

## RISK MANAGEMENT IN CONTEXT OF INDUSTRY 4.0

Dr.h.c. mult. prof. Ing. Sinay J., DrSc.<sup>1</sup>, Ing. Kotianová Z., PhD.<sup>1</sup>, Ing. Glatz J., PhD.<sup>1</sup>  
Faculty of Mechanical Engineering – Technical University of Košice, Slovakia<sup>1</sup>

juraj.sinay@tuke.sk, zuzana.kotianova@tuke.sk, juraj.glatz@tuke.sk

**Abstract:** Prevention 4.0 as part of the enterprise's safety culture is developing HSE management system to address new challenges in prevention. Industry 4.0 anticipates new linkages between technology, man, and management systems to apply the most efficient IT systems to ensure the flexibility of the production process so that its output is a product that takes into consideration customer requirements. These changes include the existence of new types of risk due to the change of the position of man from the classical production centers to the area of superstructure activities, programmer, setter, maintainer, security technician for the digitization of production processes. Risk identification is based on defining the hazards and threats of a complex manufacturing system in the context of Safety and Security – Sa&Se, their formulation so that characteristic parameters can be efficiently digitized within the manufacturing process.

**Keywords:** SAFETY, SECURITY, INDUSTRY 4.0, AUTOMATION, DIGITIZATION, RISK MANAGEMENT, W- DEPENDENCE, PREVENTION, MAINTENANCE, SMART FACTORY

### 1. Introduction

The formation of cyber-physical systems incites the world economy to constantly adaptation to the complex requirements of new systems, creating new requirements for businesses that have to adapt their activities to change. The same process goes through the man and his role within the Smart factory<sup>6</sup>.

Industry 4.0 brings a great deal of change. Actually, functioning autonomous factories are no longer just the subject of debate and research focused on the implementation of Industry 4.0 elements to real industrial practice. Increasingly, the real world and virtual world are overlapping, even in this sector. Prevention 4.0 as part of the enterprise's safety culture is developing HSE management system to address new challenges in prevention<sup>8</sup>.

### 2. Industry 4.0

The term Industry 4.0 (see Fig. 1) means a way of managing activity within technologies where production and logistics processes and within them machines and products communicate with each other and organize individual steps in the production process autonomously in synergy with the human factor. The goal is that processes take into account the requirements for safe operation so that products at the end of the production process meet customer requirements. Enterprises are targeting to creation of Intelligent (Smart) Factory<sup>4</sup>.

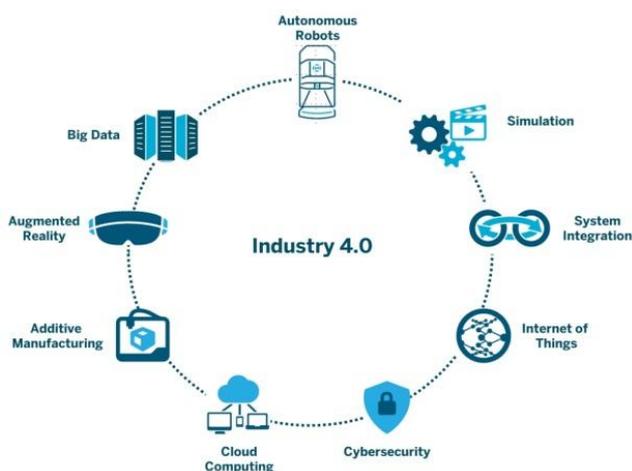


Fig. 1 Industry 4.0<sup>3</sup>

Industry 4.0 can be defined as a philosophy that defines the methods and methods of managing technologies that are already used in some areas of industrial production where machines,

machinery and products communicate with each other and organize themselves individually in the production process (Fig. 2).

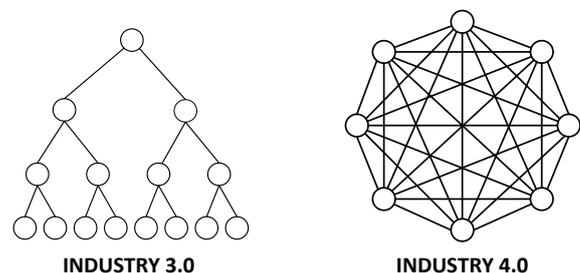


Fig. 2 Difference in information transfer - Industry 3.0 and 4.0

The term Industry 4.0 represents<sup>7</sup>:

- linking production to information and communication technologies,
- linking customer requirements directly with machine and device data,
- communication machines to machines - M2M,
- autonomous data acquisition and processing at both vertical and horizontal level,
- decentralized management,
- separate production created by communication between semi-finished products and machinery - a flexible, efficient and cost-saving resource<sup>2</sup>.

