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INNOVATION AND THE APPEARANCE OF INDUSTRY 4.0 AT THE UNIVERSITY OF SOPRON

Abstract:

Today's management and production systems are no longer sustainable; let us think of climate change, garbage mountains or even the scarcity of energy resources. Therefore, in the last 10-15 years new (digital) business models have been developed that rely on innovation to increase the efficiency and competence of management. This is collectively called the Fourth Industrial Revolution, which is a combination of technologies and a trend that transforms the different disciplines, the economy, and the industrial functioning. The collaboration and combination of never-seen technologies appeared, web control completely took control of physical limitations and digitalization became an integral part of our daily lives. Industry 4.0 is a great opportunity, but it is also a big task. This focuses on the significant new potentials and opportunities linked to these technological advances. The birthplace of these developments and innovations is often a university, a research institute, or their cooperation. In this study, we will review the importance and role of innovation and Industry 4.0 and briefly present the University of Sopron. Furthermore, the innovation and Industry 4.0 research, which have already been completed and are still under way, their results, and the possibilities for implementation, will be presented.

Keywords:

Higher education, Research and development, Innovation, Industry 4.0

JEL Classification: I23, L24, O32

1 Introduction

Changing has become a part of our lives; it is regarded as a constant factor. We have arrived in the digital age, surrounded by phenomena and tools that did not even exist a few years ago. Today, robotic manufacturing, the learning and smart factory are commonplace, we use a lot of digital services, smart devices and applications respectively.

The industrial revolutions have fundamentally changed the structure of the world economy. From the golden age of heavy industry, through the heyday of the oil industry we arrived to the world of smart factories and smart products, community spaces and media, and this is called the Fourth Industrial Revolution.

With the completion of the Fourth Industrial Revolution, Industry 4.0 poses challenges for companies that must be met. In a turbulently changing economic environment, both companies and universities need to respond increasingly quickly to changing market conditions and new challenges. This requires new knowledge, the emergence of this knowledge is the university, and their role is inseparable from research and innovation.

In our study, we briefly review the essence of innovation, the relationship between innovation and higher education, and the characteristics of Industry 4.0. The essential part of the study is the presentation of the research related to innovation and Industry 4.0 at the University of Sopron.

2 The relationship between technology and innovation

According to Schumpeter, innovation is a novel combination of factors of production; with this re-combination, we achieve innovation. This innovation will carry forward the economic system and with this, we can achieve dynamic development (Keresztes, 2013).

Innovation is inseparable from creativity, which is often based on divergent thinking. This allows you to approach a problem from multiple angles or connect elements that we do not normally consider compatible. This requires agile reasoning, a novel, original way of thinking and worldview, and creativity (Keresztes et al, 2019).

The OECD's 2005 approach (Oslo Manual, third edition, 2005) already defines innovation without the term 'technology', according to which "innovation is a new or significantly improved product (good or service) or process, a new marketing method, or the introduction of a new organizational method " (Magyar Innovációs Szövetség, 2006, p.2).

Nowadays, the concept of innovation has expanded significantly; it has undergone continuous and dynamic development. According to Bergmann and Daub, it primarily "means renewal and describes the process of implementing a creative idea, invention, knowledge, or a new concept" (Bergmann-Daub, 2006, p.2). As any product or service, technology can be developed or acquired and transferred; this process is called 'technology transfer'.

This practically includes the acquisition of know-how, the acquisition and commissioning and testing of equipment, production organization and management, repair and maintenance work, i.e. its technology too (Szalavetz, 1999).

Competitive advantage is based on the acquisition, possession and utilization of knowledge. The innovation can also create a new market; it gives cost advantages to who implements it.

This knowledge comes from continuous R&D carried out by trained professionals, during effective technology transfer and the market introduction of new ideas (Rechnitzer, 2008). In the narrower sense technology transfer is nothing more than bringing technology to market (OECD, 1990).

