

THE NEW MODEL OF THE ENGINEERING EDUCATION USING DIGITALIZATION AND INNOVATIVE METHODS

Katarína TEPLICKÁ, Jaroslava KÁDÁROVÁ
Technical University of Košice

Soňa HURNÁ
Mendel University of Brno

Abstract:

The sustainability of engineering education depends on a strategic vision in university education. The strategic vision of education at technical universities is orientated to knowledge, digitization, online education, innovative methods in education, all forms of Management and business education platform. The main goal of this article is the creation of the model of engineering education at the technical university based on synergy effect of the economic subjects of study, digitalization, all forms of management, and innovative didactic methods with direction to future education. In this research we realized project "Student firms" by using digitalization, e-learning approach in education and connecting all form of management as in business environment. Results of the implemented "Student Firms" project at the university recorded benefits in improving students' key competencies, soft skills, social competencies, financial, economic competencies, and their impact on the level of evaluation of subjects of study. The output of the research was the design of a model of engineering education at the university. This model can be a tool for making changes in education at university for his sustainability in the future.

Key words: education, digitalization, information technology, innovation, skills

INTRODUCTION

The sustainability of engineering education depends on strategic vision in education at universities. This strategic vision must connect informational, knowledge, economic and social society and their instruments and methods. The main goal of this article is the creation of the model of engineering education at the technical university based on synergy effect of the economic subjects of study, digitalization, all forms of management, and innovative didactic methods with direction to future education. The strategic vision (Fig. 1) at universities should be directed mainly to business education within which it is necessary to address the issue of financial literacy of students, increasing students' information competencies through digitization, and development of key student competencies in the knowledge economy and all forms of management.

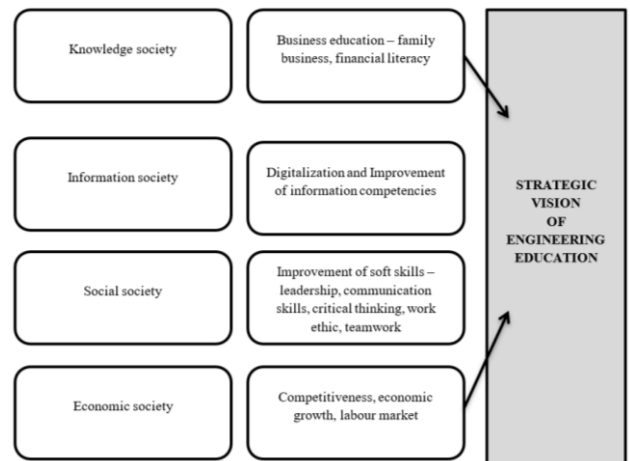


Fig. 1 Strategic vision of education

Key competencies have the character of interpersonal competencies e.g., teamwork, leadership, and intrapersonal competencies that include motivation, problem-solving, effective communication, which is associated with the field of psychology. At the same time, the education strategy should be focused on improving students' soft skills in terms of social and communication competencies. The development of information and communication technologies is a stimulus for their use in the educational process at universities. The new teaching model will enable students to acquire quality knowledge in terms of business skills, financial literacy, soft techniques, and at the same time, the requirements of the labour market for university graduates and their successful application in the labour market will be met.

Higher education, science, and research at universities are facing many challenges that arise in today's globalized economy and there is increasing pressure on improving the quality assurance in all their processes. According to the Bologna Declaration signed in 1999, higher education requires a convergent system of quality assurance [1]. University education in today's globalized economy is exposed to many challenges and increasing pressure to improve its approach to the quality assurance of all its processes. The situation exists in the field of university education, where candidates for study very carefully consider study program and country of studying. The approach of university management to quality is therefore very important [2].

