Solving Complex Management Problems by Applying Decision Support Systems

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In order to provide efficient adjustment of the business system to the changes in the market, one must pay special attention to the processes of solving complex management problems. Considering that there are established procedures and ways of solving simple problems in business practise, it is also important to establish a procedure for solving complex management problems. The solving of complex management problems conducted by established procedure, i.e. by defined phases, makes the whole act a lot more easier for the decision maker, because it directs him how to organize the problem solving activities, shortens the time of problem solving, increases the quality of decisions made, whereby the unwanted results are less likely to happen. The paper describes the application of decision support systems to solving complex management problems in business systems. The aim of decision support system application is to help the decision makers in the process of solving complex management problems and to improve the quality of decisions made in such circumstances.

Keywords: *complex problem, management, information systems, decision support systems.*

1. INTRODUCTION

By complex problems in business systems one actually considers those problems whose formulation and/or the act of solving is complex. The existence of a large number of variables in the complex problem solving process does not necessarily cause its complex nature. If there are clearly defined quantified values for a certain problem, as well as a defined algorithm for solving of a regarded problem, then it cannot be characterized as a complex one. It is only necessary to derive more mathematical estimations of such a problem, but there is no dilemma in the problem defining act, nor is there one in the act of establishing the procedure for its solution.

In business systems, one can usually find variables which have stochastic character. The presence of stochastic variables in problem solving diminishes the degree of problem determination. This classifies the problem in the category of complex problems.

Horgan [1] says that complexity is defined as "the edge of chaos". This author claims that on one side there is a completely specified situation, while the other side is the state of chaos. Between these two states there is complexity. This author points to the research of Seth Lloyd who systemized the complexity definitions. In this way it is established that the complexity concept should be attached to entropy, randomness (coincidence or stochastic) and information. The development of information technologies also has influence on the concept of the problem complexity, so that what was once considered to be complex, nowadays might be presented by a short computer programme.

All in all, there are no clear borders between simple and complex problems in business systems. As complex problems in business systems will be considered those problems where a certain complexity of formulation is present, as well as the complexity in the problem solving process. Such problems are mostly unstructured or poorly structured. However, an unstructured or poorly structured problem cannot be automatically considered as complex.

2. BUSINESS PROBLEMS: THE APPROACH AND THE SOLVING PROCESS

The solving process, the way of approaching the problem and the rationality in management actions are crucial to the functionality of a business system. The problem solving process implies its phases, including the action itself, i.e. the solution implementation, as well as the result monitoring. The way of approaching the problems means defining a string of actions in order to act in an organized and methodical manner in the situations where a problem appears. In that way, the plan defines problem solving procedures and measures according to the character and the level of complexity of the problem itself. Different approaches to the decision making process are partly the result of the particular research area. Most authors generally agree with the

