane. In the *Z*-profile (Fig. 1b), the shearing centre corresponds with the centre of gravity, therefore, it can be said that the eccentricities $\xi_i\, b_i$ (i = 1,2) are defined with respect to the longitudinal planes, whereas in the *U*-profile (Fig. 1c) the distance in the case of vertical plane is measured from the shearing plane.

If loads are applied in such a way, they will cause the bending moments acting in the above defined two planes parallel to the longitudinal axis of the beam, with consequent effects of the constrained torsion occurring in the form of the bimoment *B*, causing the stresses [6].

The aim of the paper is to find the minimal cross-sectional area

$$A = A_{\min} \tag{1}$$

for the given loads and material and geometrical properties, while satisfying the constraints. In the considered problem the cross-sectional area will be treated as an objective function [1, 3]. Because $b_1 = b_3$, it is evident from the Fig. 1 that

$$A = A(b_1, b_2) = 2\, b_1\, t_1 + b_2\, t_2\,. \tag{2}$$

3. CONSTRAINTS

The cross-section of the considered *Z*-beam (Fig. 1b) with principal centroidal axes X_i (i = 1, 2) has the centre and not the axis of symmetry and, because of that, the expressions (3) for equivalent bending moments $\overline{M_x}$ and $\overline{M_y}$ taking into account the influence of the bending moments around centroidal axes *x* and *y*, denoted as M_x and M_y respectively, will be used [1],

$$\overline{M_x} = \frac{M_x - M_y\left(\dfrac{I_{xy}}{I_y}\right)}{1 - \dfrac{I_{xy}^2}{I_x \cdot I_y}}, \overline{M_y} = \frac{M_y - M_x\left(\dfrac{I_{xy}}{I_x}\right)}{1 - \dfrac{I_{xy}^2}{I_x \cdot I_y}} \tag{3}$$

where I_x, I_y are the moments of inertia of the cross-sectional area about the centroidal axes *x* and *y*, and I_{xy} is the product of inertia.

The normal stresses σ are caused by the bending moments M_{X1} and M_{X2} in the case of the *I* and *U*-section beam (σ_{X1} and σ_{X2}), i.e. $\overline{M_x}$ and $\overline{M_y}$ in the case of the *Z*-section beam ($\overline{\sigma_x}$ and $\overline{\sigma_y}$), and by the bimoment *B* that appears in the case of constrained torsion. The normal stresses caused by the bimoment will be denoted as σ_ω [6].

The bending moments are acting in planes that are parallel to the longitudinal axis (Fig.1) at the distances $\xi_i b_i$ (i=1,2). The bimoment B will occur as their consequence and it can be expressed as the function of the bending moments and the eccentricities of their planes $\xi_i b_i$ (i=1, 2) [6] for the *I* and *U*-section beam (4) and for the *Z*-section beam (5):

$$B = \xi_1\, b_1 M_{X1} + \xi_2 b_2 M_{X2} \tag{4}$$

$$B = \xi_1\, b_1 \overline{M_x} + \xi_2 b_2 \overline{M_y}\,. \tag{5}$$

If σ_0 stands for allowable stress, the constraint function can be written for the *I* and *U*-section beam (6) and for the *Z*-section beam (7):

$$\varphi = \varphi(\sigma) = \sigma_{X1\max} + \sigma_{X2\max} + \sigma_{\omega\max} \le \sigma_0 \tag{6}$$

$$\varphi = \varphi(\sigma) = \overline{\sigma_x}_{\max} + \overline{\sigma_y}_{\max} + \sigma_{\omega_{\max}} \le \sigma_0\,. \tag{7}$$

The maximal normal stresses [6] are defined in the forms

– for the *I* and *U*-section beam

$$\sigma_{Xi\max} = \frac{M_{Xi}}{W_{Xi}} \ (\mathrm{i} = 1{,}2),\ \sigma_{\omega\max} = \frac{B}{W_\omega} \tag{8}$$

where W_{Xi} (i = 1,2) are the section moduli for the principal axes for the *I* and *U*-section, and

– for the *Z*-section beam

$$\overline{\sigma_x}_{\max} = \frac{\overline{M_x}}{W_x}, \overline{\sigma_y}_{\max} = \frac{\overline{M_y}}{W_y}, \sigma_{\omega\max} = \frac{B}{W_\omega}\,. \tag{9}$$

For the considered cross-sections W_x and W_y are the section moduli for the longitidunal axes for the *Z*-section and W_ω is the sectorial section modulus.

After the introduction of Eq. (8) into Eq. (6), and Eq. (9) into Eq. (7), the constraint function becomes (10) for the *I* and *U*-section beam and (11) for the *Z*-section beam:

$$\varphi = \frac{M_{X1}}{W_{X1}} + \frac{M_{X2}}{W_{X2}} + \frac{B}{W_\omega} \le \sigma_0\,, \tag{10}$$

$$\varphi = \frac{\overline{M_x}}{W_x} + \frac{\overline{M_y}}{W_y} + \frac{B}{W_\omega} \le \sigma_0\,. \tag{11}$$

The constraint functions (10) and (11) are reduced to (12) for the *I*-section beam, (13) for the *Z*-section beam and (14) for the *U*-section beam. The expressions (13-15) represent the constraint functions that correspond to the given stress constraints.

$$\varphi = \varphi(b_1, b_2) = 6M_{X1}\frac{1}{t_1 b_1 b_2\left(6 + \dfrac{t_2}{t_1}\dfrac{b_2}{b_1}\right)} + \\ + 3M_{X2}\frac{1}{t_1 b_1^2} + 6B\frac{1}{t_1 b_1^2 b_2} \le \sigma_0, \tag{12}$$

$$\varphi = \varphi(b_1, b_2) = 30M_x \frac{1}{t_1 b_1 b_2\left(3 + 2\frac{t_2}{t_1}\frac{b_2}{b_1}\right)} +$$

$$+3M_y \cdot \frac{b_2}{b_1} \cdot \frac{9 + \frac{t_2}{t_1}\frac{b_2}{b_1}}{t_1 b_1 b_2\left(3 + 2\frac{t_2}{t_1}\frac{b_2}{b_1}\right)} + 6B\frac{1 + \frac{t_2}{t_1}\frac{b_2}{b_1}}{t_1 b_1^2 b_2\left(1 + 2\frac{t_2}{t_1}\frac{b_2}{b_1}\right)} \le \sigma_0, \tag{13}$$

$$\varphi = \varphi\left(b_1, b_2\right) = 6M_{X1} \frac{1}{t_1 b_1 b_2\left(6 + \frac{t_2}{t_1}\frac{b_2}{b_1}\right)} +$$

$$+3M_{X2} \frac{1 + \frac{t_2}{t_1}\frac{b_2}{b_1}}{t_1 b_1^2\left(1 + 2\frac{t_2}{t_1}\frac{b_2}{b_1}\right)} + 6B\frac{3 + \frac{t_2}{t_1}\frac{b_2}{b_1}}{t_1 b_1^2 b_2\left(3 + 2\frac{t_2}{t_1}\frac{b_2}{b_1}\right)} \le \sigma_0. \tag{14}$$