LITERATURE REVIEW

The strategy of the European Union in education is oriented to the providing and realization of lifelong learning, distances education and educational mobilities ERASMUS and ERASMUS+ [3]. The main task in this area is using social networks like Facebook, Twitter, LinkedIn, and others that show possibilities for an e-books approach for education [4]. Distance education brings a new approach to education as online learning that students prefer [5]. The best important part of online education is sport education for the improvement life of students that must be provided very effectively [6]. Teacher education means using new technology and creates an educational process for students and their needs [7]. Improvement of the level of quality and effectiveness of education is built expert preparation, creativity, innovations, and business. All those forms must be evaluated by performance indicators as in the business environment [8]. The principal objective of Assessment of Learning Outcomes in Higher Education (AHELO) is to provide data to governments, institutions, and students themselves on what students at the end of their first (bachelor level) degrees know and are able to do. Education quality presents a base of the information society, knowledge society, social and economic society. The base for quality level increasing is educational methods, good pedagogues, good equipment of the laboratories, and qualitative expert preparation students what is particularly parts of the management system [9]. Requirements for education are presented in the Management

system of Education [10]. A new model of engineering education must accept all requirements of all forms of society. The knowledge society requires monitoring of knowledge. Knowledge allows monitoring the performance of students, teachers, scientists, workers in terms of productivity, efficiency, fulfilment of delegated tasks, goals [11]. Improving information flow is the basis of knowledge management and important instrument for decision making for the quality of Education [12].

The application of forecasting in education is an instrument for the quality level increases of education and using new forms of information technology what is a requirement of the information society [13]. Knowledge management is a very important approach in terms of achieving the required level of education quality and quality of performance indicators as instruments for increasing the competitiveness at universities [14]. The information we obtain in the educational process needs to be collected, recorded, analysed, evaluated, archived, and continuously used for effective management and decision-making of the educational process. Information society brings changes in education at the universities when information literacy becomes the base of education. Information literacy is connected also with the way how people – users – behave during information finding. It means the interaction of man with information sources and systems in certain concrete situations [15]. Behaviour presents the reflection on how people view, elaborate, remember information, and how they solve their problems through information. It means the requirements of social society. The information behaviour of the people is influenced by several factors, as for example internal psychical processes, social environment, situation, in which information need arose, which also characterizes the personality identity [16]. E-learning presents an actual form of education in the information society that has great importance in the period of the COVID 19 pandemic, which reached also to the area of education and education process at the universities [17]. E-learning education at the universities is made according to the various platforms as MOODLE, EDUPAGE, ULERN and another [18]. Information society presents a synergy between the information literacy of people and information behaviour [19]. Universities are presently connected to various projects to provide their laboratories and classrooms with computers. The economic society today needs people with business, financial, social, environmental, economic skills, and bases of soft skills in building a business contract and business relationship. The importance of Social Sciences and Humanities has the potential contribution that they can make to Science, Technology, Engineering, and Mathematics [20]. In education is a very important instrument for business and the improvement of level of key competencies an innovative method "Students' firm". Evaluation of results of this project was to improve the students' key competencies, obtaining new skills, knowledge, experiences, and prepare students for business in praxis. This innovative method should be implemented in education at technical

universities as a base for developing business and achieving key competencies for business in technical subjects. A survey between students showed is a necessity to learn students and starting businessmen to follow up possibilities of financing and providing prosperity and stability at the market [21]. Business skills must be part of the educational strategy at all technical universities.

METHODOLOGY OF RESEARCH

In the frame of research-orientated to the increasing education quality level in the period of COVID 19 pandemic, we realized research followed steps (Fig. 2). The main goal of this research was the creation of the model of engineering education at the technical university based on synergy effect of the economic subjects of study with digitalization, using of all forms of management, innovative didactic methods, and e-learning education on platform MOODLE. This research was orientated to the creation of the new model of engineering education as the basis for education in the future.



Fig. 2 Algorithm for creating new strategic model of education

In the first step of research, we created Students firms. The research in the education process was focused on increasing the key competencies of students in field Management. We focused on communication competencies,

information competencies, social competencies, business, and economic competencies. In the second step, we realized installing the subjects: Operational research, Economic analysis, Management, Business, Law in the e-learning portal for university MOODLE Platform education. In the third step students used digitalization for prepare documentation and evidence of the students' firms. Last step, we realized the suggestion of a new model of engineering education on the base experiences of research.

RESULTS OF RESEARCH

In the educational process was implemented innovative didactic method "Student firm" according to the state project "STUDENT FIRM" (Fig. 3), issued by the Ministry of Education for various schools.

The project consists of five steps. The first step means motivation and vision, the second step means the organization, the third step establishment of the company, the next step is business, the last step is the ended of the company. All steps were implemented in accordance with the vision of the project "STUDENT FIRM". The base of the realization project "student firm" was the strategy: Use own sources, produce own products, presented own products at the exhibition, prepare a marketing strategy for customers, sell products, and finish business in profit. In this phase, we connected all study subjects at study program Management.