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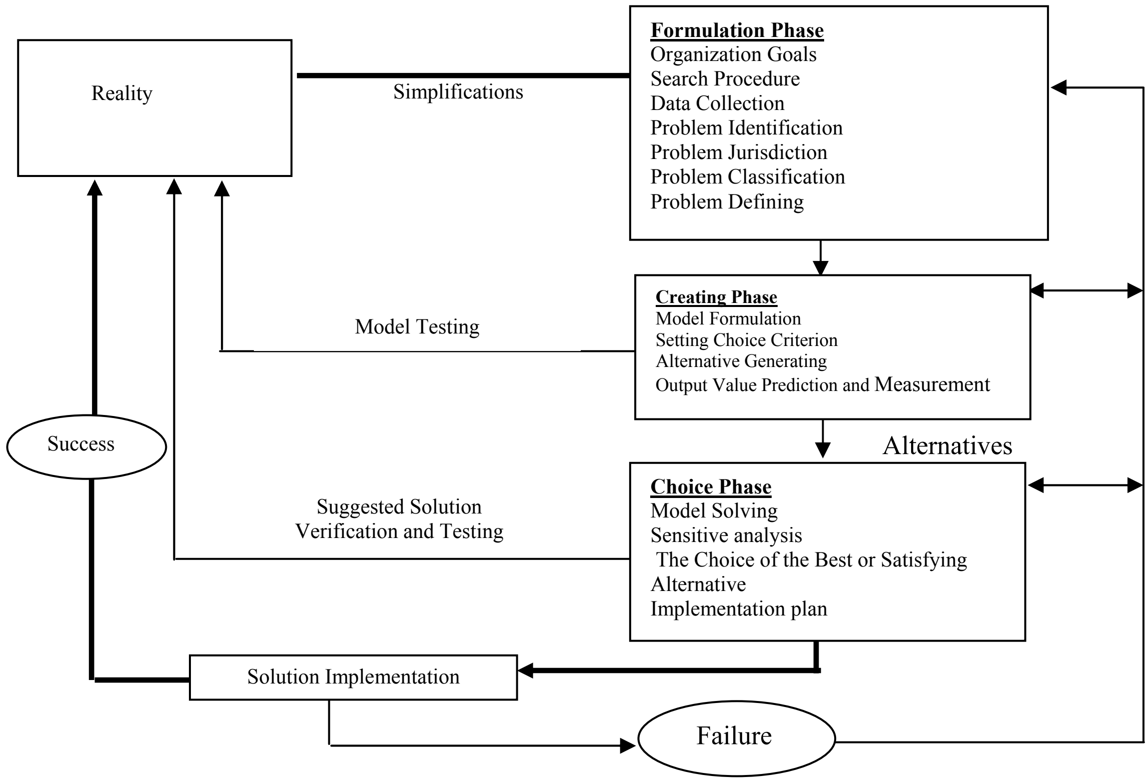

Figure 1. The Problem Solving Process [2]

thesis of four basic phases in the decision making process. However, by further researches in certain scientific areas the number of phases was extended according to the necessity criterion to analyze the studied problems. Turban and Aranson [1] depict a block diagram of the problem solving process in Fig.1.

In further working out of the complex problems solving model, it can be spoken about computer information systems which can help in certain phases of the process. Taking into account the views of Turban and Aronson [2], Luccas [5] and other authors, conclusions about the use of certain computer systems in some phases of complex problem solving may be drawn.

The papers whose topic is connected to the complex problem solving process, can be found in the existing literature[3]. Considering that the area of complex problems studying is relatively new, these papers are mostly connected to the other half of the 1990s. It can also be seen that the first papers in this area come from researches of those psychologists who were trying to clarify the complex problem solving process.

In his book, Frensch [3] defines that the complex problem solving process appears in case of overcoming the barriers which exist between the given initial state and the wanted goal. The expression "barrier overcoming" includes the complexity in terms of behaviour, understanding or other activities that should be performed in order to solve the problem.

The authors believe that every problem consists of the initial state, barriers, wanted state, as well as the tools which we use during the problem solving process. In cases where those barriers overcome, i.e. become too complex, the problem becomes complex. Complex problem solving requires an efficient interaction between the decision-maker and the arisen situation by demanding from the decision maker to include one's perceptive, personal, intellectual and social abilities in the solving process in Fig.2

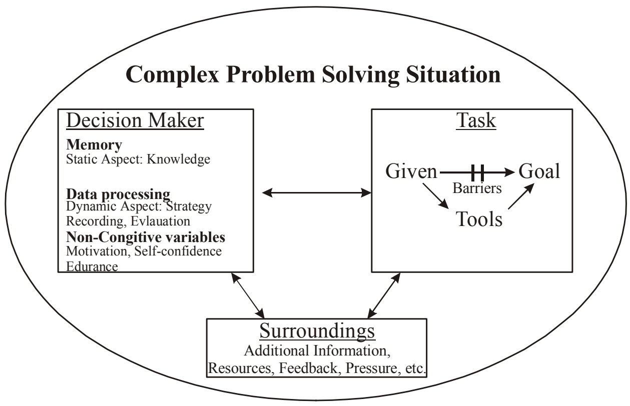

Figure 2. Complex Problem Solving Situation [3]

3. MANAGEMENT INFORMATION SYSTEMS

There are recorded research papers in different areas of literature, which describe complex problem solving by application of information systems [4]. Most authors agree that in the complex problem solving process, information systems should be applied. Information systems may give appropriate support to the decision maker in some phases of the complex problem solving process and help him to shorten the time of analyses, estimations, result synthesis etc.