Our world is changing even faster, the corporate processes are also changing in this, and they are becoming less and less transparent. The consequence of this is that the corporate management needs to be very flexible and efficient. The processes of the globalizing world are accelerating more and more with innovation and the spread of IT. Only the flexible companies remain competitive today that react quickly to market changes (Pankotay, 2017). Koloszár (2013) points out that IT developments can only be completed in conjunction with the simultaneous development and transformation of the organization, in addition to technological investment, corporate processes and structures must be affected.

The economic importance of small and medium-sized enterprises is unquestionable in all countries, they are often called the engines of the economy, and these enterprises are the main sources of economic growth and innovation (Koloszár, 2018). Start-ups can also be seen as a major source of economic growth and innovation within the SME sector. Companies are only able to develop through continuous innovation (Kovács, et al, 2017).

Innovation is an important factor at all stages of the corporate life cycle, and a significant competitive advantage can be achieved with it. New products, services and technologies increase our competitiveness if they are more efficient, cost-effective and accessible than before or than the others. Innovation is accompanied by risk and uncertainty and this must be reduced, efforts must be made to eliminate it, and it is necessary to support this 'reduction' (Szóka, 2012).

3 The role of universities and research centers in innovation

Regions and cities regard their universities as the basis of their knowledge base; they are key elements of the innovation system and supporters of development. Universities are able to innovate during interactions, e.g. by creating research networks, corporate cooperation, municipal and state cooperation.

Nowadays, in addition to education and research, universities also undertake the third mission, the so-called developmental role, and this role is increasingly appreciated (Gál, 2016). Around the turn of the millennium, the three "E" requirements (economy, efficiency, effectiveness) as in the public sector, as in higher education has become the focus of higher education innovation. Practical evaluability still faces problems due to the specifics of the sector to this day (Ágoston-Varga 2017). Completing research results with market potential is in the common interest of both universities and business, as new, innovative products and processes come into being.

Today, the 21st century's universities of the play a key role in the innovation structure of the knowledge-based economy and society, and it sees the transformation of knowledge into economic activity alongside education and research as its own function (see Science to Business). Turbulent development has posed serious challenges the higher education institutions in both Western Europe and Hungary. Challenges are also opportunities, but the roles need to be clarified. The most relevant university role is technological implementation; the most university basic research is about this (technological implementation based on theoretical ideas). Another possible role is scaling up when creating a prototype under laboratory conditions. At this point is easiest to utilize (sell) the innovation because it is already close enough to the market, so there is much less risk associated with it (Prónay, 2012).

The economy counts on higher education institutions when it comes to innovation, and rightly so do. There are many examples and opportunities for cooperation, e.g. technology and knowledge transfer office, innovation clusters, corporate business departments, laboratories, start-up and spinoff incubation, employment of doctoral students, etc. Too much bureaucracy can hamper this, there is no adequate transparency, if stakeholders will not be part of the process or the stakeholders are not motivated. (The “publish or perish” practice takes a significant amount of time from substantive work.) In many cases, the innovation and IT background of universities is weak, government assistance is needed to change this. The operational model of universities is currently being restructured. The aim is to create well-organized, performance-based, and performance-funded universities that can be the center of innovations (Drótos, 2018).

4 Industry 4.0 and its features

While the first industrial revolutions brought about an explosive change, the period called Industry 4.0 is long-drawn-out, constantly evolving. Our lives do not change overnight; also we are part of a process. Competition is no longer between companies but between processes (Suriné Lengyel, 2019).

The basis of the Fourth Industrial Revolution is to connect machines to an IT-based network that is nothing more than the Internet of Things (hereafter IoT). These IoT devices (sensors) recognize, evaluate, collect and transmit data. The most important tasks of Industry 4.0 are the sustainability of industrial processes, the optimization of operational processes, the analysis and increase of their efficiency, and the real-time response. It is also characterized by increasing the integrity and automation of industrial processes (Gludovatz, 2018).

Today, billions of smart devices connect to each other through IoT; an important question is how these devices communicate with each other. (It is estimated that the number of devices with a network connection could reach 125 billion by 2030.) Low Power Wide Area (LPWA) technology is used to serve smart devices in the world of IoT. This LPWA technology has been developed to operate high-coverage data connections that typically require low data rates and low energy with a large territorial coverage. Such devices include sensors for smart metering, system management tasks in factories, online cash registers in trade, parking meters for services, etc. (Forbes).