It follows that meeting the requirements of Industry 4.0 will have the necessary impact on<sup>5</sup>:

- quality of work,
- requirements for qualification,
- new ways of organizing work and changing of many interactions and interactions in the human-machine-environment interface that we can imagine as new forms of collaborative work in the context of a digital factory.

Individual companies according to the degree of implementation of Industry 4.0 elements can be partitioned, for example, to five levels. Each level has a specific division of Integrated Safety & Security.

The individual levels of Industry 4.0 implementation:

1. Level - Basic level of digitization: The company does not address sector 4.0, requirements are not met or only partially met.
2. Level - Digitization between departments: the company is actively engaged in the topics of Industry 4.0. Digitization is implemented in various departments and the first

requirements of Industry 4.0 are implemented throughout the company.

3. Level - Horizontal and vertical digitization: The company is digitized horizontally and vertically. The industry 4.0 requirements were implemented within the company, and the information flows have been automated.
4. Level - Full digitization: The company is fully digitized beyond enterprise boundaries and integrated into value networks. Approaches in industry 4.0 are actively pursued and embedded within the corporate strategy.
5. Level - Optimize Full Digitization: The Company is a model for industry 4.0. Strongly cooperates with its business partners and therefore optimizes its value networks.

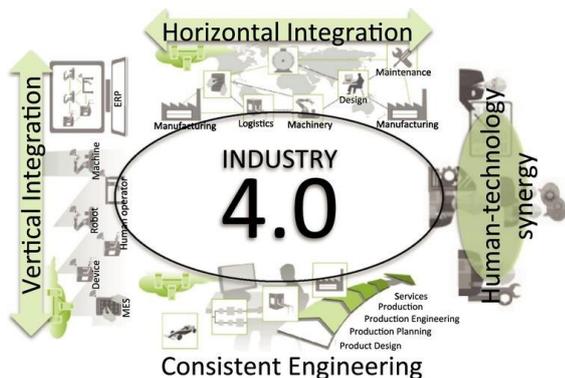
### 3. Safety & Security context

Industry 4.0 in its implementation in the company is emerging new safety requirements. On the one hand, such systems may not endanger people and the environment - "corporate (internal) safety" and, on the other hand, such devices must be protected for misuse and unauthorized interference - particularly in the area of data misuse, protection against unauthorized interference – Security<sup>1</sup>.

Hence, the risk management methodologies in both production and logistics processes, and therefore also individual machines and machine systems, must meet the requirements of interconnection on the basis of Integrated Safety & Security at all levels of organization management<sup>4</sup>.

Integration of Safety & Security must take place (Fig. 3):

- a. in a horizontal plane (from the receipt and confirmation of the order to the end of life of the product);
- b. in the vertical plane (from the lowest level of automated physical process management to the planning of production resources)
- c. as well as in the level of integration of engineering processes (product lifecycle management).



Obr. 3 Horizontal a vertical integration in Industry 4.0<sup>2</sup>

Safety and Security ratios vary depending on the Industry 4.0 elements implementation level. This dependence can be called W - dependence. (Fig. 4). With the higher level of implementation of Industry 4.0 and the implementation of a higher number of robots, cobots in the factory, the number of workers exposed to work risks will decrease. Workers' safety will be more dependent on the security of digital technologies in the factory. In the area of security, cybersecurity will become more and more important, as a result of the threat of HSE over digital ways.

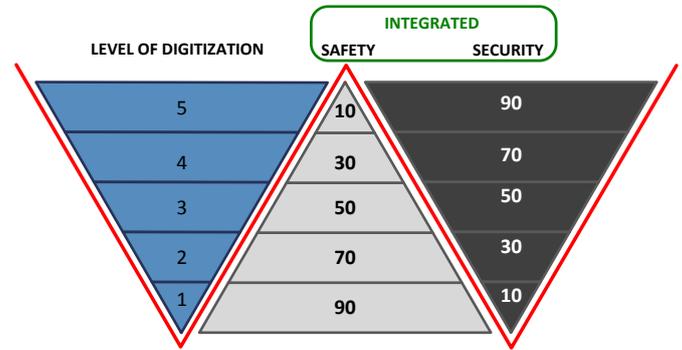


Fig. 4 W – dependency - Example of Safety and Security Ratio (%) depending on the Industry 4.0 elements implementation level

### 4. Results of discussion

The process of implementing Integrated Security Industry Sector 4.0 elements is divided into 6 steps (Fig. 5).