Fig. 3 Project student firm "JA FIRMA"

Source: Ministry of Education.

All firms realized followed tasks using knowledge from the completed subjects:

1. Establishment of student firm by business licensing (subject: Business plan, Microeconomic).
2. Creation of organizational structure in the firm (subject: Labor economic, Personal management, Management).
3. Preparation of business plan and production plan (subject: Business plan, Logistic, Strategic management).
4. Determination of work positions and tasks in the firm (subject: Production management, Personal management).
5. Obtaining of entry producing factors – material, people, money (subject: Production management).
6. Realization of the production process – products (subject: Production management, Operational research).
7. Preparation of documentation in the firm (subject: Accounting, Managerial Accounting, Financial Accounting, Financial management, Taxes, Auditing).
8. Preparation of marketing strategy (subject: Management, Marketing, Strategic management).
9. Realization of the sale at the exhibition (subject: Production management, Economy, Marketing, and Ethic).
10. Closing the student firm, prepare finished documentation, evaluating the sale (subject: Auditing, Taxes, Financial management, Accounting, Business economy).

The student firm's project was successful. Already in the first step of creating companies, students met the basic goal of communicating. Organizing, planning, performing assigned tasks, and adherence to the timetable was base activities in the firm. During the business prepared complete documentation was presented their skills. During their preparation they had to use the knowledge and skills of previous years of study and subjects they had already completed, fulfilling an important goal of the synergy of subjects. Another goal was to develop a marketing strategy. The last aim was to motivate students to achieve the profit that was the reason for closing the subject Management and passing the exam. The results of the student firms were excellent.

In the second step, we realized installing the subject Operational research, Economic analysis, Management, Business, Law in MOODLE Platform (Fig. 4) for E-learning education according to the needs of student firms for preparing documents.

Platform MOODLE presents the used E-learning approach at the university. This platform is available for any pedagogue and student at the correspondent university through their identifiers that are given by the university, as the name, the correspondent password for Access to the university system. This approach of E-learning education is promoting in the frame of the university complex, which has nine faculties. This instrument is very effective

to support distance and online education and is connected by digitalization and improvement informatic competencies of students.

Fig. 4 Platform "MOODLE" E-learning education

Source: moodle.tuke.sk.

During the lifetime of student companies, the documentation was processed in the form software application named Dominant from the company Dominant Prešov in Slovakia. In this way, the economic and information competencies of students were interconnected with digitalization. Students performed various tasks related to documentation and information processing. Controlling is a specific form of work with information, and its role was to describe all processes in the student firms. The essence of controlling was to achieve economic transparency, transparency in business activities, processes, planning, calculating, budgeting, process decisions, orders, performance, customers, products. This instrument helped students to prepare complex documentation of the student firm (Fig. 5).

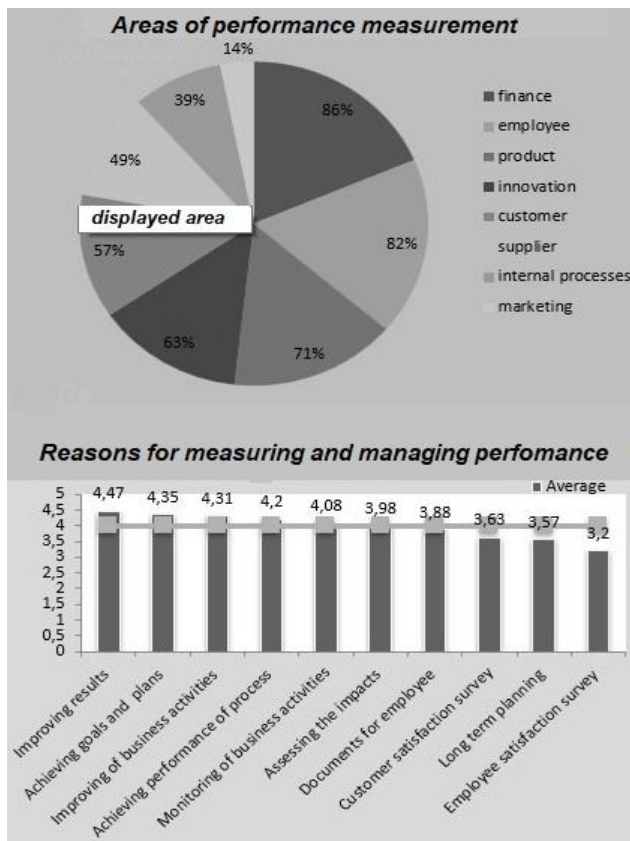


Fig. 5 Documentation of the student firms
Source: Dominanta.sk.