Turban and Aronson [2] also name information systems as a support to the problem solving process. In this way they unite the application of available tools for decision support and appropriate phases of the problem solving process, Fig.3.

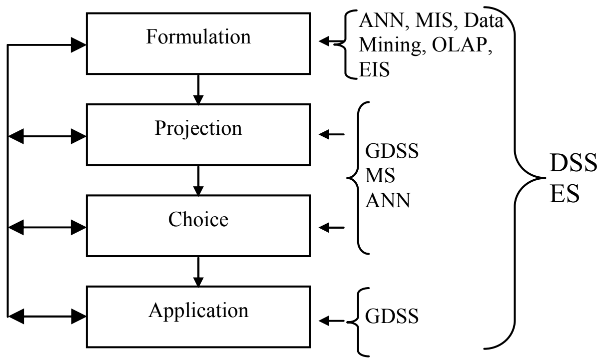

Figure 3. Problem Solving Process and Computer Information Systems [2]

In the problem formulation phase the decision support systems can offer significant help. Management information systems can indicate the early signs of the appearance of a problem by constantly monitoring the internal and external data sources. The so-called "data mining", which represents new technology for mining of special data in data bases and which can significantly shorten the time of problem identification, is also included in the process. Another technology, the so-called OLAP (On-line Analytical Processing), mostly based on the work on the Internet where the on-line web user can ask questions and analyze data in order to shorten the time of data mining and data analyzing.

Expert systems in the formulation phase can give an advice to the decision maker and thereby help the understanding of the nature of the problem, the problem diagnosis, the problem classification etc.

Luccas [5] believes that decision support systems should be applied primarily in the problem formulation phase.

In the phase of creating or making a model computer support can be given by decision support systems. In cases where group opinion is required, it is convenient to use group decision support systems.

The implementation phase supported by the decision support system results in improved communication between the employees, as well as better acceptability, understandability etc.

4. DECISION SUPPORT SYSTEMS APPLICATION

As an example of complex problem solving in business systems, an optimal production programme was chosen. For that problem a decision model was created, together with the decision support system application, i.e. the Criterium Decision Plus software.

The creation of a decision model for the choice of optimal production programme begins with the formulation of criteria and subcriteria. On the first level of the created decision model, some basic criteria which influence the choice of a production programme are identified, and they are:

- Market demands
- Production capacities
- Staff resources
- Material resources
- Financial resources, and
- Economic indexes

The highlighted basic criteria can further be divided into subcriteria which define the production programme more specifically.

The first criterion – Market demands – can be further divided into subcriteria such as:

- Market demands regarding the price of the product
- Market demands regarding the quantity of the product
- Market demands regarding the quality of the product

The second criterion – Production Capacities – can be separated into three subcriteria, which are:

- Exploitation capacity
- The state of the exploitation capacities
- The estimation of possible failures

Further division of the above mentioned subcriteria can be done by the introduction of the third level of subcriteria:

- When talking about the exploitation capacity, production capacities of companies can be analyzed according to the groups of machines, i.e. for: lathes, milling, drilling and grinding machines, digitally controlled machines, etc.
- To estimate the possible failures, the most frequent failure causes are introduced and classified as: the machine factor, the tool factor, the human factor and the organization factor.

The third subcriterion – Staff resources – can be divided into the following subcriteria:

- The stuff structure regarding the professional fields
- The stuff structure regarding the level of expertise

These subcriteria can be further separated into their subcriteria. The "regarding the professional fields" subcriteria can be divided into those professions which are present in the company, and the described model presents a couple of them: a lathe operator, a locksmith, a mechanical technician, a chemical engineer etc. The subcriteria – The stuff structure regarding the level of expertise – can further be divided into those levels of expertise which are present in the company.