4. RESULTS AND DISCUSSION

Optimization parameters have been determined by the Lagrange's multipliers method [1, 3, 5, 8]. Applying the Lagrange multiplier method to the vector which depends on two parameters b_i (i=1, 2)

$$\frac{\partial}{\partial b_i}\left[A\left(b_1, b_2\right) + \lambda\varphi\left(b_1, b_2\right)\right] = 0, \quad i = 1,2 \tag{15}$$

the system of equations will be obtained. After the elimination of the Lagrange multiplier λ, it will become

$$\frac{\partial A\left(b_1, b_2\right)}{\partial b_1} \cdot \frac{\partial\varphi\left(b_1, b_2\right)}{\partial b_2} = \frac{\partial A\left(b_1, b_2\right)}{\partial b_2} \cdot \frac{\partial\varphi\left(b_1, b_2\right)}{\partial b_1}. \tag{16}$$

4.1 Analytic solution

After introducing the expressions (4) and (5) for the bimoment into the equations (12), (13) and (14), the equation (16) can be reduced to an equation in the form (17) whose solutions give the optimal values of the ratio (18)

$$\sum_{k=0}^{n} c_k z^k = 0\,, \tag{17}$$

where: $z = b_2/b_1$ (18) is the optimal ratio of the parts of the considered cross-section. The coefficients c_k are dependent on the ratio of the bending moments and on the eccentricities ξ_1 and ξ_2 of their planes.

The solutions are in the form of the fourth order for the considered *I*-section beam, the sixth order for the considered *Z*-section beam and the eighth order for the considered *U*-section beam.

4.2 Particular cases. Optimal values z = b_2 / b_1

In the general case, bending moments about both principal axes appear simultaneously with the bimoment. Depending on the ratio M_{X2}/M_{X1} for the *I* and *U*-secton and M_y / M_x for the *Z*-section beam, there are some particular cases to consider. The optimal ratios *z* (18) obtained from the equations (17) are calculated for M_{X2}/M_{X1} (M_y / M_x) = 0, 0.5, 1; ψ = 0.5, 0.75, 1 and for $0 \le \xi_1 \le 1$; $0 \le \xi_2 \le 1$. The highest and the lowest optimal values of *z* M_{X2}/M_{X1} (M_y / M_x)=0, 0.5, 1 and ψ = 0.5, 0.75 and 1.0, are shown in a shortened form in Table 1 for the considered cross-sections.

Table 1. Optimal z = b_2/b_1 for ψ = 0.5; 0.75; 1

	M_{X2}/M_{X1}	0	0.5	1
z	I-section	$1.09 \le z \le 12$	$0.69 \le z \le 1.72$	$0.51 \le z \le 1.59$
	Z-section	$1.25 \le z \le 8.99$	$1.36 \le z \le 2.74$	$1.26 \le z \le 2.49$
	U-section	$1.39 \le z \le 12$	$0.93 \le z \le 2.22$	$0.71 \le z \le 2.09$

5. A NUMERICAL EXAMPLE. ANALYSIS OF RESULTS

This chapter will discuss some particular cases that occur depending on the loading case.

5.1 The loading cases

In this section the *I*, *U* and *Z*-section beams are fixed at one end and exposed to the concentrated bending moment M_{X1} (M_x) = 100 Nm; M_{X2} (M_y) = 0 at the free end of the beam in two ways as:

a) Loading case 1: $\xi_1 = \xi_2 = 0$ and

b) Loading case 2: $\xi_1 = 0.5$, $\xi_2 = 0$.

The initial cross-sectional geometrical characteristics are calculated taking into account the initial dimensions of the *I*, *Z* and *U*-section beam. It is assumed that the considered section has the initial wall thicknesses: b_1 = 51.75 mm, b_2 = 92 mm, t_1 = 8 mm, t_2 = 6.5 mm. This serves as the **Initial model**, with the "Initial area" of the cross-section. Starting from the initial relation $\mathbf{z}_{\text{initial}}$ and for the initial cross-sectional geometrical characteristics t_1 and t_2 the optimal relation z_{optimal} is calculated defining the "Optimum area" of the cross-section.

5.2 Minimum mass determination

To illustrate the design optimization technique, we consider the weight minimization problem of clamped *I*, *U* and *Z*-section beams shown in Fig. 1.

The problem is discussed in two ways [14, 17]: 1) The optimum dimensions of the cross-sections $b_{1\text{optimum}}$ and $b_{2\text{optimum}}$ are arrived at by equalizing the "Initial" and the "Optimum area" ($A_{\text{initial}}=A_{\text{optimal}}$) and by using the calculated optimal relation *z*. This case represents the **Optimum model 1** (Table 2). 2) In the **Optimum model 2**, the optimal values $b_{1\text{optimum}}$ and $b_{2\text{optimum}}$ are obtained from the condition requiring that the stresses must be lower than the allowable stress. Using the optimum cross-sectional dimensions as the starting point, the optimum minimal cross-sectional area $A_{\min}$ is calculated for each loading case and the results that include the saved mass of the material are provided in Table 2.

Table 2 shows that greater saved mass was obtained for the *I*-section than for the channel and *Z*-sections. Also, for all loading cases, the level of stresses is reduced in the Optimum model 1, while the saved mass of the material is increased with regard to the initial stress limits in the Optimum model 2. The calculations have shown that the maximum saved material is obtained in the Loading case 1 and the minimum in the Loading case 2 for all three shapes of cross-sections.

This allows for the conclusion that if the distance of the loading plane from the shearing plane is increased, it is less necessary to perform the optimization of the cross-section.

Table 2. Optimum model 1: $z_{initial}$=1.78

Section	Loading case	$z_{optimum}$	$\sigma_{initial}$ [MPa]	$\sigma_{optimum1}$ [MPa]	$\sigma_{optimum 2}$ [MPa]	$A_{initial}=A_{optimum 1}$ [mm^2]	$A_{min}=A_{optimum 2}$ [mm^2]	Saved mass [%]
I-beam	1	7.39	2.02	1.58	2.02	1426	1260	11.64
	2	1.45	9.44	9.38	9.44		1423	0.22
Z-beam	1	5.58	13.4	7.5	13.4		1033	27.56
	2	1.84	15.9	12.7	15.9		1398	1.96
U-beam	1	7.38	2.21	1.71	2.21		1280	10.25
	2	1.84	8.43	8.42	8.43		1425	0.12

6. CONCLUSION

In this paper, one approach to the optimization of the thin-walled open section beams, loaded in a complex way, using the Lagrange multiplier method, is presented. Accepting the cross-sectional area for the objective function and stress constrains for the constrained functions, the regions of optimal values of dimensions of all considered cross-sections are defined. As the result of the calculation, the modified constrained functions are derived as the polynomials of the fourth, sixth and eighth order, depending on the shape of the profile. The obtained functions are subjected to the given constraints and the obtained solution results give the optimal values of the ratios of the parts of the considered cross-section.

