

**8th INTERNATIONAL CONFERENCE ON INDUSTRIAL
ENGINEERING**

**INNOVATION CENTER OF THE FACULTY OF MECHANICAL
ENGINEERING**

&

**INDUSTRIAL ENGINEERING DEPARTMENT, FACULTY OF
MECHANICAL ENGINEERING, UNIVERSITY OF BELGRADE,
SERBIA**



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Editors:

**Vesna Spasojević Brkić
Mirjana Misita
Uglješa Bugarić**

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Vesna Spasojević Brkić
Mirjana Misita
Uglješa Bugarić

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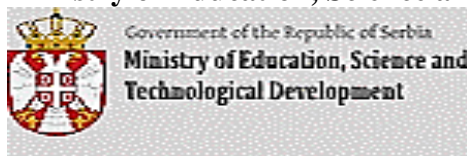
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PREFACE

Since the first event in Belgrade, Serbia more than 25 years ago, in 1996, International Conference on Industrial Engineering - SIE has been held regularly every 3 years. This time we are one year late due to pandemic conditions. 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 first aim of the 8th International Conference on Industrial Engineering – SIE 2022 is to celebrate 70 years from founding of our department by prof. dr Vukan Dešić! We are proud of professor Dešić who, as stated in one of the archive documents was “a man of excellent professional abilities and one of the best experts” and thank him for all his immeasurable contributions! The second aim of SIE 2022 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 conference 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 conference 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 2022 traditionally provides an international forum for the dissemination and exchange of scientific information in industrial engineering fields through the large number of multidisciplinary topics and continues tradition established by prof. Dešić to gather and bring together experts in the field.

The book brought together almost 200 authors from 20 countries, namely from Canada, Croatia, Finland, Germany, Iran, Italy, Libya, Montenegro, Netherlands, North Macedonia, Poland, Portugal, Russia, Bosnia & Herzegovina, Singapore, Slovakia, Switzerland, Turkey and USA and Serbia. The 84 submitted full length manuscripts were peer-reviewed, and 81 of them were 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 five chapters, including plenary lectures and numerous results of national and EU projects are there presented (financed by MESTD, PSHE SR ARV, SF RS, EC, EF RD, TUKE, INAIL etc.).

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 8th International Conference on Industrial Engineering – SIE 2022! We wish to all participants a pleasant stay in Belgrade and are looking forward to seeing you all together at the 9th Conference on Industrial Engineering – SIE 2025.

Belgrade, September 2022

EDITORS



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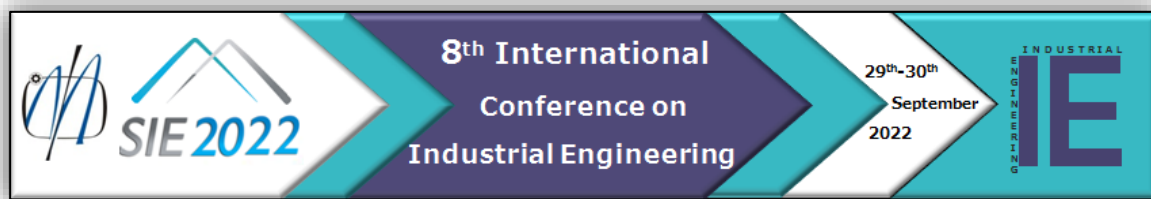
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FACTORS AFFECTING SMEs FAILURE - PART ONE: GENERAL ASPECTS

Ivan Mihajlović¹, Nenad Nikolić², Peter Schulte³

¹Faculty of Mechanical Engineering, University of Belgrade, Serbia
imihajlovic@mas.bg.ac.rs

²Technical Faculty in Bor, University of Belgrade, Serbia
nenadnikolicbor@gmail.com

