Smart (Digital) factories within the concept of Smart Industry in Slovakia

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Abstract: *Smart industry is a consequence and product of the Fourth Industrial Revolution, in which the landscape of industrial production is changing dramatically as digitalisation is applied. The Concept of Smart Industry for Slovakia emerged out of intensive cooperation between the Ministry of Economy of the Slovak Republic (MoE SR) and industry representatives in order to present a concept of smart industry to the general public. The aim of the paper is to assess the potential that smart factories and the Horizon Europe (2021–2027) support programme hold for innovation and research, because a smart factory is precisely the sort of flexible and important link in the transformation of traditional industry into smart industry in the Slovak Republic that will secure a prominent status for Slovak industrial enterprises on the industrial map of Europe and will generally benefit and influence the economy of society as a whole.*

Keywords: *Industry 4.0, Smart industry, Smart factory, innovation, digitalisation*

JEL codes: L1, L11, M21, M31, M40

1 Introduction

The Fourth Industrial Revolution has been a driver guiding industrial production worldwide out of the era of steam and electricity and into the epoch of digitalisation. The Concept of Intelligent Industry for Slovakia delivers benefits to Slovak industrial enterprises by introducing automation and digital production, the digitalisation of control systems, the use of communication networks to secure the flexibility of business processes, and the opportunity to create new business models for enterprises. Slovak industrial enterprises, conscious of the trend of the Fourth Industrial Revolution, are working to incorporate it into their production processes (MoE SR, 2017). As digitalisation here takes hold, the smart enterprise is emerging. Radziwon et al. (2014) and Mabkhot et al. (2018) describe a smart factory as a manufacturing solution offering flexible and adaptive production processes that will solve problems faced by manufacturing facilities with dynamic and rapidly changing boundary conditions in a world of increasing complexity. This specific solution is related, on the one hand, to automation, conceived as a combination of software, hardware and/or mechanics, which should optimise production, thereby reducing unnecessary work and resource wastage. On the other hand, there is the prospect of collaboration between various industrial and non-industrial partners, where the smartness comes from forming a dynamic organisation. A smart factory is a real-time context-sensitive manufacturing environment that can handle turbulence in production by leveraging decentralised information and communication structures for the optimal control of manufacturing processes (Lucke et al., 2008). In other words, a smart factory is an intelligent manufacturing system that integrates the communication process, computation process and control process in manufacturing and services in order to satisfy industrial requirements (Chen et al., 2017).

2 Methodology and Data

In this paper, we have focused on smart factories within the framework of the Concept of Smart Industry in Slovakia. To that end, the paper seeks to assess what potential is offered by smart factories as a major agent of change in the transformation of traditional industry into smart industry in the Slovak Republic. In order to evaluate smart factories in terms of smart factory support, it also evaluates the Horizon Europe (2021–2027) programme as a vehicle for the roll-out of innovations in Slovak industrial enterprises.

3 Results and Discussion

3.1 Smart factory

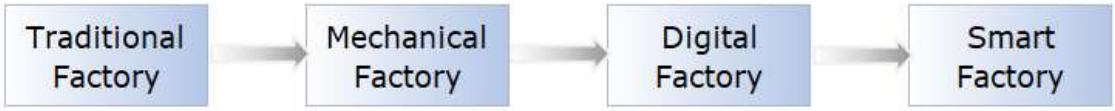
The transformation from traditional manufacturing to smart manufacturing has a profound and lasting impact on the future of manufacturing worldwide. As the heart of Industry 4.0, a smart factory integrates relevant physical and cyber technologies and renders them more sophisticated and precise in order to improve the performance, quality, controllability, management and transparency of manufacturing processes (Shi et al., 2020). A signature feature of a smart factory is that the machines and products here communicate with each other, reconfiguring themselves for the flexible manufacture of multiple types of products and optimising production (Lyu & Zhang, 2016). In doing so, they help manufacturers to meet dynamic and rapidly changing customer demands and maximise efficiency by facilitating real-time communication between the factory and the market (Wang et al., 2016; Lee et al., 2015). A smart factory can extend the scope of connectivity beyond the factory and further strengthen relationships with suppliers and customers. Sjödin et al. (2018) define a smart factory as a networked and flexible manufacturing system that draws on a continuous flow of data from interconnected plants and production systems in order to learn and adapt to new requirements. Greater flexibility as value added in manufacturing and business processes requires the most advanced technologies and platforms in communication, paving the way for greater automation through a multitude of communication channels and digital management systems (MoE SR, 2017). Industrial enterprises will simply be forced into embracing platforms and leveraging the value of digital and information technologies for advanced service offerings (Sjödin et al., 2017). This smart, networked system exploits continuous data exchange for interconnected plants and production. The creation of a smart manufacturing platform that can extend the reach of smart factories is vital and desirable for the modern manufacturing industry (Okeme et al., 2021).