The whole is based on the emergence of digitization, Big Data, Cyber-physical systems, artificial intelligence and digital services in manufacturing. With the spread of automation, the proportion of live labor is shrinking in manufacturing, a lot of labor is being freed up, and fewer but more skilled jobs are being created. Automation threatens 50-60% of jobs in Europe and the United States, while the numbers are even higher in less developed regions. Those professions are safe that cannot be simplified; they require individual thinking and social skills (Varga-Czech, 2019).

Other key features of the Industry 4.0 trend are horizontal integration and end-to-end integration of manufacturing throughout the whole value chain. Horizontal integration involves the immediate sharing of data, while vertical integration involves collaboration with partners in the supply chain and digital connectivity. This closely cooperating production and value chain can only work if factories, products and machines communicate with each other via using software. This is realized through Cyber-physical systems, which means the integration of embedded information technologies (Szóka, 2017).

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5 Presentation of the University of Sopron

The University of Sopron has a national and regional role as an internationally significant higher education institution. It has four faculties, at its faculties the education looks back on centuries-old traditions.

The legal predecessor of the Faculty of Forestry is the Mining Officer School founded by Károly III. in 1735 in Banská Štiavnica, which was raised to academic rank by Maria Theresa in 1762. The autonomous College of Forestry was established in 1952, the education of wood industry engineers started in 1957, and with the establishment of the autonomous Faculty of Wood Engineering the University of Forestry and Wood Industry was established in 1962.

The former Faculty of Wood Engineering has been operating as simonyi Károly Faculty of Engineering, Wood Science and Applied Art since October 1, 2013. The faculty participates in Industry 4.0 research, developing tools and methods to increasing the competitiveness for both small and large companies.

The Higher Kindergarten School was established in 1959, which operated as the Benedek Elek College of Pedagogy from September 1, 1996, and in 2000 it become part of the University of Sopron than Benedek Elek Faculty of Pedagogy.

The University established the Faculty of Economics in 2000 in response to the challenges of the age, but economics training began before that, in 1995. In 2016, the Faculty adopted the name Alexander Lámfalussy Faculty of Economics. The faculty is a supporter of Industry 4.0 tendres and projects, the development of financial background and solutions, the evaluation of profitability and KPIs are the faculty's competencies.

The four faculties of the University of Sopron announce their study programs in eight education fields and 58 programmes. It provides its students a competitive knowledge, projects and experience-based learning environment by supporting the activity and innovation. The faculties are characterized by digital technology and the use of digital teaching and distance learning tools and methods (e.g. Moodle courses, gamification, Web 2.0 applications, e.g. Kahoot, etc.), they also organize Flashmob. In its spirit, the University of Sopron is a “green university”. It strives to shape the natural, social and human environment in order to preserve and improve the quality of life. The University of Sopron is also characterized by the “triple helix” model, which describes an interactive relationship based on joint development, and examining the relationship between government, business and universities in the process of knowledge marketization.

6 Benedek Elek Faculty of Pedagogy

6.1 eTwinning for Teacher Training Institutes

In the framework of the “Knowledge, Impressions, Differences of Early Childhood Education” tender, a project was launched (entitled “eTwinning for Teacher Training Institutes”) in 2018 at the University Faculty of Pedagogy in cooperation with Dolnośląska Szkoła Wyższa, University of Lower Silesia (Poland) in Wrocław. The aim of the program was for the higher education institutions of the participating countries to jointly develop teacher and student projects in an international, intercultural environment, using ICT tools, in line with the training profile.

The program provides technical, pedagogical, methodological assistance, online tools and services, as well as free tools and opportunities to support professional development, mainly in the field of digital competence development. During the joint work, they carried out introductory projects in the field of early childhood educations and micro-researches, and shared good practices for the purpose of knowledge dissemination. Students were able to experience the methodology of collaborative learning and gain experience for their later, own projects.