The fourth subcriterion – Material resources – can be divided into further subcriteria:

- The raw materials supply according to their species

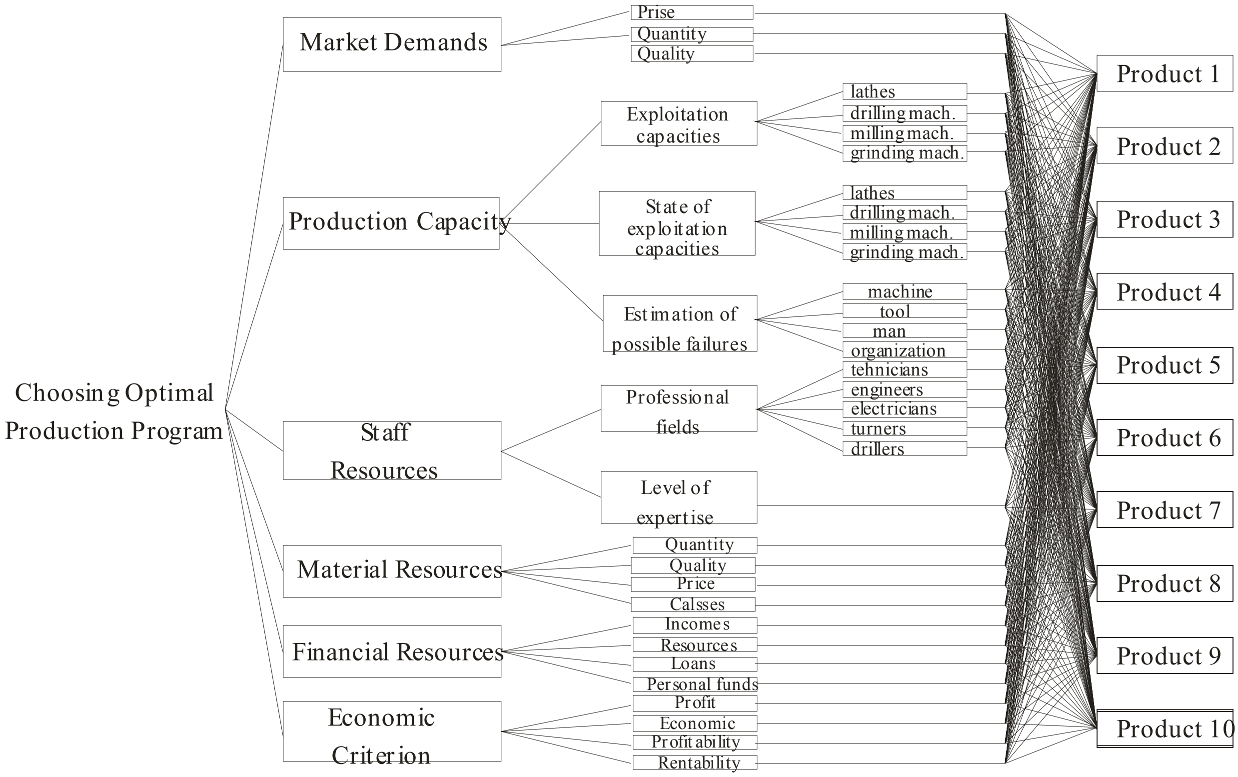

Figure 4. The scheme of the influential factors hierarchical structure

- The raw materials supply according to their quantityThe raw materials supply according to their price

The fifth criterion – Financial resources – can be divided into the following subcriteria:

- Incomes (regarding the deposit dynamics)
- Resources (of additional finances)
- Loans
- Personal funds

The sixth criterion – The Economic one – is being estimated with the help of the following parameters:

- Profit
- Economy
- Profitability
- Productivity

The created decision model enables the users to widen the criteria according to their own needs and understanding of the specific business systems.

This problem is introduced as a hierarchical structure: the main goal, the influential criteria and alternatives, as presented in Fig.4. The defined structure has five levels: main goal, three levels of criteria and subcriteria, and the fifth level which represents the list of alternatives. Ten products were taken in the example as alternative solutions. The total number of the defined blocks is 79. The depicted structure is easily changeable when needed by adding or erasing blocks, by adding or erasing levels, by changing the terms in the blocks or their values etc.

After having defined the hierarchical structure, it is necessary to evaluate the influential criteria. Data analysis is possible with the help of the well-known AHP method (Analytical Hierarchy Process). In order to apply the weights criteria, it is possible to use either a verbal or a numerical scale.