The research "Student firm" evaluates the level of education by Japan concept „KAIZEN“ (Fig. 6), which presents the most known approach to systematic improvement, based on creative thinking. KAI – improvement (everything can be improved), ZEN – improvement is permanent; reacting to any new possibility, change of positions, and new information. Kaizen is orientated mainly to students and their performance since students are bearers and co-creators of education values. This concept is very important for the changes in engineering education. KAI-ZEN include too globalization and studying in abroad. Globalization has a significant impact on education as new work positions can students’ study abroad. The influx of foreign students in Slovakia increased significantly. The factors that affect students' ability to adapt to different global challenges have great importance in education. The university must be prepared to meet students not only academically, but also socially and culturally [22].

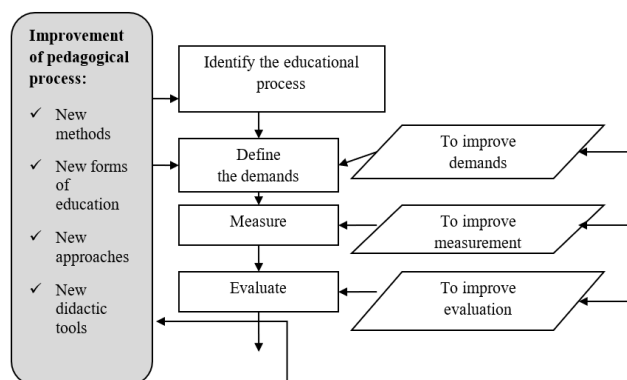


Fig. 6 PDCA cycle for improvement in education

DISCUSSION

The strategic vision of education at technical universities must be based on the requirements the Education in Slovakia Operational Program orientated to knowledge, social, economic and information society. The synergy of education quality, quality of information, quality of the school, and education system presents a key factor in universities’ education and innovation of education. Information literate person can determine the type of necessary information, extend of necessary information, effective and useful way for information obtaining, he manages the critical evaluation of obtained information and information source, he makes the synthesis of information from various information sources, as well as the composition of obtained information to the own base of knowledge. Moreover, he manages the use of information effectively for the achievement of a determined goal, to know economic, legislative, and social limitations, connected with information using, to respect ethical and legislative norms for information handling. Information is base for changes in education and job position on the labor market. For the students are significant factors for finding a job position as salary, job security, and a good working team [23]. New model (Fig. 7) of engineering education content all requirements of economic, social, informatic, knowledge society.

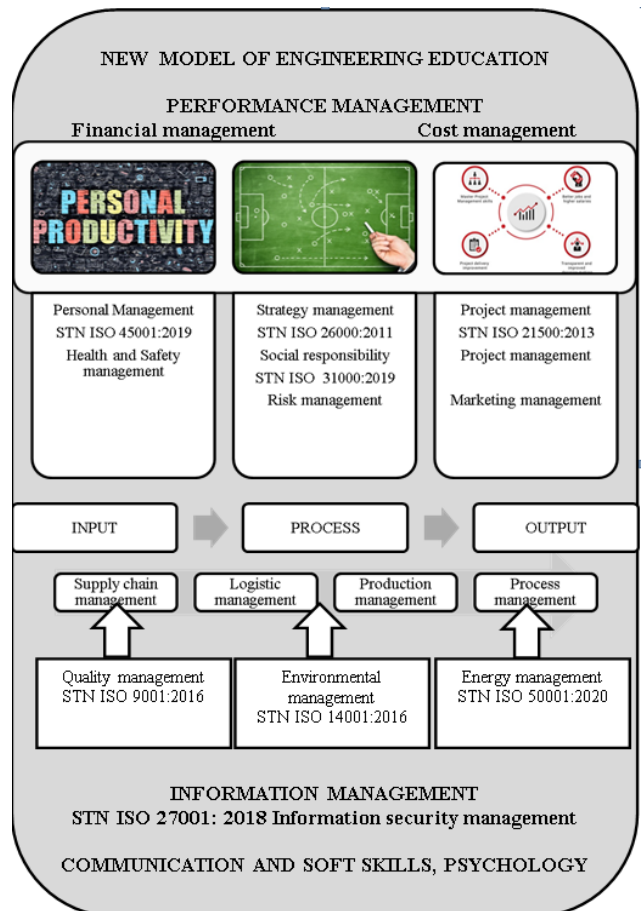


Fig. 7 New model of engineering education

The global objective of the Operational Program Education in Slovakia, the following priority axes have been cre-

