Research industry 4.0 application in Slovak companies

Kotianová Zuzana
Faculty of Mechanical Engineering – Technical University of Košice, Slovakia [1]

zuzana.kotianova@tuke.sk

Abstract: *A survey was carried out at the Technical University in Košice within the project APVV-15-0351 "Development and application of risk management models in terms of technological systems in accordance with the Industry 4.0 strategy" in order to provide companies with relevant information for assessment how managers in Slovak industry perceive the readiness of organizations to implement Industry 4.0, their current situation and the use of deeper knowledge of the environment in the application of elements of Industry 4.0 for the benefit of their further development. The survey was conducted anonymously.*

Keywords: INDUSTRY 4.0, SURVEY, INTEGRATED SECURITY

1. Introduction

In the last decade, most developed industrial countries have been intensively involved in the beginning of the so-called Fourth industrial revolution known as Industry 4.0. It is a concept based on such elements as the industrial internet, cyber-physical system, artificial intelligence, additive manufacturing, etc. It turns out that the early capture of the beginning of this industrial revolution is crucial for individual industrially oriented countries, not only in terms of their competitiveness. Globalization and the resulting risk factors (data security, sensitivity, and vulnerability of information, crisis preparedness) will examine the impact of digitization on the continuity of business management. Even in Slovakia, which is industrially oriented, many experts from practice, academics and usually also politicians deal with this issue. They come with different opinions, views, knowledge, and determination to introduce Industry 4.0 to various areas of Slovak industry. The crucial question is whether Slovak industrial enterprises are sufficiently prepared for the introduction of Industry 4.0 [1].

2. Digitization

Digitization and automation of production and logistics technologies as part of Industry 4.0 bring several positive aspects [2]. They create conditions for the expansion of production capacities, assertion in a competitive environment through increasing productivity and quality of manufactured products, new opportunities and new customers, replacement of people in dangerous operations and events. Individual stages of digitization in organizations can be described up to five levels, Table 1.

Table 1: *Stages of digitization*

Dimension ***Vertical Integration***	*Dimension* ***Horizontal Integration***	*Dimension* ***Digital Product Development***	*Dimension* ***Cross-sectional technology criteria***
Stage 5 – Optimized full digitization: The company is a showcase for Industry 4.0 activities. It collaborates strongly with its business partners and therefore optimizes its value networks.			
Continuous cross-corporate integration that is constantly optimized.	Continuous cross-corporate integration and collaboration in value networks.	Product development is processed digitally inside and outside the company (digitized end-to-end solution).	Simulation and optimization of value and information flows in real-time within the value network. IT security adjusts promptly to new risks. Occurring security problems are immediately solved. Encryption is optimized along the value networks.
Stage 4 – Full digitization: The company is completely digitized even beyond corporate borders and integrated into value networks. Industry 4.0 approaches are actively followed and anchored within the corporate strategy.			
Continuous cross-corporate integration.	Continuous cross-corporate integration in value networks.	Product development information are digitally forwarded.	Service-oriented cloud-based platform. Services are offered for the partners in the value networks. Information and data are exchanged in real-time along the supply chain. Optimization of the entire production through Big Data solutions. Access to data is protected. Cross-corporate encryption of data and authentication for global access.
Stage 3 – Horizontal and vertical digitization: The company is horizontally and vertically digitized. Requirements of Industry 4.0 have been implemented within the company, and information flows have been automated.			
Complete internal/enterprise-wide integration of all enterprise systems and machines.	Complete internal/enterprise-wide integration of all enterprise systems and machines.	Product development is continuously digitally supported.	SOA has been established. All functions are provided as services. (Semi-) products and their functionalities are available as services. To exchange information within the enterprise, cloud principles are applied. Production is adjusted and optimized in real-time. IT security is increased using an advanced security model. Access to data is continuously protected, and data is transmitted in an encrypted state within the enterprise.
Stage 2 – Cross-departmental digitization: The company is actively engaged with Industry 4.0 topics. Digitization is implemented across departments and first Industry 4.0 requirements are implemented throughout the company.			
Cross-departmental integration.	Cross-departmental	Production and product development	Implementation of first services (SOA with an

	integration.	are supported by several enterprise systems. Data and information exchange are not automatized.	enterprise service bus (ESB)). First experience with Big Data and its applications. Development of the first IT security models.
Stage 1 – Basic digitization level: The company has not addressed Industry 4.0. Requirements are not or only partially met			
Integration of enterprise systems only departmental-specific. The enterprise systems along the enterprise's value chain support only their respective fields of activity.	Integration of enterprise systems only department al-specific. The enterprise systems along the enterprise's value chain support only their respective fields of activity.	Product development is not digitally supported.	No service-oriented or cloud-based approaches. Data and information flows are not used for product improvement/optimization. Confidentiality, availability, and integrity of the data are not guaranteed.