In order to estimate the first level criterion, it is good to use the verbal scale which has the following classes: critical, very important, important, and unimportant, as in Fig. 5. The production capacity criterion and the economic criterion are marked as the most important (critical), while the other criteria are marked with the same mark – very important. Anyway, the scale can be created according to one's needs. The option Add Scale allows you to add a numerical or a verbal scale. In the first case one must define the biggest and the smallest value which can have the alternatives on the numerical scale.

When dealing with the material supply subcriterion according to its species, one should introduce a new scale with the following classes: absolutely satisfactory, satisfactory, unsatisfactory, it is difficult to supply raw material, and it is very difficult to supply raw material. With the exploitation capacity of lathes criterion, it is possible to introduce a new numerical scale where the top value would actually represent the exploitation capacity, while the values that you add are real or accomplished capacity.

The necessary values which define the criteria in a qualitative and a quantitative manner will be based on the achievements of a regarded business system "GOŠA " from Smederavska Palanka in the previous year.

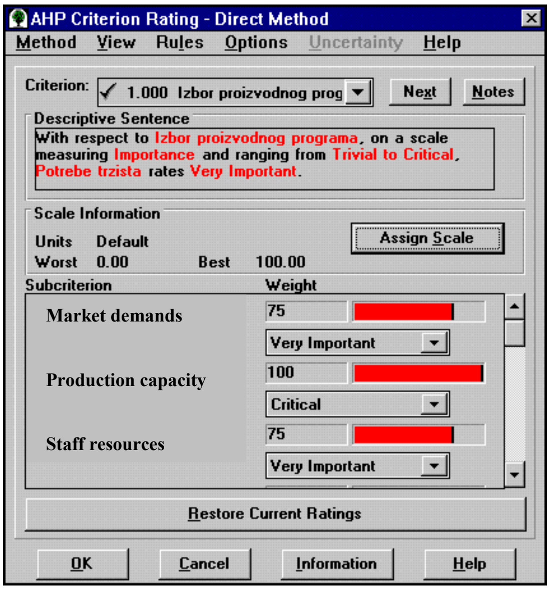

Figure 5. The heaviness mark criterion application

Fig.6 shows the results, i.e. the sequence of alternatives according to their importance and regarding the main criterion, the optimal product programme choice, while every criteria and subcriteria mark was taken into consideration. The results show that product N°4 has the highest values, after which products N°7, 5, 1, 2, 3, 10, 9, 6, and 8 follow.

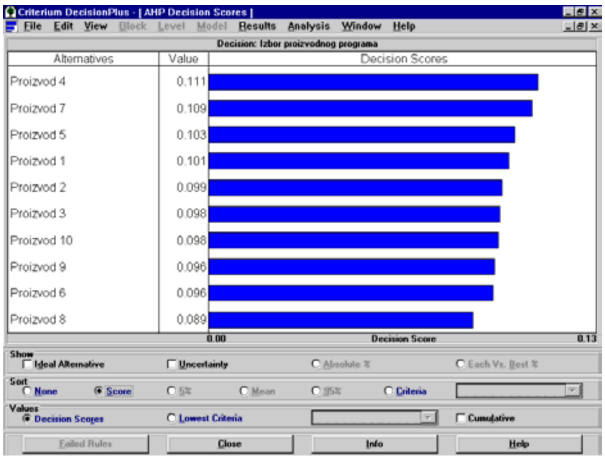

Figure 6. The sequence of alternatives

Fig.6 gives a sensitivity chart for the given optimal production programme. The vertical red line in the sensitivity chart stands for the significance level, and all lines cutting close to the significance level indicate the high sensitivity of the optimal plan in regard to the changes in significance of influential criteria. When evaluating certain criteria, especially in the first level, it is possible to make an unintentional mistake. In other words, the evaluation here should be carried out by an expert, where an imprecise evaluation may lead to false results. This diagram enables the decision maker to analyze if there are any eventual overlapping alternatives nearby the given evaluation, which would indicate the structure changes of the analyzed results in case of smaller oscillations in significance evaluation of the analyzed criterion.

This "what would happen if the significance of some criterion changes" research procedure in similar decision support systems is conducted with the help of a so-called "what if" analysis, where different values are added to the initial state and the results are analysed after the calculation (e.g. Expert Choice Software).