³Institute for European Affairs INEA Senden, Germany
Dr.Peter.Schulte@gmx.de

Abstract. *This manuscript is presenting the results of the research, conducted during the International Visegrad project: “How to prevent SMEs from failure (Actions based on comparative analysis in Visegrad countries and Serbia)”. The project was realized during the period 2018-2019. The importance of the factors that can influence SMEs failure were collected through specially designed questionnaire that included individual and non-individual factors. In the group of non-individual, external and internal factors were analyzed. The ranking of collected factors were done using the contemporary multi criterion decision making tools. The results of this previous project will be introduced, in the first part of the paper, as the input for the results obtained in 2021-2022 in frame of the new research project, which will be presented in the second part of the paper.*

Key words: *SMEs failure, important factors, MCDM tools.*

1. INTRODUCTION

Entrepreneurship presents one of the factors of production and through the entrepreneurial activities, entrepreneurs optimally combine the remaining factors of production - land, labor and capital to generate the profit of their operations. Also, entrepreneurial activities should be considered as the engine of innovation that brings new ways of organizing the factors of production to produce new

goods and services. This way, it is one of the main drivers of the economic prosperity [3,4,2].

There are large number of manuscripts available, presenting the examples of good entrepreneurial practice, e.g. the cases of success stories in entrepreneurship. This, of course, can be considered as the valuable information for entrepreneurs, especially those at the start-up level. Based on such examples of good practice, it is possible to learn and to accept effective operational models available. On the other hand, there are limited number of available publications dealing with entrepreneurial failures, or examples of business mistakes made by entrepreneurs, that resulted in their failure. Limited number of publications, dealing with such cases, are also source of valuable information. This form of available information can also be used as the learning resource, from which it is possible to learn from somebodies else mistakes. If the most common reasons for SMEs sector failure are available to early stage entrepreneurs, those can be used as the road mark of obstacles to be avoided in their entrepreneurial life cycle.

Having this fact in mind, in this article (in its first part, some of the most important results of the research project “How to prevent SMEs from failure (Actions based on comparative analysis in Visegrad countries and Serbia)” will be presented. As it will be given in the discussion of obtained results of this project, one of the most important reason for SMEs potential failure is inadequate acceptance of digitalisation in

the SMEs sector. Accordingly, in the second part of this manuscript, some possibilities and barriers for acceptance of the digitalisation in SMEs sector will be addressed.

2. METHODOLOGY

The idea to study the most influential factors that can lead to SMEs failure, was generated during the activities of the International Resita Network for Entrepreneurship and Innovation [10]. Through this network, initial research scope was developed, e.g. the measuring scale that can be used to evaluate the importance of the factors that led to failure of SMEs, including the level of their recovery after the failure. Based on this measuring scale, the interviews were organized, on the network level, and initial results were collected. This initial results gave the possibility to further “fine tune” the measuring scale and to develop the final questionnaire for the SMEs owners, which can be used to measure the importance of the reasons that can lead to the SMEs failure.

The idea for this research, together with the initial results obtained in the Resita Network activities, was the starting point in preparation of the project: “How to prevent SMEs from failure (Actions based on comparative analysis in Visegrad countries and Serbia)”. Project was submitted and accepted for financing by the International Visegrad Fund [11], in the period 2018/2019. Besides coordinating institution, that was University of Belgrade - Technical Faculty in Bor, partner institutions were: University of Ss. Cyril and Methodius in Trnava; Óbuda University, Keleti Faculty of Business and Management – Hungary; Tomas Bata University in Zlin – Czech Republic; The Managers of Quality and Production Association – Poland.

The main goal of the project was considering the analyses of the factors that were leading to potential failures of SMEs and their abilities to recover, after the failure, in Visegrad countries (Slovakia, Hungary, Czech Republic and Poland) and in Serbia. In well developed economies, failure of previous businesses is usually taken as positive experience of entrepreneurs. This way, it doesn't influence the ability to receive new grants and/or credits from adequate financial institutions. In case of South-East Europe, entrepreneurs who fail usually are limited in potential monetary sources for new business. Once they fail, nobody wants to invest in their future ventures. This way, they cannot learn from their own previous experiences. Realizing this fact, this project was focused to assess the most important factors influencing the potential failure of SMEs ventures, and based on that, to develop the final measuring scale, that can help existing business to

avoid potential failure in their future operations [12]. As the direct result of the research on this project, one specialised monograph was published, with the title “How to prevent SMEs failure (Actions based on comparative analysis in Visegrad countries and Serbia)” [6]. Also, one special issue of the international journal Serbian Journal of Management, was published presenting the results of this project [7].