It is not possible to assume that in a company with a lower level of digitization there are fewer risks, but the nature of the risks is changing and so is the way they are managed. If the Industry 4.0 strategy is implemented, there will be fundamental changes in the conditions for the employment of employees in the conditions of production processes of goods and services. Through the implementation of the individual phases of Industry 4.0, the work in the production lines will be refined and humanized. Simple manual actions disappear. Employees will be coordinators who ensure smooth production and will act only when their machine calls for action. It can be stated that areas, where Industry 4.0 elements are not implemented, will be more oriented to the area of Safety, while areas, where Industry 4.0 elements are more actively used, will be more oriented to the area of Security [3, 4].

3. Survey of Slovak companies

The survey was focused on Slovak industrial companies. It was performed in electronic form in the years 2017-2019 in 53 Slovak companies. The survey consisted of three areas, the first was general about the company, the others were about two areas:

1. integrated safety&security,
2. analysis of the elements of Industry 4.0 in the companies.

The survey was based on subjective estimates of the top managers of the organization. The first part of the survey was general, descriptive about the organization. This part consisted of 6 questions. Out of the total number of 53 respondents, the most respondents from the automotive industry were 41.5% with the number of employees more than 250, Fig.1.

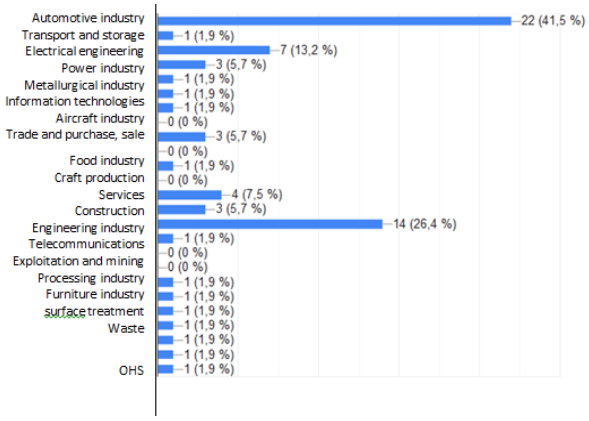

Fig. 1 *Areas of operation of organizations*

The second area was the analysis of the current state of integrated security in the companies. It consisted of 23 questions. Regarding the area of the integrated security survey, 37.7% (Fig. 2) of the respondents answered that the idea of integrated security in their company has long been implemented by top management, regularly re-evaluated and systematically improved, and that it is promoted mainly by security technicians. 41.5% of respondents answered that integrated security is part of the corporate education system. When asked how the risk management system is integrated into the process or management of the company, 34% answered that in an appropriate way in all major processes.

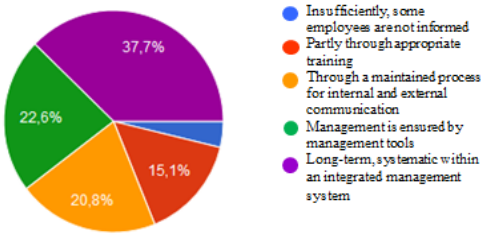

Fig. 2 *Attitude of top management to integrated security in the companies*

Out of the total number, 62.3% answered that the requirements for integrated security are also introduced into maintenance activities such as employee monitoring, identification when uploading data to the CMMS (Computerized maintenance management system), etc., Fig. 3.

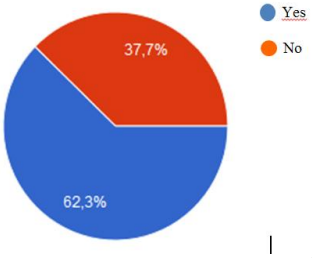

Fig. 3 *Question regarding integrated safety requirements implemented in maintenance activities*

Furthermore, up to 77.4% of companies apply maintenance management concepts (e.g. TPM, RCM, RBI) as part of machine / equipment risk management, Fig. 4.

