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INFLUENCE OF INDUSTRY 4.0 ON PROJECT RISK MANAGEMENT

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1. Introduction

"Modern science has deprived us of illusions about the existence of stable and unchanging rules in the world whilst the awareness of uncertainty, impossibility and hazard, amplified by technological development, has grown. (…) As risk is integrated into the dynamic, evolutionary model of the world it is an objective entity." [Szumski, 1994, p. 26]

The reality that surrounds us is dynamically changing. It creates exciting opportunities for development, but at the same time increases the risk involved in the decisions we make. Projects, in comparison to other areas of a company`s operations, are associated with a higher level of risk due to their unique nature and circumstances. In addition, in most cases project implementation involves high capital expenditures, without having full information on the future stages of the implementation. All of these factors force enterprises, and above all project managers, to apply appropriate methods of risk detection in projects.

This chapter outline the distinguishing features of Industry 4.0, also known as the fourth industrial revolution, and define project risk as a potential event or circumstance that may contribute to a delay in the project, increase the cost of its implementation or cause other adverse changes in the project. Project risk management is an integral part of many project management methodologies, traditional and agile methodologies being the most popular.

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2. The fourth industrial revolution

According to subject literature industry underwent three fundamental changes [Paprocki, 2016, pp. 39-58]:

- the first industrial revolution, epitomised by the steam engine. In the 19th century, the invention and implementation of the steam engine ushered the era of industrialisation in manufacturing;
- the second industrial revolution associated with the growing importance of electricity at the beginning of the 20th century. Electricity replaced steam engines, and production lines could produce goods in large series;
- the third industrial revolution, related to the development of the personal computer market at the end of the 20th century. More and more efficient computers and data processing systems have made it possible to control machines using software. Consequently, machines became more efficient, precise and flexible, and the process of digitisation enabled ever-increasing degrees of automation. Planning and control systems were established to coordinate activities within production.

„The three industrial revolutions of the past were all triggered by technical innovations" [Brettel, Friederichsen, Keller, Rosenberg, 2014, p. 37].The fourth industrial revolution, also known as Industry 4.0, is defined as a combination of ICT, the Industry and Internet of Things [Kagermann, 2015, pp. 23-45], and is also seen as a term that bridges technology with the organisation of the added value chain [Hermann, Pentek, 2015, p. 11]. It means the unification of the real world of production machines with the virtual world of the Internet and information technology. People, machines and IT systems automatically exchange information in the course of production. Industry 4.0 spans the whole chain of activities, from placing an order, through delivering components for ongoing production, to sending goods to customers or providing after-sales services. Enterprises that implement Industry 4.0 solutions can reduce production costs and respond flexibly to customer inquiries, which gives them a significant competitive advantage.

Industrie 4.0 isfocused on creating smart products, procedures and processes, it is difficult to enumerate all its consequences [Kagermann, Wahlster, Helbig, 2013, p. 18]. Nevertheless, several hypotheses underpinning the emergence of Industry 4.0 have been put forward [Drath, Horch, 2014, p. 56]:

1. ICT infrastructure will become cheap and widely used in enterprises;
2. Devices, machines, plants, factories and final products will be connected to the Internet on a massive scale;
3. Equipment, machines, plants, factories and final products will be able to store full documentation and information about themselves in an external location.

Some contexts where the fourth revolution has been applied include: automatic vehicles, advanced robots (working with people, cleaning or providing care), 3D printing and new materials such as self-cleaning clothes, ceramics which turn pressure into energy, graphene. The fourth resolution poses a managerial challenge of up grading the machine park to reflect New requirements introduced by the disruptive technologies of Industry 4.0 [http://www.forschungsnetzwerk.at/downloadpub/mck_industry_40_report.pdf, p. 13].

Thanks to the fourth revolution enterprises can produce more economically and respond faster to the individual needs of customers. The time necessary to adapt machines to new requirements has been reduced, and the flexibility of enterprises has definitely increased. Most machines can modify their activities on their own, adapting to new tasks. This enables manufacturers to fulfil small-series orders, and even to produce individual items at the cost of standard serial production. In addition, data generated by systems become more easily accessible and thus useful. Therefore, Industry 4.0 allows creating new business models, including those that incorporate project management. The challenge lies in noticing and implementing them as soon as possible.There is also a need to remem ber that technology creates enormous opportunities as well as New risks alike. [Schwieters, PwC, 2015].

3. Risk in projects

Project risk is "the possibility of a venture developing in such a way that the planned completion dates, costs or specifications are not achieved – when these discrepancies are difficult or unacceptable compared to the assumptions" [Jędrych, Pietras, Szczepańczyk, 2012, pp. 90-91]. The concept of risk in the project is closely related to the concept of uncertainty. A. Stabryła even states that in practice both concepts are often used interchangeably [Stabryła, 2006, p. 306].