7 Faculty of Forestry

7.1 Agricultural climate.2 research

Preparing for climate change requires special adaptation in sectors directly exposed to climate change, such as non-irrigated crop production, grazing livestock. The object of the project is to examine the vulnerability of these sectors in order to create a scientific and professional background that will enable the establishment of a comprehensive, national decision support system (hereinafter DSS). The aim of the system is to provide regional and local information available based on geographic information system (hereinafter GIS) on the future development of environmental and management conditions.

The project seeks to analyze responses to climate change in a new area of research that has not been studied so far (e.g., the presence of stressors in leaves). The task is complex, due to the variety of background data; it requires a lot of testing. While the main direction was the establishment the DSS, in parallel, notable results were come into being, such as the development of precision agricultural technologies (agricultural DSS). It utilizes several complementary natural renewable energies for economical heating, cooling and lighting of a greenhouse and an office building which operating in an agricultural environment.

7.2 Investigation of the growing conditions of woody biomass

Biomass can be grown, traditionally in forests or, more recently, in plantations. The research challenges related to woody biomass production are twofold. On the one hand, it is necessary to produce biomass as much as possible and at a good price, and on the other hand, especially in the case of forests, the preservation and development of their environmental, nature protection and public welfare functions is a very important social need.

The primary goal of the project is to provide an infrastructural background for the development of new methods that allow the efficient implementation of woody biomass production, in such a way that at the same time other social needs are met. During the project, four laboratories will be developed, which will work closely together in the near future. The GIS laboratory is the best connected to the study. The aim of this is to create a modern survey opportunity for woody biomass stands and natural ecosystems. The purchased laboratory equipment it is possible to carry out accurate survey of the plant stands and the wildlife in respect in large areas. Field survey results can be evaluated in the GIS laboratory.

7.3 "Let's grow with nature" - Agroforestry as a new outbreak opportunity

The project started in September 2017 and will end at the end of November 2020 in the framework of a consortium collaboration with the University of Sopron, the University of Kaposvár and the University of Dunaújváros. The basic research tasks are carried out within the framework of five sub-programs, they excamine the ecological parameters of agroforestry systems, the possibilities of secondary utilization of areas for small game rearing, the utilization of soft deciduous woods produced in the systems, the conditions of herbaceous biomass production, and finally the economic and social significance of agro-forestry systems. In addition to the basic research activities, the project places great emphasis on educating the supply of researchers, at the consortium level, 34 undergraduate students and doctoral students were involved in the implementation of the project objectives.

The result of the project is that during of wood scientific research has provided materials science and manufacturing technology answers to the applicability of softwood timber produced in agro-forestry systems in the pencil industry. Another result is the successful development of the high value-added utilization of certain wood materials (interior design, special wood products). In cooperation with a Hungarian industrial company, the manufacturability of wood materials with increased bending by longitudinal compaction was investigated, and the efficiency of production was improved.

8 Alexandre Lámfalussy Faculty of Economics

8.1 New Trends in the Spatial Structure of Hungarian Industry in the Context of the Fourth Industrial Revolution

A four years long research will take place from the end of 2017 at the faculty (project number: 125091). This research is funded by the National Research, Development and Innovation Office entitled “New Trends in the Spatial Structure of Hungarian Industry in the Context of the Fourth Industrial Revolution”. The results of the research series have been published at several conferences, the results are being published, and some of them are expected to be published in English in the summer of 2020.

Among other things, the researchers examined that smart specialization linked to Industry 4.0 how could help regions develop, increase regional competitiveness, and how could reduce the regional disparities. It was established that new technologies in Industry 4.0 have a major impact on the economy and society, but they prevail to a differentiated extent in time and space (Kiss, Tiner, 2019).

Further research focused on the international embeddedness of the topic. In it, they researched the existence of the basic conditions necessary for the Fourth Industrial Revolution, as well as which countries are the starting point for change and which are the first to follow, as well as the lagging ones. It was found that Germany could be considered clearly the center of the Fourth Industrial Revolution, and that France, the United Kingdom and Italy were also part of the center. The Netherlands, Spain and Belgium are also among the first followers, while the Baltic States, Slovenia, Croatia and Greece are among the lagging states, but Hungary is not in a much better position. Furthermore, the situation of Industry 4.0 in Hungary was examined, and the extent of the related new technologies was assessed at the regional level. The change in the number of Internet subscriptions, the use of the Internet by companies, the number of IT staff employed, and the change in the proportion of personal computers and workstations were examined by county breakdown. Using factor analysis, the collected indicators were combined into one indicator, and then the counties were classified into clusters based on these indicators. As a result of the research, it was established that Győr-Moson-Sopron, Bács-Kiskun and Csongrád counties are considered to be the most prepared for the challenges of the new industrial revolution (Balog et al, 2018).