The final measuring scale that was developed during the research on this project, contained 36 questions grouped into six groups [5]: I1 – Individual factors/Private time activities; I2 – Individual factors/Personal characteristics of entrepreneurs and managers of SMEs; I3 – Individual factors/Start-up motivation; E1 – Non-individual external factors/PESTEL analysis; E2 – Non-individual external factors/Infrastructural issues; E3 – Non-individual internal factors/Factors of business environment. In the research, 450 opinions of entrepreneurs/managers of SMEs were successfully collected, who evaluated the influence of given factors influencing the failure, using the Likert's 5-point scale [8]. The research was conducted in all four Visegrad group countries and in Serbia. However, the number of responses from Poland was much smaller, compared to other countries, so it isn't given in the individual country-based results. The demographic characteristics of the investigate group of SMEs owners/entrepreneurs is given in the reference [9]. In the same research, a structural equation model (SEM) was developed, indicating that there is a strong relationship between the groups of factors and the level of recovery of the SMEs [9], but not the extent to which each particular factor affected the SMEs failure. Considering that it is not enough to just establish that there is a link between certain groups of failure factors and SMEs outcomes, but also to determine the impact of each particular factor, additional analysis was performed in this direction. This way, for the ranking of the failure factors of SMEs, the hybrid Fuzzy Analytic Hierarchy Process (FAHP)–Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) model was used, which represents a new approach to ranking of the failure factors. Subsequently, the ABC method was applied to the obtained results in order to distinguish the group of the most influential factors [8].

3. RESULTS

The most important issues, ranked by the representatives of the V4 countries and Serbia, are presented in Figure 1. Based on the research results, further analysis was conducted using the FAHP-PROMETHEE method, in order to assess the significance of all the particular factors, which affect SMEs failure. Based on the obtained results it was concluded that the most important factors which negatively influenced the success of SMEs are:

Economic issues (financial difficulties), Competition in market, Inadequate possibility of increasing capacity, Political - legal difficulties, Supply of electricity, Management of receivables/payables and Legislative issues. All of this factors were clarified as the group A, during the ABC analysis. Group B was consisted of the following factors: Difficulties in obtaining new technologies, Transportation system, Social issues, Availability of suppliers for the necessary production materials, Drop in motivation, Not Enough qualified work force, Technological issues, Inability to find new potential shareholders/partners, Delays in loan repayments. Group C, that is composed of the less important factors for the SMEs potential failure, in accordance to the opinion of the SMEs owners and entrepreneurs was: The need of achievement, Good business connections as a start-up motive, Low availability of markets for products/services, Risk taking as the most important personal characteristic of an entrepreneur for SME success, Environmental issues, Independence, The fact that motivation for SME start-up was self-fulfilment, The level of unencumbered fixed assets, The fact that motivation for SME start-up was job satisfaction, Self-confidence, Creativity, Internal locus of control, Motivation for SME start-up was a desire to be independent, and Motivation for SME start-up was of financial nature.