Particular attention is paid to calculating the saved mass by means of the proposed analytical approach. The saved mass can also be calculated for different loading cases.

The aim of the paper is the optimization of thin-walled elements subjected to the complex loads. It can be concluded that the optimization approach considered in this paper gives the general results that can be effectively used for deriving the expressions recommendable for technical applications.

Acknowledgements

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SIMULATIONS IN REANALYSIS PROCEDURES

Natasa Trisovic[1], Wei Li[2], Ljubica Milovic[3]
[1]Faculty of Mechanical Engineering, University of Belgrade, Serbia
[2]School of Mathematics and Statistics, Xidian University, Xi'an China
3Faculty of Technology and Metallurgy, University of Belgrade, Serbia

Abstract. *Most numerical simulations of physical systems are rife with sources of uncertainty. Uncertainty in simulations stems from the stochastic nature of geometric and physical parameters, indeterminate nature of initial/boundary conditions, and inadequacy of physical models coupled with discretization errors. The present will discuss the introducing of a probabilistic treatment of important problem parameters.*

Key words: *reanalysis, eigenvalues, design variables, simulation*

1.INTRODUCTION

Dynamic response of mechanical systems depends on structural parameters. The objective is to evaluate the structural response for successive modifications in the design avoiding the difficult solution of the modified equations. The structural modifications may be caused by external factors or by the designer in order to improve the characteristic of the response (eigenvalues and eigenvectors). Modification of dynamic characteristics means change of corresponding design variables to get desired dynamic behavior of structure. The design variables depend on the type of optimization problem. In the design of structural components, such as stiffened panels and cylinders, the design parameters represent the spacing of the stiffeners, the size and shape of the stiffeners, and the thickness of the skin. The thickness of plates, cross-sectional areas of bars, areas, moments of inertia, and torsion constants of beams represent sizes of the elements. Joints and members could be eventually added or deleted during the design procedure so that the geometry of the structures may be modified. Reanalysis methods can include the next activities:

(a) Modification in the geometry with no further change in the number of degrees of freedom.

(b) Modification of design variables (mass, damping and stiffness).

(c) Increase or reduction of the number of DOFs by changing the supporting manner and addition or deletion of joints and members.

(d) Alteration of the kind of material on some places if modification is possible. The main purpose of dynamic reanalysis is to provide numerical procedures to evaluate the structural response after modifications of design variables.

Simulation in structures is a very important field of investigation, due to its influence on subjects such as structures reliability and model validation amongst others. Simulation in structures can be used where the uncertainties introduced by random forces were applied to the structure Lin (1969). Conducted research Stanojevicat.all (2013), Tadic (2012, 2011), Dragojlovic (2012), Milanovic (2008) gives retrospective in uncertainty assessment in different research area.

Pascual (2012) cited that he followed the study of the case where uncertainty is introduced by random variables or by random fields modeling material properties (e.g., Young’s modulus, mass density, Poisson’s ratio, damping coefficient) or geometric parameters.

Cacciola at all (2005) did research on the procedure for the dynamic reanalysis of linear systems subjected to deterministic or stochastic loads. The structural modifications may be imposed by external factors (e.g. design alterations for operational reasons, or discrepancies between the predicted and measured properties of the structures) or by the designer in order to improve the characteristic of the response (e.g. layout optimization). Joints and members could be eventually added or deleted during the design procedure so that the topology of the structures may be modified. Reanalysis techniques are commonly devoted to efficiently determine the structural response produced bythe following events:

1. modification in the geometry with no further change in the number of degrees of freedom (DOFs);
2. alteration of dynamic characteristics of structural components (mass, damping and stiffness);
3. variation of the number of DOFs due to addition or deletion of joints and members;
4. alteration of loads due to both modification of the original number and position of joints and for changing in the intensity of external excitations.

Cacciola at all (2005) stated that most reanalysis methods are not able to deal with the last two modifications, which are usually named topological modifications as they imply a change in the dimension of the system due to addition or deletion of DOFs.

Kirsch and Liu (1997) focused a static reanalysis method by researching the characteristic of a modified initial design for the case of layout modification (no changes in the number of degrees of freedom).

Lecomte (2013) investigated the response of uncertain vibro-acustic and structural dynamic systems. In this paper, it is shown the comparison of the exact means, variances, covariances, as well as the exact stochastic and covariance coefficients, with their estimates obtained through Monte-Carlo simulations that confirmed the advantages of the analytical approach.

Voormeeren (2010) dealt with the problem of small random errors in substructure measurements in experimental dynamic substructuring using the frequency response functions (FRF). An uncertainty propagation method is derived, which allows the quantification of the uncertainty of the coupled system's FRFs propagated from uncertainties in measured substructure FRFs. A numerical example was used to verify the proposed method; the verification was performed through comparison with a Monte Carlo simulation.

2. METHODOLOGY

The problem of dynamic modification of a construction with the goal of improving dynamic characteristics has been a worldwide challenge for many researchers in previous decades (Trisovic (2007), Trisovic at all (2010), Allaboudiat all (2013).

The methods thereby used are widely different, from strictly mathematical do entirely experimental. Dynamic response of a mechanical structure must be improved by either (i) load control, or (ii) change in dynamic characteristics of a structure. Loads are often the result of interaction of the structure and its environment, so they are not easily controlled. In that case, it is important to know that the dynamic response can be improved by redesigning (reanalyzing) the dynamical characteristics of the structure. Having this in mind, the application of the techniques of reanalysis in obtaining the desired conditions for FE model of mechanical structures has shown a rapid improvement in previous decades. There are numerous techniques that are applied in dynamic reanalysis of mechanical structures. One of them has been already mentioned, *sensitivity analysis* that is successfully applied in general as well as in specific dynamical problems. The success of the procedure of dynamical modification depends on many factors, most important of which are: complexity of a structure including the boundary conditions, and modification method that a research team will choose to apply.

Although many papers have been published in the area of dynamic modifications of structures, the methodology of modification (reanalysis) of structures is still under intense development. In this paper, a procedure for dynamical modification that can be successfully applied to all types of structures is presented. Dynamic reanalysis is most often used in real structures that have poor dynamic behavior in exploitation. Successful "reparations" require a proper dynamic analysis and behavior diagnostics of observed structure. Application of results obtained by construction reanalysis achieves, among other results, prolongation of the life cycle of a construction.