According to Shi et al. (2020), a digital factory involves digitalising manufacturing processes, production equipment, materials, process methods and environmental information in a smart factory. Now that data has become a vital element, enterprises can establish a data processing backbone for production. Smart factories are viewed as a follow-up to digital factories and can be established in several stages (Figure 1):

- the transition from a traditional factory to a mechanical factory, where machines replace labour;
- a mechanical factory generates data from automated mechanical devices in a virtual environment. When the data is connected and controlled by a network, this is a sign of the maturity of a digital factory;
- a digital factory evolves into a smart factory by interconnecting processes.

In the manufacturing industry, a smart factory is considered to be the end stage of the Fourth Industrial Revolution (Jung *et al.*, 2021).

Figure 1 Phases in the development of a Smart Factory



Source: own processing according to Shi et al., 2020

The main goal of the digital (smart) factory concept should especially be the comprehensive innovation of products, processes and business models. The Slovak government supports Slovak industry by introducing innovations into Slovak industrial enterprises and by drawing on various European Union programmes for research and innovation. One of these programmes is Horizon Europe, the European Union's 9th Framework Programme covering the period from 2021 to 2027.

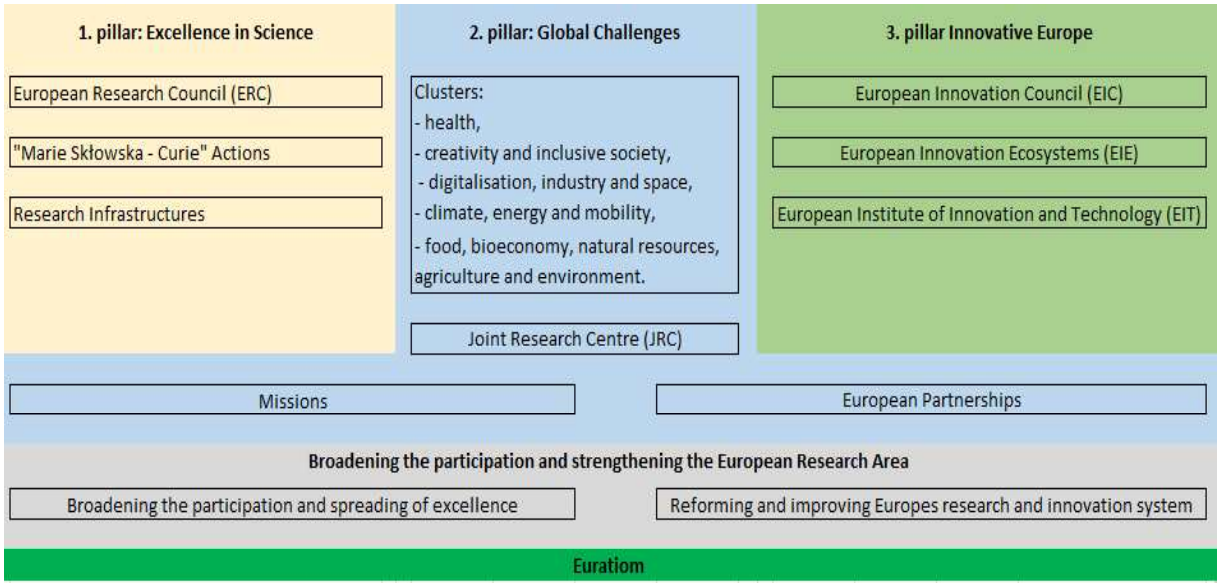
3.2 Promoting innovation Horizon Europe 2021 - 2027

The government also supports local businesses through various European Union programmes for research and innovation. One of the programmes is the European Union's 9th Framework Programme for the period 2021 to 2027. Horizon Europe builds seamlessly on Horizon 2020, which is one of the most important programmes funding projects in science, research and innovation in the European Union between 2014 and 2020. In order to prepare Horizon Europe, the outcome of the strategic planning exercise has been translated into a Strategic Plan (2021-2024) for the submission of proposals for the first four years of Horizon Europe (2021-2027). It is the document "Towards a first Strategic Plan for Horizon Europe" that explains the process of developing the first Strategic Plan and provides the basis for the Horizon Europe Work Programmes.

Its main objectives are to strengthen the EU's science and technology base and the European Research Area (ERA); to strengthen Europe's innovation capacity, competitiveness and employment; to meet citizens' priorities and sustain our socio-economic model and values. Particular reference can be made here to the manifestation of the objectives and vision of the European Green Deal, the digital transition, the transition to sustainability and the recovery from the COVID-19 crisis.