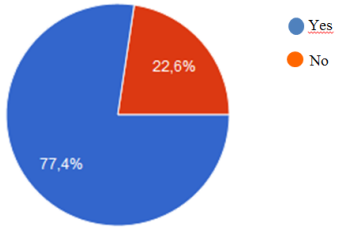

Fig. 4 *Maintenance management concept (e.g.TPM, RCM, RBI) as part of machine / equipment risk management*

The third part of the survey was devoted to the analysis of the current state of digitization in relation to security. This part consisted of 24 questions. The results were interesting and the fact that 34% of respondents are aware of the need to implement Industry 4.0 but consider it little known in the company. 32% of respondents perceive that digitization in relation to security is only marginally reflected in the management of the company. The estimate of the degree of digitization in 18.9% of companies was about 51% - 60%, Fig.5.

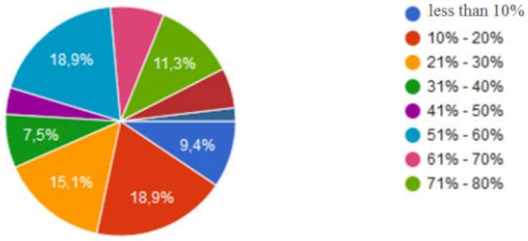

Fig. 5 *Estimation of the degree of digitization in the companies*

When estimating the ratio of automatic to manual production, 32.1% of respondents answered that it is 20:80, Fig. 6.

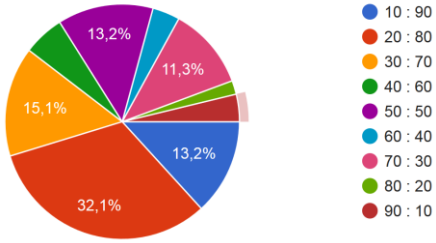

Fig. 6 *Estimation of the ratio of automatic to manual production*

The following Fig.7 points to the implemented individual elements of Industry 4.0 in the surveyed companies.

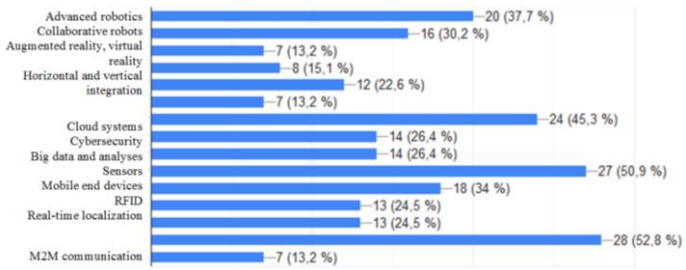

Fig. 7 *Individual elements of Industry 4.0 in the companies*

4. Conclusion

The fourth industrial revolution is closely linked to the degree of automation used in the organization. The perception of the organization's readiness for Industry 4.0 can therefore be directly influenced by the perception of the degree of automation in the examined organization. Although Slovakia is a relatively small country, the sample of 53 organizations cannot be considered sufficiently representative. Many sectors in the survey were not statistically sufficiently covered, which is why the results were so highly dispersed. On the other hand, the obtained results can be understood as the first part of further research, which provides a rough estimate of the degree of readiness of Slovak organizations for Industry 4.0 in terms of integrated safety and Industry 4.0 in relation to safety and health at work.

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References

1 Turisová R., Sinay, J., Pačaiová, H., Kotianová, Z., Glatz, J. (2020): Application of the EFQM Model to Assess the Readiness and Sustainability of the Implementation of I4.0 in Slovakian Companies / - 2020. In: Sustainability. - Basel (Switzerland) : Multidisciplinary Digital Publishing Institute Roč. 12, č. 14, pp. 1-14 [online]. - ISSN 2071-1050 (online).

2 Pačaiová, H., Sinay, J. (2017): Effective risk management as a part of the manufacturing technologies digitization in the context of Industry 4.0 strategy / - 2017. In: SAFETY AND HEALTH AT WORK 2017. - Mannheim: ISSA-Section Machine and System Safety, 2017 P. 13-26. - ISBN 978-92-843-6131-1.

3 Sinay, J.; Kotianová, Z. ; Glatz, J (2018): Risk management in context of Industry 4.0 / - 2018. In: Industry 4.0 : an International Scientific Journal. Roč. 3, č. 6 (2018), s. 340-342 [print]. - ISSN 2534-8582.

4 Pačaiová, H., Sinay, J. Kotianová, Z., Glatz, J., Nagyová, A. (2019): Impact of Management Systems Integration on the Implementation of Industry 4.0 Concept / - 2019. In: QMOD-ICQSS Conference 2019 : Leadership and Strategies for Quality, Sustainability and Innovation in the 4th Industrial Revolution:. - Lund (Sweden) : Lund University Library Press pp. 1-14 [online]. - ISBN 978-91-7623-086-2.