3.1. Dynamic analysis and diagnostics of a model and its groups

Dynamic analysis and diagnosis of a model implies the analysis and interpretation of model behavior and its modification. On the basis of the analysis of energy distributions in main oscillation modes for all construction elements, the following cases are observed, on the grounds of which it is possible to derive the algorithm for reanalysis of similar structures.

I Elements in which the kinetic and potential energies (and the difference in their increase) are negligible with respect to other elements.
II Elements in which the kinetic energy is dominant compared to potential energy
III Elements in which the potential energy is dominant compared to kinetic energy
IV Elements in which the potential and kinetic energy exist and are not negligible in comparison with other elements

In simulation, a sequence of random numbers is generated according to the assumed distribution. Assume that the distribution of events occurrence, in our case, has the normal (Gaussian) distribution:

A random variable *X* with a probability distribution $f:\mathbb{R}\to\mathbb{R}>0,\ x\mapsto f(x)$

$$f(x)=\frac{1}{\sigma\sqrt{2\pi}}\exp\left(-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^{2}\right)$$

has normal distribution with the parameters μ , σ, which is written as $X\sim \mathrm{N}\left(\mu,\sigma^{2}\right) or \left(\mu,\sigma^{2}\right)$,

where μ is mathematical expectation and σ is standard deviation.
Probability distribution function of normal distribution is given by the expression:

$$F(x) = \frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^{x} \exp\left(-\frac{1}{2}\left(\frac{x-\mu}{\sigma} \right)^2 \right) dt$$

3. EXAMPLE

Using the example of a cantilever beam, the application of the reanalysis steps has been demonstrated in determining the zones of the construction that are most sensitive to changes. Two models are observed: original and arbitrarily modified. The condition is that the modification be small. It is thus possible to considerably save calculation time, and it will be particularly demonstrated that by the line finite elements the reanalysis formula generates entirely reliable results. The type of modification is determined by the type of finite elements, type of boundary conditions, model geometry, and the like.
Consider a cantilever beam of length 1 m, rectangular cross-section, $b \times h = 100mm \times 50mm$, divided into 5 finite elements (Fig.1).

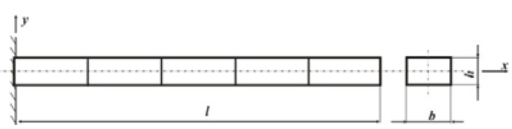

Fig. 1 Original cantilever beam
ρ=7833kg/m^3, E=206840000000 N/m^2;
b=0.1m, h=0.05m, l=1m

This cantilever beam is referred to as the original cantilever beam. For the analysis of sensitivity to changes, the *original cantilever beam* is modified across the entire length, with small modifications[1]. That cantilever beam is called a *modified cantilever beam* (Fig. 2).

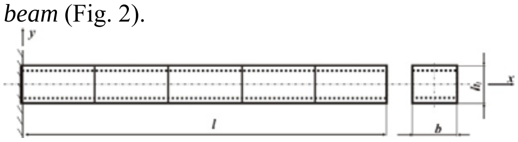

Fig. 2 Arbitrarily modifiedcantilever beam
b_1=b, h_1=1.1h

In this case, the chosen construction variable is the height of the rectangular cross-section *h*. Calculations are performed with the software package MatLab that possesses the function for calculating eigenvalues and eigenvectors. The lowest frequencies are always of the utmost interest for analysis. The table below (table 1) showstwo initial eigenvalues for the original cantilever beam and the modified one, where the height, as a construction variable, is increased by 10%.

Table 1

Original cantilever beam	Height increased by 10% across the entire length
Frequencies, f_{0i}[Hz]	Frequencies, f_{0i}[Hz]
260.24	286.26
41.51	45.66

Fig. 3 shows a digram of potential, ΔE_p ,and kinetic, ΔE_k , energy growth rates and their difference ΔE_p - ΔE_k for the increased height across the entire beam length, by 10 %, for the first oscillation mode. The first frequency of a modified cantilever beam is f'_{01} = 45.66Hz.

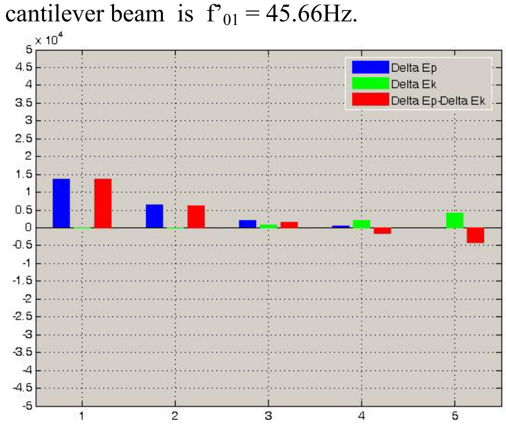

Fig. 3 Diagram of potential and kinetic energy growth rate distributions and their mutual difference for modified and original cantilever beam [J].

Fig. 5 displays a diagram of potential, ΔE_p ,and kinetic, ΔE_k , energy growth rates and their difference ΔE_p - ΔE_k for the modified cantilever beam after the first iterative step (Fig. 4) for the first oscillation mode.

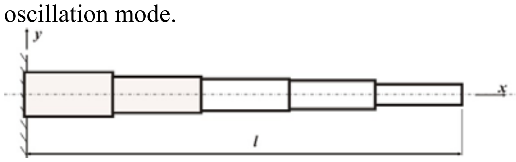

Fig. 4 Modified cantilever beam after the first iterative step

The aim of modification is to increase the frequency by 10 %. Note the convergence compared to the previous diagram, which is evidenced by reduced ’columns’ characterizing the change in potential and kinetic energy growth rates.

[1] In theliterature dealing with dynamic reanalysis it is stressed thatmodifications should be small, so that the chosen modification process converges to the desired eigenvalues of the pairs, however it is not easy to determine what is ’small’;

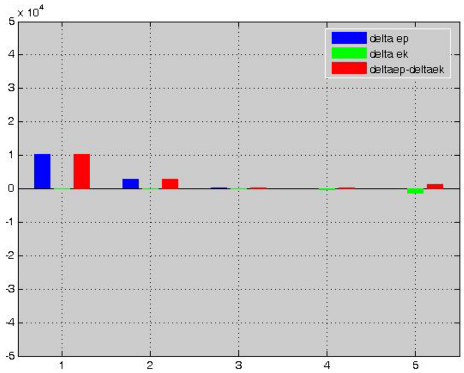

Fig. 5 Diagram of potential and kinetic energy growth rate distributions and their mutual difference for the modified cantilever beam after the first iterative step (Fig. 4,4), and the original cantilever beam [J].