ated: Reform of the education and training system, Further education as a tool for human resources development, Support for the education of people with special educational needs, Modern education for the knowledge and information society. All those requirements were implemented in new model of engineering education.

A proposal of the new model of engineering education was realized after the research project of student companies, after connecting study subjects with the project, after using online access through the E-learning portal MOODLE, through new knowledge of all forms of Management as project management, performance management, personal management, strategy management, quality management environmental management, energy management and using new information and communication technologies as based for digitalization. Encouraging business and global thinking and activities is a very actual topic and represents the main objective of the new challenge of the European Commission "More entrepreneurs for Europe". The process of globalization significantly affects the business skills that belong in a knowledge economy among the key competencies needed for the labor market and for the success of establishing businesses. Education of entrepreneurial talent can begin as early as in universities [24]. The EU provides a framework within which EU Member States can exchange best practices and learn from each other, to ensure the implementation of lifelong learning and mobility, improve the quality and efficiency of education and training, promote equality, social cohesion, and active citizenship, stimulate creativity, innovation, and entrepreneurship.

CONCLUSION

The new model of engineering education is based on innovations of education at universities (new methods, forms of education, approaches, didactic tools). It is a prerequisite for employing students in the labor market and base for business and business environment. Knowledge of hard and soft skills is essential nowadays. The inclusion of new forms of education in individual technical subjects is a prerequisite for the satisfaction of potential employers. At the same time, new innovative forms of education improve students' knowledge and skills. They are also a good incentive tool for continuous improvement and continuous education. Business education in today's globalized world, and especially in the European Union, is the foundation for entrepreneurship. Business skills according to the European Commission are among the necessary skills of the 21st century. The suggestion of a new model of engineering education can mean for universities a new direction in education and define a new educational strategy to state economic, social, personal, information, economic competencies of students and there on the labor market.

ACKNOWLEDGEMENT

This contribution is part of project KEGA 009TUKE-4/2020 Transfer of Digitalization into Education in the Study program Business Management and Economics and VEGA 1/0317/19 "Research and development of new smart solutions based on the principles of Industry 4.0, logistics, 3D modelling and simulation for streamlining production in the mining and building industry".

REFERENCES

- [1] Š. Markulík, L. Kamenický, "Measuring the quality of higher education institutions in Slovakia," *ICEMS 2014 – International Conference on Education and Management Science*, pp. 5-9, 2014.
- [2] M. Šolc, Š. Markulík, A. Sutoova, "Quality in contemporary university environment," *CY-ICER – international conference on educational research*, Vol. 143, pp. 703-707, 2014.
- [3] M. Kara, Z. Yildirim, "Faculty performance improvement in distance education: interventions for performance improvement," *Performance Improvement Quarterly*, vol. 33(2), pp. 173-205, 2019.
- [4] H. Zarzour, S. Bendjaballah, H. Harirche, "Exploring the behavioral patterns of students learning with a Facebook based e-book approach," *Computer and Education*, vol. 156 (103957), 2020.
- [5] R.L. Shearer, T. Aldemir, J. Hitchcock, J. Resig, J. Driver, M. Kohler, "What students want: a vision of a future online learning experience grounded in distance education theory," *American Journal of Distance Education*, vol. 34(1), pp. 36-52, 2019.
- [6] T.L. Wallhead, P.A. Hastie, S. Harvey, S. Pill, "Academics perspectives on time future of sport education," *Physical Education and Sport Pedagogy*, vol.1, pp. 1-16, 2020.
- [7] M.L. Wilson, A.D. Ritzhaupt, L. Cheng, "The impact of teacher education courses for technology integration on pre service teacher knowledge: A meta-analysis study," *Computer and Education*, vol. 156, 103941, 2020.
- [8] R. Rajnoha, P. Lesníková, V. Krajčík, "Influence of business performance measurement systems and corporate sustainability concept to overall business performance: save the planet and keep your performance," *Economics and Management*, vol. 1, pp. 111-128, doi: 10.15240/tul/001/2017-1-008. 2017.
- [9] Š. Markulík, et al., "Causal dependence of events under management system conditions." *MM Science Journal*, vol. 10, pp. 1040-1042, 2016.
- [10] Š. Markulík, R. Kozel, "Transformation of product characteristics in terms of a management system," *MM Science Journal*, vol. 20, pp. 900-902, 2016.
- [11] K. Teplická, S. Hurná, J. Kádárová, "Comparison of Using Managerial Instruments in Industry Companies in Slovakia and the Czech Republic," *Technology, Education, Management, Informatics*, vol.8, (4), pp. 1191-1197, 2019.
- [12] A. Sütőová, S. Segiňáková, "Improving information flow for decision making on product quality in the automotive industry," *Quality Innovation Prosperity*, vol. 22 (1), pp. 73-80, 2018.
- [13] A. Kolková, "The Application of Forecasting Sales of Services to Increase Business Competitiveness," *Journal of Competitiveness*, vol. 12 (2), pp. 90-105, 2020. <https://doi.org/10.7441/joc.2020.02.06>