The new programme will be implemented through three main pillars, namely Excellent Science, Global Challenges and Innovative Europe (Figure 1).

Figure 2 Pillars of Horizon Europe



Source: ERAPORTAL, 2022

Conclusions

Considering how dynamic the business environment is and bearing in mind the current digital factory structure, a smart factory needs to be built in order to modernise the manufacturing industry, turning it into an intelligent manufacturing system that combines the communication, computing and control processes of smart manufacturing, and

responds flexibly to the requirements of the business environment in the digital age. The role of support programmes is to transfer innovation to Slovak industry and to promote research priorities for innovation. This should be the pathway for Slovak industry to be a leader in the era of smart technologies. Although the Slovak government has approved support programmes for research, innovation and innovative solutions, it should also play an important part in adapting legislation to support smart industrial enterprises in Slovakia and to meet the needs of smart industry in the digital era, thereby offering even greater support, as they are a key enabler and strategic element in society.

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References

ERAPORTAL (2022). O programe. Retrieved from: https://eraportal.sk/horizont-europa/heu-o-programe/#tabs_desc_62575_2.
Chen, B., Wan, J., Shu, L., Li, P., Mukherjee, M., Yin, B. (2017). Smart factory of Industry 4.0: Key technologies, applicationcase, and challenges. IEEE Access, vol. 6, pp. 6505–6519. Retrieved from: https://ieeexplore.ieee.org/document/8207346.
Jung, W. K., Kim, D. R., Lee, H., Yang, I., Youn, B. D., Zontar, D., Brockmann, M., Brecher, Ch., Ahn, S. H. (2021). Appropriate Smart Factory for SMEs: concept, Application and Perspective. International Journal of Precision Engineering and Manufacturing, vol. 22(1), pp. 201-215. Retrieved from: https://doi.org/10.1007/s12541-020-00445-2.
Lee, J., Bagheri, B., Kao, H. A. (2015). A cyber-physical systems architecture for Industry 4.0 - based manufacturing systems. Manufacturing Letters, vol. 3, pp. 18–23. Retrieved from: https://doi.org/10.1016/j.mfglet.2014.12.001.
Lucke, D., Constantinescu, C. Westkämper, E. (2008). Smart factory – A step towards the next generation of manufacturing. Manufacturing systems and technologies for the new frontier, pp. 115-118. Retrieved from: https://link.springer.com/chapter/10.1007/978-1-84800-267-8_23.
Lyu, Y., Zhang, J. (2016). Big-data-based technical framework of smart factory. Computer Integrated Manufacturing Systems, vol. 22(11), pp. 2691–2697.
Mabkhot, M. M., Al-Ahmari, A. M., Alkhalefah. H. (2018). Requirements of the Smart Factory System: A Survey and Perspective. Machines, vol. 6(2), 23. Retrieved from: https://doi.org/10.3390/machines6020023.
MoE SR (2017). Koncepcia inteligentného priesmyslu. Retrieved from: https://www.mhsr.sk/inovacie/strategie-a-politiky/smart-industry.
Okeme, P. A., Skakun, A. D., Muzalevskii, A. R. (2021). Transformation of Factory to Smart Factory. In: Proceedings of the 2021 IEEE Conference of Russian Young Researches in Elektrical and Elektronic Engineering (ElConRus), pp. 1499–1503. Retrieved from: https://doi.org/10.1109/ElConRus51938.2021.9396278.
Radziwon, A., Bilberg, A., Bogers, M., Skov, E. (2014). The Smart Factory: Exploring Adaptive and Flexible Manufacturing Solutions. Procedia Engineer, vol. 69, pp. 1184-1190.
Shi, Z., Xie, Y, Xue, W., Chen, Y., Fu, L., Xu, X. (2020). Smart factory in Industry 4.0. Systems research and behavioral science, vol. 37(4), pp. 607-617. Retrieved from: https://doi.org/10.1002/sres.2704.
Sjödin, D. R., Parida, V., Cenamor, J. (2017). Adopting a platform approach in servitization: Leveraging the value of digitalization. International Journal of Production Economics, vol. 192, pp. 54-65. Retrieved from: https://doi.org/10.1016/j.ijpe.2016.12.033.
Sjödin, D. R., Parida, V., Leksell, M., & Petrovic, A. (2018). Smart factory implementation and process innovation: A preliminary maturity model for leveraging digitalization in manufacturing moving to smart factories presents specific challenges that canbe addressed through a structured approach focused on people, processes, and technologies. Research-Technology Management, vol. 61(5), pp. 22–31.

Wang, S., Wan, J., Li, D., Zhang, Ch. (2016). Implementing smart factory of Industry 4.0: An outlook. International Journal of Distributed Sensor Networks, vol. 12(1). Retrieved from: https://doi.org/10.1155/2016/3159805.