Also, a significant conclusion related to the cantilever beam cross-section modification is that stiffness, i.e. cross-section height, should be increased in the fixed-point zone, while the beam's free end should be loosened, i.e. mass should be decreased in that zone.

4. SIMULATIONS

In simulation, a sequence of random numbers is generated according to the assumed distribution. Assume that the distribution of events occurrence, in our case, has the normal (Gaussian) distribution:
A random variable X with a probability distribution
$f:\mathbb{R}\to\mathbb{R}>0,\ x\mapsto f(x)$

$$f(x)=\frac{1}{\sigma\sqrt{2\pi}}\exp\left(-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right)$$

has normal distribution with the parameters μ, σ, which is written as $X\sim N\left(\mu,\sigma^2\right) or \left(\mu,\sigma^2\right)$, where μ is mathematical expectation and σ is standard deviation.
Probability distribution function of normal distribution is given by the expression:

$$F(x)=\frac{1}{\sigma\sqrt{2\pi}}\int_{-\infty}^{x}\exp\left(-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right)dt$$

Further research included the execution of simulations *Ek, Ep*, growth rates *Ek* and *Ep*, differences in growth rates, first frequency in a cantilever beam and a modified beam for 1000 values of Young's modulus of elasticity according to the Gaussian distribution.
On the basis of simulation, the following results were obtained, as presented in the figures (Fig.11-16). The figures show the diagrams of distribution Ek, Ep, growth rates Ek and Ep, and differences in growth rates for each element separately.
Table2 shows the simulation results for the original beam frequency (frequency) and the modified beam frequency (frequency 1) for different values of Young's modulus of elasticity. Frequency growth rate was calculated as a difference between the modified beam frequency and the original beam frequency.

Tab. 2 Thesimulation results for the original beam frequency (frequency) and the modified beam frequency (frequency 1) for different values of Young's modulus of elasticity

No	Young's modulus	Frequency	Frequency 1
1	216008194057,00	43,52331847	47,87565032
2	221020777903,00	40,47158724	44,51874596
3	209951519584,00	41,8644712	46,05091832
4	213280508641,00	38,98414442	42,88255887
5	204137145899,00	39,82625243	43,80887767
6	218644848354,00	39,47510831	43,42261914
7	231827190259,00	40,42324048	44,46556453
8	222337773090,00	42,70373323	46,97410656
...			
1000	197682543995,00	39,15874433	43,07461876

A set of 1000 results obtained by the normal distribution (program **R** [2]) was used for further analysis where the Laplace criterion was applied to determine the uncertainty.
The Laplace criterion assumes equal probability for certain states to take place, so that probability represents

$$v\left(s_{ij}\right)=\frac{1}{m}$$

where$m$ is the number of likely states (1000 in this case). Therefore the expected value is:

$$\overline{p_i}=\sum_{j=1}^{m}p_{ij}*v\left(s_{ij}\right)=\frac{1}{m}\sum_{j=1}^{m}p_{ij}$$

In Table 3 a division into the confidence intervals was performed and frequency of the observed quantities occurrence was calculated. The result for the occurrence of the oscillation frequency rounded growth rate indicates normal distribution.

Table 7. Confidence intervals

Frequency rounded growth rate	3,2	3,4	...	4,2	...	4,7
Frequency of occurrence	1	1	...	206	...	2

Fig. 6 shows normal distribution of the probability of the frequency of occurrence of eigenfrequencies growth rate difference. It is evident from the diagram that the highest probability of the

[2] **R** is a free software programming language and a software environment for statistical computing and graphics. The R language is widely used among statisticians and data miners for developing statistical software and data analysis. Polls and surveys of data miners are showing R's popularity has increased substantially in recent years.

occurrence of eigenfrequencies growth rate difference is 4.2, with the occurrence probability of 20.6%.

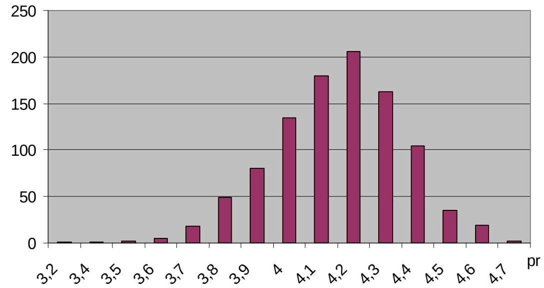

Fig 6 Normal distribution of occurrence probability of frequencies growth rate difference

By transforming the frequencies of occurrence of eigenvalues growth rate difference according to the Laplace criterion, we will obtain normal distribution of the occurrence probability, i.e. the degrees of uncertainty of the occurrence of eigenfrequencies growth rate difference.

The above text gives the probability of eigenfrequencies differences distribution in the original and the modified beam. Given that the normal distribution of eigenfrequencies growth rate difference was obtained, it is interesting to take a look at the probability distribution of eigenfrequencies in the original and the modified beam. Fig. 7, 8 and 9 present the distribution of eigenfrequencies occurrence probability for the original, the modified beam and optimized cantilever beam respectively.

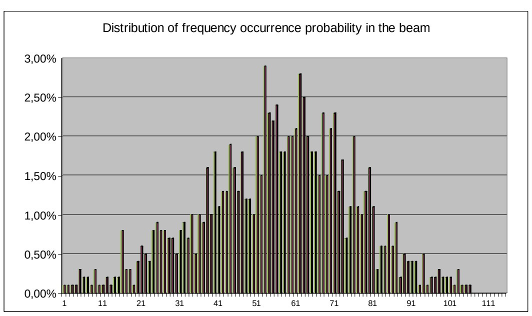

Fig.7. Distribution of frequency occurrence probability in the beam

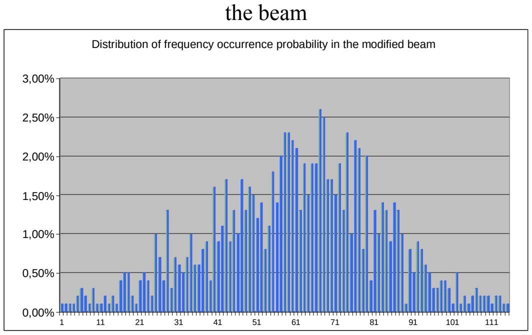

Fig. 8. Distribution of frequency occurrence probability in the modified beam

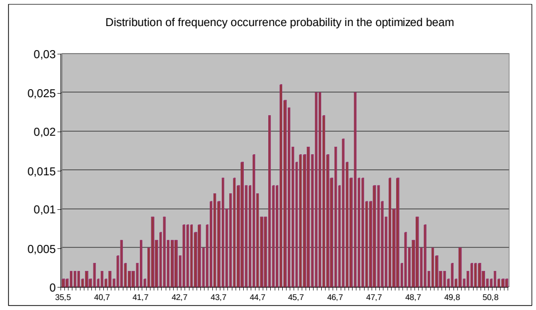

Fig. 9. Distribution of frequency occurrence probability in the optimized beam

5. CONCLUDING REMARKS

Studying the dynamic behavior of a construction can predict its response to change in shape, changes in size of its elements or change in materials used. Generally, the aim of system modification with respect to improvements in dynamic behavior is to increase eigenfrequencies and widen the distance between two neighboring frequencies. The specific importance lies in lowest frequencies and those close to the system exciting frequencies.