8.2 Habits, opinions and expectations related to the smart city - research among the students of the University of Sopron

By smart city we mean a settlement (typically a city) that uses innovative and often artificial intelligence-based information and communication technologies to reduce its costs and energy consumption and make it more efficient. The questionnaire research examining the habits, opinions and expectations related to the smart city was conducted among the students of the University of Sopron and started in October 2019.

The researchers made six statements. The economic activity of the students completing the questionnaire is quite high compared to their life situation. Respondents do not feel that the city of Sopron is particularly innovative, and they almost do not see any innovative businesses in the city generated by the university environment. The intensity of interest in local public life is low. Respondents consider the city to be a basically livable, pleasant and safe city. The evaluation of each local service is average, the evaluation of the related intelligent developments is positive. Almost all of the students have a smartphone. There are big differences in what current, public (partly smart) technological developments the respondents have heard about. The various intelligent systems were mostly rated as more than 60% important or very important. At higher education levels (MA, MSc, PhD), students are much more informed than at lower levels (FOKSZ, BA).

9 Simonyi Karoly Faculty of Engineering, Wood Sciences and Applied Arts

9.1 Industrial IoT technologies and solutions for wood manufacturing companies

The research and project are exemplary in using low-cost and reliable IoT technology for two wood-based SMEs to improve productivity. One of the goals was to be able to deduce from the electricity consumption data whether the given machine is working properly, whether maintenance and repairs are needed or not. The other goal is to be able to infer the expected electricity consumption, based on which the company can enter into a more favorable contract with the electricity supplier.

They first examined the electricity consumption of the machines and then analyzed what IT infrastructure is needed to create a post-sensor environment. As the companies had (analog) machines that are not suitable for collecting digital data, electricity consumption sensors (mFi sensors and mFi ports) were installed. The center of the system is a Hadoop-based shared file system and a node.js-based unit, this system is called SensorHUB. This database management system called SensorHUB (operating at Budapest University of Technology) was used to store the data. A patented mobile application (Controller Software) has been developed, which can be used to get (to download) the electricity consumption data of each device from the SensorHUB environment and using this the management can monitor the electricity consumption anywhere. As a result of the project, cost-cutting measures were implemented and, using the application, the collected data could be displayed on a mobile phone in real time (Pödör etc. 2017).

9.2 Monitoring, controlling and analyzing of production processes in an Industry 4.0 approach

The possibilities of optimizing the production processes were investigated in the framework of the research of József Cziráki Doctoral School of Wood Science and Technology, in 2018. This research and development focused on an interdisciplinary field (wood industry, production management and informatics). The task – and also the goal – was how to implement a company-level energy management and monitoring system in a factory that uses heterogeneous systems.

The production processes of a multinational wood company (furniture company) have been digitized, automated and optimized using IoT tools. To this end, heterogeneous IT systems and tools were integrated in the factory, and then an enterprise-level energy management and monitoring system was planned and implemented. They were first to make operations more efficient by installing production management systems with the help of an integrated system related to quality management that helps the real-time production management. The essence of the development was the uniform management of color data measured by a smart-camera system, which data had to be supplemented with other descriptive data (eg time, supplier, shift, etc.). The goal was to be able to track the position of each timber online and to enter all the relevant data in a central database after the timbers had been pared. Then the quality control and process control of the pre-pare was performed with additional physical tools (computers, photocells, printers). This is done by passing the wood under the photocell and under the camera and the software calculates an average color value that will be the color value of that timber. Data collection and analysis were executed with a self-developed application and database structure. The natural color of the surface of timber and the effects that influence this have been investigated. The company's image and video analysis solution for analyzing wood materials (e.g. timbers) needed to be developed, so they developed an image and video analysis application that can determine the color and defects of wood materials relative to each other.