Fig. 5 The Implementation of elements of Industry 4.0

1. Mapping the level of integrated Sa&Se for selected technologies in the Industry 4.0 context - analyzing the processes that have the greatest impact on HSE from the point of view of Safety and Security, critical process analysis with the highest priority, and analyzing the devices with the highest added value ... etc.
2. Creation of pilot projects for the implementation of digitization for integrated Sa&Se - demonstration of a

- suitable concept for integrated Sa&Se and demonstration of business value.
3. Defining the necessary capabilities for the Integrated Sa&Se area - analyzing information from pilot projects, developing a strategy for the implementation of elements of Industry 4.0 and defining the needs and requirements for recruiting suitable staff.
  4. Maximum Effective Data Analysis - data collection between different levels of Industry Platform 4.0, a follow-up analysis for the need for effective implementation of Integrated Sa&Se elements at Industry 4.0 level and above, and the creation of "multifunctional" expert teams.
  5. Transformation to a higher level of digitization - digital culture support in the company, experimentation with new technologies, innovative ways of operation, implementation of Industry 4.0 elements to all areas of the enterprise.
  6. Active planning and development of a comprehensive integrated Sa&Se ecosystem - introduction of complex platforms.

## 5. Conclusion

Industry 4.0 strategy includes the integration of Safety and Security. Safety and Security supposed to be interconnected (influencing). Application of Safety and Security control systems changes the static principle to dynamic, assumes identification of all production and distribution processes, data mobility as part of BIG DATA technology and human factor activity to ensure the functionality of relevant applications. Industry Strategy 4.0 requires a proactive approach to risk analysis, the essence of which is to implement the Safety and Security principles into the development and construction of machines and complex technologies in the context of using the Cyber Physical Systems principles.

*This contribution was created by the implementation of APVV-15-0351 project of " Development and Application of a Risk Management Model in the Setting of Technological Systems in Compliance with Industry 4.0 Strategy" and VEGA project no. 1/0121/18 of Development of methods of implementation and verification of complex security solution in Smart Factory as part of Industry Strategy 4.0.*

## References

- 1 Pačaiová, H. and col.: Metódy posudzovania rizík v rozhodovacích procesoch, Košice, BEKI Design, 2016, ISBN 978-80-553-3033-4.
- 2 Marques, M. a col.: Decentralized decision support for intelligent manufacturing in Industry 4.0 [cit. 2018-08-11]. Dostupné na internete: <<https://content.iospress.com/articles/journal-of-ambient-intelligence-and-smart-environments/ais436>>.
- 3 Industry4 prináša odpovede ako rozbehnúť Industry 4.0 vo firmách [cit. 2018-08-11]. Dostupné na internete: <<https://touchit.sk/industry4-prinasa-odpovede-ako-rozbehnut-industry-4-0-vo-firmach/107366#prettyPhoto>>.
- 4 Sinay, J., Kotianová, Z.: Nové trendy v BOZP v kontexte stratégie Priemyslu 4.0, Advances in Fire and Safety Engineering 2017, Bratislava : STU, 2017 p. 16-25, ISBN 978-80-8096-245-6.
- 5 Kotianová, Z. and col.: Hlavné piliere stratégie Priemyslu 4.0, Aktuálne otázky bezpečnosti práce, Košice : TU, 2017 p. 1-5, ISBN 978-80-553-2857-7.
- 6 Sinay, J., Pačaiová, H., Kotianová, Z.: Integrovaná bezpečnosť v rámci Stratégie Priemysel 4.0, TVIP 2017. Hustopeče : České ekologické manažérske centrum, 2017 p. 1-7, ISBN 978-80-

- 85990-30-0.
- 7 Bothof, A., Hartmann, E.: Zukunft der Arbeit in Industrie 4.0. Berlin: Springer Vieweg – Institut für Innovation und Technik, 2015, 165 p. . ISBN 978-3-662-45915-7.
  - 8 DGUV Deutsche Gesetzliche Unfallversicherung. Neue Formen der Arbeit, Neue Formen der Prävention. Berlin: Raufeld Medien, 2016, 47 s.