Assuming that Young's modulus of elasticity has normal distribution for 1000 simulation results, it is obtained that the frequency of free oscillations also has normal distribution in both the initial cantilever beam and modified beam and optimized beam. The results indicate that the behavior of the frequency of oscillations distribution correlates with the frequency of distribution of Young's modulus of elasticity and that the dependency exits irrespective of the cantilever beam design and shape respectively.

The analysis of uncertainty in the original, modified and optimized beams established for all three cases normal probability distribution in the rate of frequency occurrence. Difference was found in the interval of frequency normal distribution in the original cantilever beam compared to the distribution interval in modified and optimized beams. A broader confidence interval in modified and optimized beams indicates adverse effects of non-ideal material on the procedure of dynamic modification.

A versatile procedure for conducting reanalysis studies in the presence of uncertainty has been developed by. Combining Monte Carlo simulation tools with finite element modelling modules.

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ESTABLISHING TECHNOLOGICAL CYCLE TIME LENGTH OF THE PRODUCTION PHASE IN THE COMBINED MODE OF WORKPIECE MOVE

Jelena R. Jovanovic[1,2,3], Radisav D. Djukic[1,3]
[1]Technical College of Applied Studies, Cacak, Serbia
[2]Faculty of Mechanical Engineering, University of Belgrade, Serbia
[3]Office of the Manufacturing and Engineering Management, "Sloboda" Co. Cacak, Serbia

Abstract: *In the literature there are a number of different formulas for calculating technological cycle time length depending on the mode of workpiece move, with the confusion being present especially in the combined mode of organization of the sequence of operations flow. Taking into account this fact, the paper develops two models for calculating technological cycle time length of the production phase according to the combined mode of workpiece move. Validity check is done for the existing and developed relations.*
Key words: *manufacturing cycle, technological length, combined mode of workpiece move*

1. INTRODUCTION AND RELATED WORK

In terms of theoretical considerations, industrial practice and duration, three types of cycle time length can be distinguished: technological cycle time or ideal manufacturing cycle ($T_t \equiv T_{ci}, t_t \equiv t_{ci}$), manufacturing (real) cycle (T_{cs}, t_{cs}) and projected manufacturing cycle (T_{cp}, t_{cp}), Fig. 1.

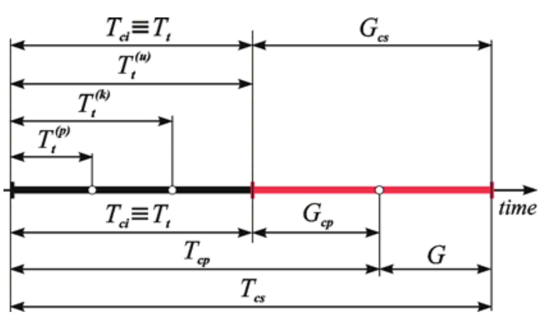

Fig. 1: Types of cycles as determined by duration

Time dimension of the technological cycle includes the projected times necessary for performing all technological operations, of the production phase (t_t) or complex item (T_t), on the items of a single lot. The benchmark points of the technological cycle (TC) of any production phase were defined at the start of manufacturing the first item in a lot, on the first operation, and at the end of manufacturing the last item in a lot, on the final technological operation. The production phase (PPh) implies a segment of the manufacturing and technological process characterized by a sub-set of technological operations by means of which the workpiece is transformed from one to another qualitative condition.

The TC length (t_t) of PPh is affected by the total number (n) of operations, time of technological operations $\theta_n = \left(t_i, i = \overline{1,n}\right)$, lot size ($q$) and batch ($p$), as well as by the workpiece move (WM) that can be consecutive (U), parallel (P) and combined (K), relation (1). In the current Russian literature other parameters are also used, e.g. number of workplaces (c_i), formula (2). Given that this is an organizational element, influential in cycle projection, its impact on TC is eliminated, assuming that each technological operation is executed in a single workplace ($c_i = 1$).

$$A = \{n, \theta_n, q, p, WM\} = \left\{n, \left(t_i, i = \overline{1,n}\right), q, p, \{U, P, K\}\right\} \Rightarrow t_t = \left\{t_t^{(u)}, t_t^{(p)}, t_t^{(k)}\right\} \quad (1)$$

The combined type of work flow in manufacturing process is most often encountered in serial production. Its goal is to eliminate downtimes emerging at some workplaces (operations) at parallel type due to different duration of successive operations [12].

Calculations of TC according to the combined mode of WM $t_t^{(k)}$ are performed in the literature using different formulas: (2) [1, 9, 15, 16, 17, 19, 22], (3) [10, 18], (4) [5, 14], (5) [3, 4], (6) [2], (7) [13, 21], (8) [6, 8, 11, 12] i (9) [20]. Formula (3) is similar to formula (2), which is employed in the Russian literature, however p = 1 is adopted for the lot size of the production-transport batch and the number of workplaces is identical to the number of technological operations, i.e. $c_i = 1$.

$$t_t^{(k)} = q \cdot \sum_{i=1}^{n} \frac{t_i}{c_i} - (q-p) \cdot \sum_{i=1}^{n-1} \min_i \left\{ \frac{t_i}{c_i}, \frac{t_{i+1}}{c_{i+1}} \right\} \tag{2}$$

$$t_t^{(k)} = q \cdot \sum_{i=1}^{n} t_i - (q-1) \cdot \sum_{i=1}^{n-1} t_{ki}, \; t_{ki} = \min_i \{t_i, t_{i+1}\} \tag{3}$$

$$t_t^{(k)} = \sum_{i=1}^{n} t_i + (q-1) \cdot \left[t_{i\max} + \sum_{j=1}^{s} \left(t_{vj} - t_{mj} \right) \right],$$

$$t_{vj} > t_{j-1} \wedge t_{mj} < t_{j+1} \tag{4}$$

$$t_t^{(k)} = \sum_{i=1}^{n} t_i + (q-1) \cdot \left(\sum_j t'_{oj} + \sum_j t''_{oj} \right),$$

$$t_{oj-1} < t'_{oj} > t_{oj+1} \wedge t_{oj-1} > t''_{oj} < t_{oj+1} \tag{5}$$

$$t_t^{(k)} = \sum_{i=1}^{n} t_i + (q-1) \cdot \left(\sum_j t'_{oj} - \sum_j t''_{oj} \right),$$