Risk is a combination of internal and external factors that affect the implementation of the adopted project objectives and significantly affect the profitability of both the project and the entire organization. The ISO 31000: 2009 Risk Management standards define these factors in the context of:

- impact on the project – as a deviation from the expected result,
- various aspects (financial, health, safety, environmental protection) implemented at various levels (strategic, tactical, operational) of the entire organisation, project, product or process,
- uncertainty – as a state of partial lack of information about an event, its consequences or the probability of its occurrence.

The classification of project risk by cause distinguishes the following risks [Pietras, Szmit, 2003, p. 82]:

1. brought upon by external causes – determined by external forces and not under control of the entity managing the project. This risk is related to the forces of nature, economic conditions of the market, decisions taken in the political or legal sphere.
2. brought upon by internal causes – can be controlled by the entity managing the project and includes the method of project planning used. This risk is associated with the human factor.

According to the standards of the Project Management Institute project risk is defined as "an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, or quality" [PMI, 2013, p. 301].

4. Project risk management and Industry 4.0

Risk management plays an important role in the areas of business activity of enterprises, especially during projects. This is due to several main reasons. Firstly, enterprises are characterized by the uniqueness of innovation, which means that this type of activity involves a much higher level of risk in comparison with other areas of the company's operations [Roszkowski, 2014, p. 155]. Secondly, the lack of full knowledge for future periods is characteristic for projects, that are closely related to uncertainty and risk [Wyrozębski, 2014, p. 104]. Project risk management is based on identifying threats to the project and determining actions aimed at eliminating the detected threats or minimising their impact on the project. These activities should be carried out at every stage of the project life cycle. [Zaskórski et al., 2013, p. 31] J. Kisielnicki emphasizes, in turn, that risk management consists in striving for a state in which the level of risk is acceptable to the project's sponsor. The author emphasizes that it is necessary to identify the factors that may affect the correct implementation of the project in the earliest possible way [Kisielnicki, 2011, p. 132].

The risk management process is sequential and should be implemented on a continuous basis. The process is divided into four stages [Pritchard, 2002, p. 23-26] [PMBoK, 2013,pp. 301-304]:

1. risk identification – identifying potential factors that may have a negative or positive effect on project implementation
2. qualitative risk analysis – risk factors are prioritised through evaluation; additionally, the likelihood of a risk factor occurring is related to its consequences.
3. quantitative risk analysis – the process of analysing the impact of identified risk factors on the overall project objectives.
4. risk control – developing acceptable solutions and actions that maximise opportunities and minimise project risks.

5. risk control – the process of implementing risk response plans, monitoring the identified risk and identifying new risks.

Fig. 1. The risk management process in project
Source: [PMI, 2013, s. 301-304].

As project management has abundant literature, organisations from every sector of the economy can choose from a number of methodologies to use for risk management. These methodologies are a source of standards and procedures describing specific actions and processes that can be implemented by members of the project team together with the project manager to succeed in their venture [Wyrozębski, 2014, p. 205]. The most popular classification of methodologies distinguishes two approaches to project management – traditional and agile.

Traditional project management assumes that the customer has a clearly defined need, a deadline for the work and a specific amount of money that they are willing to spend on the project. It brings good results primarily in situations where the goal and the way of achieving it are clearly and understandably formulated, and there is little probability of changing the scope during the project. In projects managed using a traditional methodology, there is low probability of unaccounted risk. Risks are identified only when they are common to particular tasks carried out as part of the project. [Wysocki, 2013, p. 27].

Agile project management emerged as a response to the need of implementing projects in conditions of increased uncertainty. Agile methodologies and assumptions have been developed and implemented as a solution for more effective work in the field of software design, although currently they are also used for other types of projects. The basic principles of this approach are efficiency, adaptability and collaboration. Some authors also emphasise the importance of simplification, which brings the agile approach closer to the principles of lean thinking based on flexibility and simplicity. As a result, the project team focuses on elements which contribute to the usability of the final effect and on setting priorities for the implementation of the

project. [Pichler, Schulze, 2005, pp. 371-373] In projects managed with an agile methodology there is a possibility of unplanned risk, especially in activities that were not in the original project plan. [Wyrozębski, 2007, pp. 151-152].

Digitisation in the broad sense of the term plays a key role in the Industry 4.0 concept, which is why the authors of various research studies assume that agile methodologies will become more and more widespread in project management. Some authors forecast that traditional methods will be completely abandoned as they are too rigid and formalised. [Cao, Zhang, 2016, pp. 1011-1016] In addition to agile project management methods the use of the hybrid approach may also increase. Hybrid methods make use of rigid frames imposed by traditional methods, but at the same time they integrate agile methodologies into a compre-hensive project management process. Another approach that may gain in popularity is the network approach in organisation of work for task forces. The network approach introduces a new organisation of work and production, including both the creation and functioning of a fully integrated system that can identify, react and adapt to the changing needs of the customer, thereby increasing the chances of achieving the intended effect of the project. [Bendkowski, 2016, p. 31].