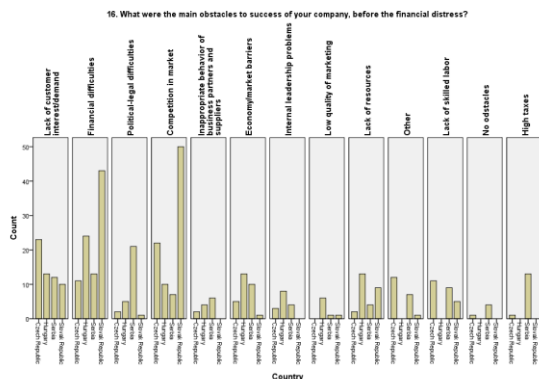


Figure 1. Initial results of the most important factors influencing SMEs failure

4. CONCLUSIONS

As it can be seen, the largest number of factors, located in the group A and group B, in accordance to the influence on the success of the SMEs operations, relates to non-individual factors. Accordingly, it can be concluded that the main problems lie within the SME itself - in the form of non-individual aspects and in its environment. On the other hand, the factors that least affect the failure of SMEs belong to a group of individual factors, which refer to the personal characteristics of the entrepreneur/manager of SME. Of course, this form of the response was to some extent expected, considering that it is based on the personal opinions of the entrepreneurs/managers

themselves. Obviously, the entrepreneurs newer see themselves as a possible problem, rather as a solution to their business problems, and this is one of the reason they have chosen to be the entrepreneurs. On the other hand, it is not surprising that among the highest ranked factors that can lead to failure, in their opinion, are competition in the market, economic and political issues. Namely, Serbia, as well as the Visegrad countries - in accordance to obtained results, are still facing many economic problems, especially in the SME sector, also the legislative issues with the public policies and legal documents still are not being developed rapidly enough for this specific sector. When it comes to the competition in the market, there are problems considering the demand and supply, but also issues resulting from unequal market conditions for private and public sector firms. The factor related to Competition in market is with highest ranks in the case of Slovak and Czech Republic and to less extent rated in Hungary in Serbia. Economic issues are mostly indicated as the main influential factor in Slovak Republic and Hungary, and with less importance in Serbia and Czech Republic. Political-legal issues are highly rated in Serbia. After the problems of economic and legal nature, the significant problem encountered by the SMEs is the inability to increase capacity, which is at the same time the main infrastructural problem of the SMEs. This problem primarily occurs due to low technical and technological equipment of SMEs and to some extent due to lack of available sources for investment and lack of competent work force. Namely, in case of Serbia, SMEs have equipment that is approximately between 5- and 10-year old, while every fourth SME has equipment older than 10 years [8, 1]. This certainly leads to an increase in product costs - due to high maintenance costs, which makes SME products less competitive in the market and accordingly results to a decrease in SMEs profit. Consequently, SMEs do not have enough resources to invest in the modernisation of the production process, which could improve their position in the market. So this way, this is one closed loop paradox that is not that easy to resolve. The technological issue that led to SMEs failure were highly scored in the case of Hungary and Serbia, while this was with low scores in the case of Slovak Republic. Also, technological issues, related to Difficulties in absorption/acquisition of new technologies/innovation was rated to the highest extent in the case of Serbia and Hungary, and to less extent in the case of Slovak Republic. The issue of not having enough qualified work force in the region, was highly ranked in Hungary, to medium extend in Slovak Republic and Serbia and to lowest extent in Czech Republic.

Entrepreneurs/managers of SMEs have also listed electricity supply as one of the most significant external problems they encounter. Of course, considering that the research was done before the present energetic crisis, the issue of inadequate supply

was not the problem in those days. First of all, the main problem SMEs are facing, when it comes to the energy, was the price of electricity for commercial customers, as well as costly and complex procedure for connection to the electricity distribution system - in case of new start-ups [8]. This problem was especially indicated by the entrepreneurs in Hungary, and it was ranked with the smallest influence in the case of Czech Republic.

On the other hand, The main internal problem that SMEs face is the collection of receivables, since this factor has been ranked by entrepreneurs/managers of SMEs in the group A. Namely, in most cases, the enterprises are obligated to pay all the taxes and the liabilities on time, even in the cases when they didn't manage to collect their revenues from the customers. This makes extreme ballast to their business cash flow, which is especially large problem for newly started businesses, which do not have previously accumulated capital assets. This issue was with the highest rank in the case of Slovak Republic, followed by Serbia and with minimum scores in the case of Hungary and Czech Republic.