$$t_{oj-1} < t'_{oj} > t_{oj+1} \wedge t_{oj-1} > t''_{oj} < t_{oj+1} \tag{6}$$

$$t_t^{(k)} = \sum_{i=1}^{n} t_i + (q-1) \cdot t_{i\max} + (q-1) \cdot (t_{i\max} - t_{i\min}) \tag{7}$$

$$t_t^{(k)} = \sum_{i=1}^{n} t_i + (q-1) \cdot \left(\sum_k t_k - \sum_j t_j \right),$$

$$t_{k-1} < t_k \geq t_{k+1}, \quad t_{j-1} \geq t_j < t_{j+1} \tag{8}$$

$$t_t^{(k)} = \sum_{j=1}^{n} t_j + (q-1) \cdot \sum_{j=1}^{n} (t_j - t_{j-1}) \cdot I_j,$$

$$t_j \leq t_{j-1} \Rightarrow I_j = 0 \wedge t_j > t_{j-1} \Rightarrow I_j = 1 \tag{9}$$

Formulas (2), (3), (4) and (9) are based on the comparison of time between two adjacent operations, formulas (5), (6) and (8) are based on the comparison of time between three adjacent operations, whereas calculations of TC using formula (7) are based on the operations of the shortest and longest time length. In [7] formulas (4), (5), (6) and (7) are denied, however comparison between the results obtained using formulas (2), (3), (8) and (9) has not been considered in the literature and investigations so far.

2. VALIDITY CHECK OF THE EXISTING AND INVESTIGATIONS OF THE NEW MODELS

Investigation of the formula for calculations of TC of PPh x_j in the quantity of q according to the combined mode of WM by the batches of p = 1 piece will be based on the comparison of time for:

1) three adjacent operations, Fig. 2 – model 1, and
2) two adjacent operations (α-1, α), Figs 3 and 4 – model 2.

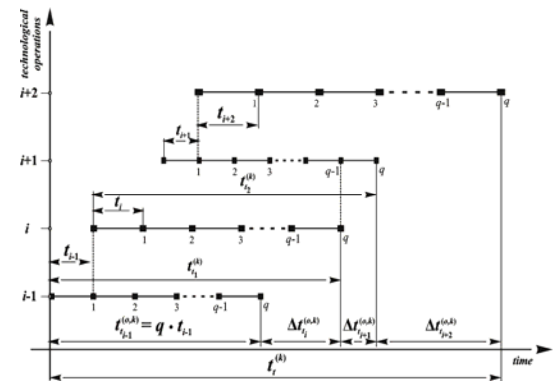

Fig. 2: Graphic representation of a combined mode of workpiece move in the manufacturing process

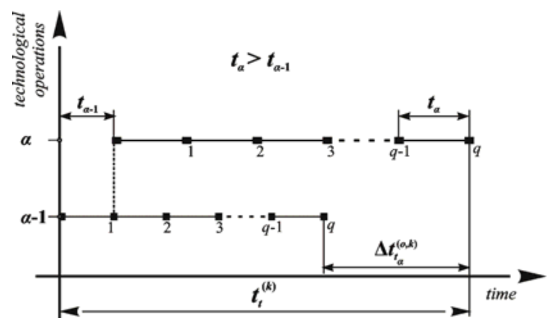

Fig. 3: $\theta_2 = (t_{\alpha-1}, t_\alpha), t_\alpha > t_{\alpha-1}, p = 1$

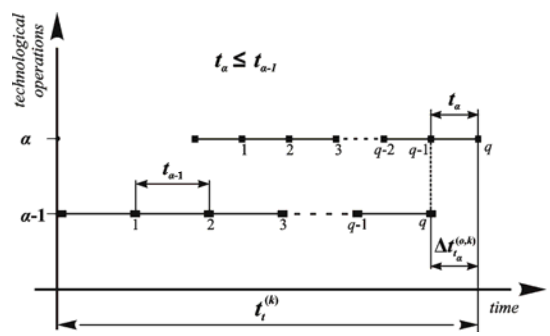

Fig. 4: $\theta_2 = (t_{\alpha-1}, t_\alpha), t_\alpha \leq t_{\alpha-1}, p = 1$

Using the corresponding proofs [23] with Fig. 2, on one hand, and Figs 3 and 4, on the other hand, formulas (10) and (11) were developed.

Using the example of a multivariate creation of a chosen PPh, determined by four alternative technological procedures V_j, each of which has ten operations, check validity of the existing formulas (2)-(9) is performed and of the formulas developed in this paper (10) and (11), based on the results obtained by the help of the formulas and Gantt charts. Table 1 gives the elements required for applying the formulas and Table 2 presents values of the technological cycle time obtained by appropriate formulas and Gantt charts (Fig. 5).

$$t_t^{(k)} = \sum_{i=1}^{n} t_i + (q-1)\cdot\left(\sum_k t_k - \sum_j t_j\right), \left(\forall x_j \middle| j=\overline{1,m}\right) \in PPh \wedge A = \{n, \theta_n, q, p=1,K\},$$
$$t_k \in \left(t_i \middle| i=\overline{1,n}\right) \wedge k = \left\{\{k=1 | t_1 \geq t_2\}, \{k=\overline{2,n-1} | t_{k-1} < t_k \geq t_{k+1}\}, \{k=n | t_n > t_{n-1}\}\right\} \wedge$$
$$\wedge t_j \in \left(t_i \middle| i=\overline{2,n-1}\right) \wedge j = \left\{\overline{2,n-1} | t_{j-1} \geq t_j < t_{j+1}\right\} \tag{10}$$

$$t_t^{(k)} = \sum_{\alpha=1}^{n} t_\alpha + (q-1)\cdot\left(t_1 + \sum_{\alpha=2}^{n}(t_\alpha - t_{\alpha-1})\cdot F_\alpha\right), \left(\forall x_j \middle| j=\overline{1,m}\right) \in PPh,$$
$$\forall \alpha | t_\alpha > t_{\alpha-1} \Rightarrow F_\alpha = 1 \wedge \forall \alpha | t_\alpha \leq t_{\alpha-1} \Rightarrow F_\alpha = 0, A = \{n, \theta_n, q, p=1,K\} \tag{11}$$