The next important step was to support energy efficiency and management. To develop the framework, it was first necessary to get to know the physical and IT tools of the company, and then the sensors providing the data sources of the developed framework were installed in the equipment. With the help of thus formed integrally operating framework, it has become possible to run several analyzes. The shortcomings of the previous framework were highlighted and then the physical and software environment of the new framework (with ERP, SCADA, RS-232, RS-435 networks) was planned and implemented. Where possible, processes have been optimized (e.g. downtime, maintenance), i.e. electricity consumption has been reduced. They can send management reports on production process and electricity consumption with 10-minute updates, so helped their work visually also (Gludovácz, 2018).

9.3 Assessing the feasibility of Industry 4.0 by due diligence of wood companies

In this doctoral school, another two-year research focused on Industry 4.0 maturity and applied technologies (among wood industry companies), which started in 2017. The methodology of the maturity survey was an identification of development potential to map the company according to the degree of digitization.

It consisted of four steps. The first step was a meeting with the company's decision-maker leaders. In doing so, the goals of the project and the concepts of Industry 4.0 were clarified. In the second step, the operation of the plant was examined, which was viewed according to the direction of the material flow (from the receipt of the raw material to the delivery of the finished product). Visualization techniques, leader habits, and interpersonal relationships were also examined during the factory tour. In the third step, the questionnaire was completed jointly. The fourth step was the evaluation of the questionnaires and the feedback.

A couple of evaluation aspects: automation, technical level of digitization in each production area, quality level of system operation, assessment of digitization – recognition of algorithmizable tasks, current maintenance needs of process elements, etc.

As a result of the research, it was established that similar circumstances were found in wood industry companies as in other processing industries. There is no significant difference in the development of Industry 4.0 in other industry companies in Hungary compared to the wood industry. Conscious organizational development and focusing on processes is a living practice in only about 30% of companies. Human resources, a well-trained workforce, proved to be a serious bottleneck almost everywhere. There is a lot of manual work, 80% -85% of the employees are semi-skilled workers. Examining the industry, they found three areas where the implementation and efficiency of it are low: 3D printing, internal logistics, and maintenance. The most critical area was maintenance activity among the companies surveyed. Although companies have shown a mixed picture in terms of their fleet (plant), the attention paid to maintenance is low in most cases, the most common repair strategy is only to eliminate the fault.

Regarding Big Data solutions in general, the amount of corporate data depends largely on the size and ownership structure of the company. Some owners require reporting obligations and want to make the corporate processes to be transparent. If there is a need for data, ie they want to make a significant part of the decisions based on these data, and then great emphasis is also placed on collecting the necessary data (Suriné Lengyel, 2019).

Conclusions

Industry 4.0 is a big technological leap for us, and it is also an opportunity for Hungary to become one of the competitive countries. The Government of Hungary has developed the Digital Welfare Program, according to the program; the digital transformation will not avoid any sector or type of enterprise. The first step in the Industry 4.0 journey is to raise awareness of the impact this development can have on business and values. The big words are beautiful, but for that, we, the economy and even society, need to catch up.

In my opinion, higher education institutions around the world need to be behind digital innovation and research, and their role in technology implementation is important and indispensable. That is why the University of Sopron (also) strives to participate in such tenders and projects, with it the unicversity can close up at the forefront of research.

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Agrárklíma.2 – VKSZ_12-1-2013-0034 (Agricultural Climate)

Fás biomassza termesztési feltételeinek vizsgálata – GINOP 2.3.3-15-00039 (Examination of the conditions of woody biomass conditions)

Termeljünk együtt a természettel – EFOP-3.6.2-16-2017-00018 (Let's produce together with nature)

A felsőoktatási rendszer K+F+I szerepvállalásának növelése intelligens szakosodás által Sopronban és Szombathelyen – EFOP-3.6.1-16-2016-00018 (Increasing the role of R & D & I in the higher education system through intelligent specialization in Sopron and Szombathely)