Although the level of digitalisation of the business operations in the SMEs sector was not directly investigated in this project, it was concluded that this is also one of the potentially important reasons for unsuccessful operational result. Basically, this can also be connected with the outdated technology and inability to increase production capacities. Also, this problem was directly investigated in the factor "Difficulties in obtaining new technologies", which was also highly ranked by the entrepreneurs and the managers of the SMEs. Based on this, it was decided that this issue had to be additionally addressed. Based on this, new international project was organised, in frame of the same research group, with the subject: Possibilities and barriers for Industry 4.0 implementation in SMEs in V4 countries and Serbia. The results of this project will be addressed in the second part of this manuscript.

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REFERENCES

[1] Chamber of Commerce of Belgrade (2015). Development of SMEs 1990-2015. Chamber of Commerce of Belgrade. <http://www.kombeg.org.rs/Slike/CeEkonPolitikarestIRazvoj/2015/Razvoj%20MSP%201990-2015%20Srbija-Beograd.pdf>

[2] Fernandes, C., Ferreira, J.J, Veiga, P.M, Kraus, V & Dabic, M., Digital entrepreneurship platforms: Mapping the field and looking towards a holistic approach, *Technology in Society*, 70, 101979

[3] Ferreira, J.J, Fayolle, A., Fernandes, C & Raposo, M. (2017). Effects of Schumpeterian and Kirznerian entrepreneurship on economic growth: panel data evidence. *Enterpren. Reg. Dev.*, 29 (1–2) 27–50.

[4] Kimmitt, J., Muñoz, P & Newbery, R.. (2020) Poverty and the varieties of entrepreneurship in the pursuit of prosperity, *J. Bus. Ventur.*, 35 (4) 105939.

[5] Mihajlovic, I., Nikolic, N., Dhamo, Z., Schulte, P & Kume, V. (2015). The Reasons for SME's Failure, Comparative Analysis and Research, Proceedings of FIKUSZ '15 Symposium for Young Researchers, 7-22 pp. Conference Proceedings compilation Obuda University Keleti Faculty of Business and Management 2015. Published by Óbuda University <http://kgk.uni-obuda.hu/fikusz>

[6] Mihajlovic I. (2018). Monograph: How to prevent SMEs failure (Actions based on comparative analysis in Visegrad countries and Serbia), Published by Technical faculty in Bor- Editor in Chief;: I. Mihajlovic, ISBN: 978-86-6305-095-2.

[7] Mihajlovic, I., Milosevic, I., & Stojanovic, A. (2019). Editors Note: International Visegrad project: how to prevent SMEs from failure - actions based on comparative analysis in Visegrad countries and Serbia, *Serbian Journal of Management* ,14 (2), 249 - 255.

[8] Nikolic, N., Nikolic, Dj., Marinkovic, S., & Mihajlovic, I. (2020.), Application of FAHP–PROMETHEE Hybrid Model for Prioritizing SMEs Failure Factors. *Engineering Management Journal / EMJ*, pp.1-18.

[9] Nikolic, N., Jovanović, I., Nikolić, Đ., Mihajlović, I., & Schulte, P. (2019). Investigation of the Factors Influencing SME Failure as a Function of Its Prevention and Fast Recovery after Failure. *Entrepreneurship Research Journal*, Vol 9, No 3, Article number 20170030.

[10] Schulte, P., Živković, D., Graef, M., Vadjnal, J., Trisca, G., Mihajlović, I., Pavlov, D., Kume, V., Živković, Ž., Dimitrova, M., Zečić, Dž, Halebić, J. & Tantau, A. (2013). Letter to Editor: Resita network - academic entrepreneurship and innovation network of South Eastern European universities: an example of successful networking in entrepreneurship and innovation at academic level, *Serbian Journal of Management* 8 (1), 117 – 130.

Web references

[11] <https://www.visegradfund.org/>

[12] <https://mksm.sjm06.com/visegrad-project-2018/>