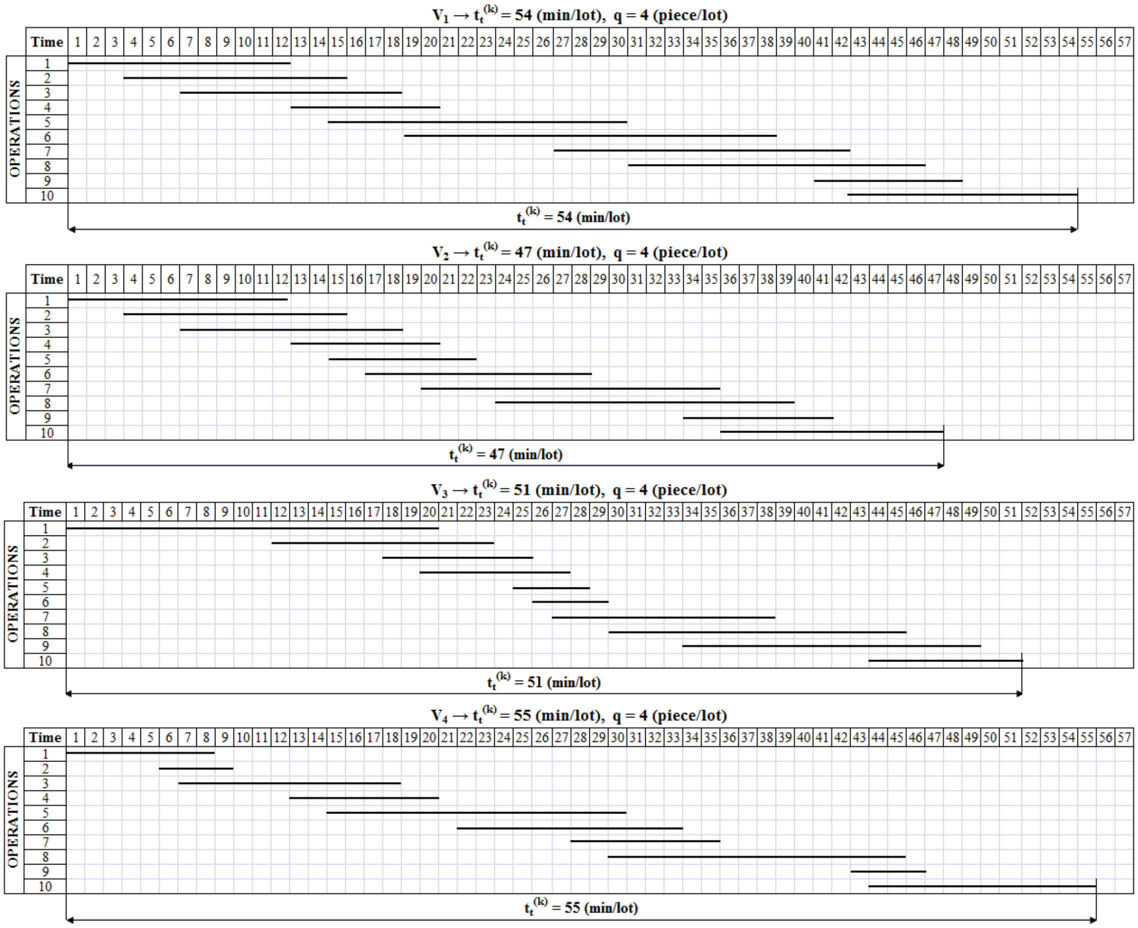

Fig. 5: Gantt charts with cycle values $t_t^{(k)}$ by variants V_j

Table 1: Representation of the parameters required for the calculation of TC t_t depending on the variant of manufacturing V_j and formula

Technological procedures $\theta_n, n=10$		$\sum_{i=1}^{n} t_i$	$\sum_{i=1}^{n-1} t_{ki}$	t_1	$t_{i\max}$	$t_{i\min}$	$\sum_{j=1}^{s}(t_{vj} - t_{mj})$	$\sum_j t'_{oj}$	$\sum_j t''_{oj}$	$\sum_k t_k$	$\sum_j t_j$	$\sum_{i=1}^{n}(t_i - t_{i-1})\cdot I_i$		$\sum_{i=2}^{n}(t_i - t_{i-1})\cdot F_i$
V_j	$t_i, i=\overline{1,10}$ *min/lot*											I $t_0 = t_1$	II $t_0 = 0$	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
V_1	$t_1=3, t_2=3, t_3=3, t_4=2, t_5=4, t_6=5, t_7=4, t_8=4, t_9=2, t_{10}=3$	33	16	3	5	2	4	5	4	11	4	4	7	4
V_2	$t_1=3, t_2=3, t_3=3, t_4=2, t_5=2, t_6=3, t_7=4, t_8=4, t_9=2, t_{10}=3$	29	11	3	4	2	3	0	2	10	4	3	6	3
V_3	$t_1=5, t_2=3, t_3=2, t_4=2, t_5=1, t_6=1, t_7=3, t_8=4, t_9=4, t_{10}=2$	27	12	5	5	1	3	0	0	9	1	3	8	3
V_4	$t_1=2, t_2=1, t_3=3, t_4=2, t_5=4, t_6=3, t_7=2, t_8=4, t_9=1, t_{10}=3$	25	15	2	4	1	8	11	6	16	6	8	10	8

Table 2: Values of TCs $t_t = \left\{t_t^{(u)}, t_t^{(p)}, t_t^{(k)}\right\}$, depending on the mode of WM for q = 4 and p = 1 piece

Variants	$t_t^{(u)}$	$t_t^{(p)}$	Formulas notation for the calculation of TC $t_t^{(k)}$ with cycle values in *min/lot*										
			(2), (3)	(4)	(5)	(6)	(7)	(8)	(9) - I	(9) - II	(10)	(11)	Gantt chart
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
V_1	132	48	84	60	60	36	57	**54**	45	**54**	**54**	**54**	**54**
V_2	116	41	83	50	35	23	**47**	**47**	38	**47**	**47**	**47**	**47**
V_3	108	42	72	**51**	27	27	54	**51**	36	**51**	**51**	**51**	**51**
V_4	100	37	55	61	76	40	16	**55**	49	**55**	**55**	**55**	**55**

3. CONCLUSION

On the grounds of obtained results, Table 2, the following can be established:

- The TC values obtained with the help of Gantt charts, according to the combined mode of WM (Fig. 5), are identical with the results obtained using formulas (8), (9-II), (10) and (11). Formulas (8) and (10) are based on comparing time between three adjacent ($\alpha-1, \alpha, \alpha+1$) operations, whereas (9-II) and (11) on comparing time between two adjacent ($\alpha-1, \alpha$) technological operations. Formula (9) does not contain an unambiguous definition of the value t_{j-1} for j=1, that is, the expression: $t_0 = ? \Rightarrow (t_1 - t_0) \cdot I_1 = ?$. The application is conditioned for the value $t_0 = t_1$ (9-I) and $t_0 = 0$ (9-II), Table 2, columns 10 and 11.
- Other formulas do not produce satisfactory results. Formulas (5), (6) and (7) yield values $t_t^{(k)}$ that are lower compared to the values $t_t^{(p)}$ for individual variants of manufacturing, which is not feasible in practice.

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