- [14] P. Malega, V. Rudy, J. Kovač & J. Kovač, "The Competitive Market Map as the Basis for an Evaluation of the Competitiveness of the Slovak Republic on an International Scale," *Journal of Competitiveness*, vol. 11(4), pp. 103-119, 2019.
- [15] P. Awasthy, J. Hazra, "Collaboration under outcome-based contracts for information technology services," *European Journal of Operational Research*, vol. 286(1), pp. 350-359, 2020.
- [16] Z. Anikina, L. Gonchareva, A. Evseeva, "Constructing academic identity in the changing Russian higher education context: preliminary perspectives," *Higher Education Research and Development*, vol. 39, (5), pp. 855-868, 2020.
- [17] D. Hrehová, K. Teplická, "The informational communication technology is a tool of global education," *International Scientific Conference Globalization and its Socio-Economic Consequences*, Vol. 74, 06008, 2020.
- [18] M. Campiloo, M. Sanchez, P. Diaz, "Present and future of school intergenerational programs: A study from Spain," *Educational Research*, vol. 62 (4), pp. 375-389, 2020.
- [19] X. Zhang, D.P. van Donk, J. Jayaram, "A multi theory perspective on enablers of inter organizational information and communication technology: A comparison of China and the Netherlands," *International Journal of Information Management*, vol. 54, 2020.
- [20] I. Josa, A. Aguado, "Social sciences and humanities in the education of civil engineering: current status and proposal of guidelines," *Journal of Cleaner Production*, vol. 311, 127489, 2021.
- [21] K. Čulková, D. Hrehová, M. Janošková, "Business competencies of non-economists' students in conditions of Slovakian universities", *International Scientific Conference Economic and Management, Poprad, Slovakia*, pp. 150-161, 2017.
- [22] V. Ferencz, D. Hrehova, A. Seňová, "Higher education require adaptation of students study abroad programs," *19th International Scientific Conference – Sustainability in the Global Knowledge Economy*, Vol. 74, 02003, 2020.
- [23] M. Hitka, L. Kozubikova, M. Potkany, "Education and gender based differences in employee motivation," *Journal of Business Economics and Management*, Vol. 19(1), pp. 80-95, 2018.
- [24] D. Hrehová, K. Teplická, Harmonization of skills and needs of the global labour market, *International multidisciplinary scientific conference, Albena, Bulgaria*, Vol. 1, 2016.

Katarína Teplická

ORCID ID: 0000-0002-4827-6781

Technical University of Košice

Department of Management of Earth Sources

Park Komenského 19, Košice, Slovak Republic

e-mail: katarina.teplicka@tuke.sk

Jaroslava Kádárová

ORCID ID: 0000-0002-5101-0773

Technical University of Košice

Department of Management, Industrial

and Digital Engineering

Park Komenského 7, Košice, Slovak Republic

e-mail: jaroslava.kadarova@tuke.sk

Soňa Hurná

ORCID ID: 0000-0001-7001-4860

Mendel University of Brno

Faculty of Business and Economics

Zemědělská 1, Brno, Czech Republic

e-mail: sona.hurna@mendelu.cz