Bearing in mind the above we may suppose that project risk management in Industry 4.0 will require the project manager to apply various, even conflicting methods at times, by following well-developed routines and simultaneously applying new competences. This is due to the necessity of adapting to work in conditions of even greater uncertainty and volatility of the environment in which the projects will be implemented. Accordingly, such state of affairs forces project managers to use agile methodologies more frequently [Czakon, 2012, pp. 7-10].

There are four aspects of Industry 4.0 that project managers should consider in terms of project risk management, or perhaps even start implementing them in projects [www.i-scoop.eu/industry-4-0/]:

1. The Internet of things (IOT), i.e. the use of software and networks to connect "things" via the Internet. This includes household items, consumer goods and many other devices. Greater connectivity will significantly improve performance of projects with regard to sharing data between project teams and external stakeholders, reducing the risk of a lack of information.
2. Big Data – a method of legally collecting information from various sources, then analysing and using them for company purposes. Research shows that by 2020, 60 percent of data that organisations consider mission-critical will exist outside the company's premises. [www.constellationr.com/2017-year-integration-enables-industry-40-growth] Data collected by entrepreneurs come through browsing data, e-commerce and social media usage obtained from the general public. Where to find data resources that could be used by project teams is still a matter of further debate and analysis. Managing data that in the so-called

cloud may one day enable forecasting of the project result using predefined variants. Therefore, Big Data could provide a new level of accuracy and automation of project risk management.

3. Automation, which means a significant reduction or replacement of human physical and mental work by the work of machines governed by the principle of self-regulation and performing specific activities without human involvement. In all projects the amount of work is relative and statistics show the need to automate some of the tasks carried out by the project team. Automation increases the team's morale and allows them to focus more on the implementation and monitoring of the project.
4. Self-learning machines – machines that can imitate human intelligence with the use of special algorithms. As a consequence, having the right information it is possible to predict project results with very high precision. The basic principle of machine learning is that devices become smarter over time. It can become an ideal solution for improving the project risk management quality.

Although the new Industry 4.0 technologies discussed above exist and are in use, their full potential is not yet known. „Industry 4.0 may require less employees without a change in production" [http://doku.iab.de/forschungsbericht/2015/fb0815_en.pdf]. Some entrepreneurs believe that learning machines will replace people in manufacturing, services and other industries. If that were true we may suppose that risks associated with people will be minimised, and robots will be able to do all the work without any risk. But what is the importance of experience and talent? Research from 2017 shows that directors of companies emphasise the importance of talent as well as intelligence of employees, as without the former there is no possibility of employee growth. [www.gartner.com/doc/3678617?srcId = 1-8619339564]. IT Directors also emphasise that the most important barriers to success are culture, resources and talent. This leads us to conclude that recruiting talented workforce will be a new challenge for the project manager in Industry 4.0. The risk associated with talent will be at the top of the identified hazards. It means putting more emphasis on the recruitment of employees for the implementation of projects.

According to the PMI report on the impact of disruptive technologies on projects, organisations with a mature digital transformation strategy believe that the project manager will become an authority in the field of breakthrough technologies. It follows that the new way to deal with project risk in Industry 4.0 will be to employ a new type of project manager. Having a new type of manager and talented workforce in the project team means the need to implement worker training and development. Training will therefore become an indispensable investment for Industry 4.0 companies. [https://www.pmi.org/learning/thought-leadership/pulse/benefits-disruptive-technologies-projects]

Organisational culture should also evolve when adapting to the new realities of Industry 4.0 in order for project management teams to cope with risk and become more flexible in action. Project managers should begin by understanding the dynamics of Industry 4.0, then start changing the culture, which will certainly not be an easy task.

It should be emphasized that Industry 4.0 does not mean replacing project managers or replacing project teams, but identifying tasks that can be delegated to machines. Thus, the human element, with its irreplaceable experience and talent, remains in place. To summarise, Industry 4.0 is aimed at improving projects through their creation. In project risk management this is possible with the aid of knowledge and application of appropriate methodologies.

5. Summary and conclusions

The presented analysis of literature shows that the concept of Industry 4.0 and the associated fourth industrial revolution has and is going to have a huge impact on project risk management. Industry 4.0 in project management pertains to a growing number of projects, whose management is growing in importance. It also means using other management methodologies. The main stimulus for the development of Industry 4.0 is the rapidly expanding digitisation, which will have an influence on increasing the use of agile or hybrid project management methods. This will have an impact on further changes in organisational structures and methods of working in project teams, resulting in project management that is better adapted to changes taking place in the turbulent digital environment of Industry 4.0.

Projects will be implemented in order to create or introduce innovative products and services, using a flexible method of operation. Industry 4.0 is running projects in a virtual space, with loosely connected people. Intercultural and social skills as well as talent will be of high importance for projects requiring management diverse individuals working in a virtual workspace or in an online lab. Organisational culture should also evolve and adapt to the new reality. Project teams created in Industry 4.0 will be more and more fluid and therefore will require a flexible style of organisation and adequate style of risk management. [www.ipma.world/fourth-industrial-revolution-means-project-management/]

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