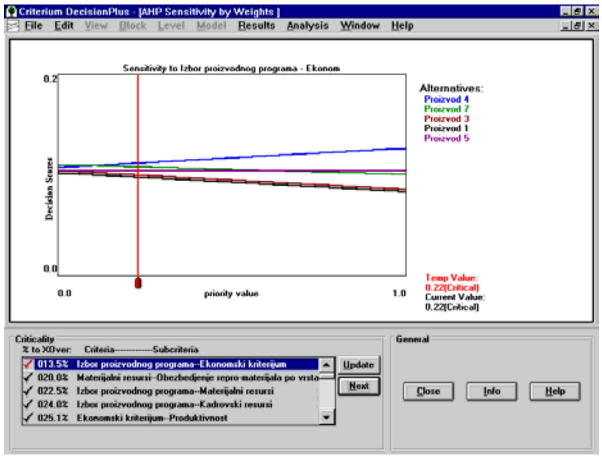

Figure 7. Sensitivity Analysis

The described software tool also has the possibility to include the uncertainty factor in the calculation. For example, when dealing with the market demands criterion, it is possible to take into consideration a schedule according to which one may predict a certain product demand.

The result analysis brings us to a conclusion that the existing production conditions are the most suitable for the production of products with numbers 4, 7, 5, 1, 2 etc. However, although product N°2 has the biggest unit profit, there is no demand for this product regarding its quantity, which means that the market could not absorb all the produced quantity of this product. There are more similar examples in the given example, and to avoid the unwanted side effects , it is the most important to set an adequate number of influential criteria, i.e. to project a decision model which would represent the real model in the most precise way.

Based on the created decision model, it is possible to analyse the production programme according to relevant criteria and that way improve the decision quality, diminish the time needed to make a decision, diminish the costs of analyses etc.

5. CONCLUSION

The paper has described the application of information systems to the complex problem solving in business systems, the goal of which is to simplify the decision making process. The goal is to increase the efficiency of the decision maker, as well as to improve the quality of chosen decisions. Complex problem solving in business systems sets the question of decrease of suspense presence, the influence of the ability and knowledge on the decision maker in complex problem solving, which can be the topic of further researches.

Based on the creation and the application of the optimal production programme choice model, one can come to the following conclusion:

1. The created decision model together with the decision support system application can

significantly improve the optimal production programme choice in a business system and make it easier.

2. Qualitative data used in this model are subjective estimations of employees and as such should be taken with reserves.
3. It is possible to improve the decision-making if one integrates a decision support system and an expert system, i.e. if you apply a hybrid system.
4. The choice of the optimal production programme must be regarded as realistically as possible through further development of engineering demands on the production system level.

The research shows that the created model and the applied information system can help the decision maker in majority of phases of the problem solving process, but the mere choice of a solution, the evaluation of the possibilities of the firm, the evaluation of the influential criteria, recognition of shortcomings, generating of new ideas and so on, are the activities which still depend only on the decision maker.

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РЕШАВАЊЕ КОМПЛЕКСНИХ МЕНАЏЕРСКИХ ПРОБЛЕМА ПРИМЕНОМ СИСТЕМА ЗА ПОДРШКУ ОДЛУЧИВАЊУ

Драган Д. Милановић

У циљу обезбеђења да се пословни систем ефикасно прилагођава променама на тржишту, мора се посветити посебна пажња процесима решавања комплексних менаџерских проблема. С обзиром да за једноставније проблеме у пословној пракси постоје утврђене процедуре и начини за њихово решавање, од значаја је да се утврди процедура за решавање комплексних менаџерских проблема. Решавање комплексних менаџерских проблема спроведено по утврђеној процедури, дакле по дефинисаним фазама, олакшава доносиоцу одлуке читав поступак јер га упућује како да организује активности на решавању проблема, скраћује време решавања проблема, повећава квалитет доносених одлука а самим тим и мању вероватноћу појаве неповољних резултата. У раду је описана примена система за подршку одлучивању за решавање комплексних менаџерских проблема у пословним системима. Примена система за подршку одлучивању има за циљ да доносиоцима одлука помогне у процесу решавања компексних менаџерских проблема и да побољша квалитет одлука.