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UNCERTAINTY IN THE SPHERE OF THE INDUSTRY 4.0 – POTENTIAL AREAS TO RESEARCH

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Abstract. The world stands on the threshold of a new age of technology, which will launch a fourth industrial revolution (Industry 4.0). According to this idea, web-based network will support smart factories at every stage of the work on the product, from design through to servicing and recycling. It is a vision of a world in which the real environment connects to the digital one using follows driving forces: Internet of things, cloud computing, big data, cyber-physical systems, and others. The Industry 4.0 concept is based on developing smart chains preparation based on communicating with each other means of production, products, components, plants, humans. Established in Germany, the concept of Industry 4.0, is the brainchild – its beginning reaches 2011. It is therefore fraught with high level of uncertainty in many aspects (economic, social, technological, legal, etc.). The main aim of this article is to analyze different dimensions of uncertainty regarding the Industry 4.0, both in terms of opportunities and threats. Due to the freshness of the topic and the great complexity of the Industry 4.0 phenomenon, the main aim of the article is to identify potential areas requiring the necessary research in order minimizing negative – today uncertain – effects occurring in both the design concept Industry 4.0 as well as during its functioning.

Keywords: Industry 4.0, uncertainty, Intenet of Things, cyber-physical systems.

JEL Classification: D24, D81, L85, O14.

1. Introduction

The Industry 4.0 concept (founded in Germany) is based on developing smart chains built on communicating with each other means of production, products, components, plants, humans. According to this idea, web-based network will support smart factories at every stage of the work on the product, from design through to servicing and recycling (Maślanek 2014).

The Industry 4.0 is one of the effects of transformation of era of mathematization to the era of informatization of all sciences – medical, energy, media, legal, automotive, biotechnology, computational linguistics, neuroinformatics and finally manufacturing (Wahlster 2014).

According to a Fraunhofer Institute study on the basis of the analysis of German companies in the following industries: engineering and producing electrical components and automation, in the period of 2014–2025 should expect an increase in gross profits by approx. 30% (Szulewski 2016).

The beginning of all industrial revolutions took place in the industry. It caused a huge change in society. In the current industrial revolution is the opposite. The beginning of the transformation process is not driven directly by the industry itself. As the main driving force should be considered the invention of social networks and intelligent devices used by workers of manufacturing companies. The development of this interconnections drives today development of production sector (Schuh *et al.* 2014).

Many of Germany's competitors have recognized the trend for using the Internet of Things in the manufacturing environment and are promoting it through a range of institutional and financial measures. Germany is not the only country that identified the potential use of the Internet of Things in the production and its impact on industrial processes as strategic challenges. The terms "smart production", "smart manufacturing" or "smart factory" are used in Europe, China and the USA to refer specifically to digital networking of production to create smart manufacturing systems (Kagermann *et al.* 2013). Chinese version of "Industry 4.0" is known as "Made in China 2025" plan (Zhang *et al.* 2014).

Universality in industrial applications: Internet of Things, Internet of Services, Internet of Media, big data, communications inter-machines and cyber-physical systems using interoperability, decentralization and full virtualization certainly will affect different course of many phenomena than is apparent from past experience. The direction, the strength and intensity of these changes are increasingly becoming unpredictable. In addition, the present pace of economic, political, social, environmental and technical changes faced by almost every organization in the world is unprecedented. This makes economic space is becoming more and more undetermined. This vague situation determines the appearance of uncertainty (Wawiernia 2013).

Uncertainty is a condition in which the observer of any phenomena in a given place and time, is not being able, with complete certainty, to define the further course of this phenomenon (Zawiła-Niedzwiecki 2007). The main aim of this article is to analyze the various elements that affect the uncertainty of Industry 4.0, both in terms of opportunities and threats. Due to the freshness of the topic and the great complexity of the phenomenon of Industry 4.0, the main effect of the article is to identify potential areas requiring the necessary research to minimize the negative effects occurring in the Industry 4.0 concept.

2. Industry 4.0 – analysis of the phenomenon

Revolution 4.0 is the transformation of industry based on centralized production to decentralized production based on cyber-physical systems (Maślanek 2014). It also products transform from uniform to customization and users transform from partially to fully participating in production (Zhang *et al.* 2014). Industry 4.0 can also be described as the digitization of material production, driven by cyber-physical systems in the Internet of Things (IoT) environment, which consists of two main components in the form of Internet of Services (IoS) and Internet of Media (IoM).

The implementation of this concept requires proper cooperation between the parties of tools, connecting and merging of previously separated systems, the identification of new targets and management of new functions (see Fig. 1).

The heart of the Industry 4.0 will become the factory 4.0, which will be characterized by supply products even in individual pieces, not accompanied by increasing costs. In this way, mass production will be combined with personalization at the level of the production line. It has been impossible so far to implement (Kagermann *et al.* 2013).

In addition, smart factory should be characterized by (Ślązak 2015; Stein 2016):
– use available on the market innovative solutions, eg. in order to identify in real-time people, equipment, works and goods;
– efficient communication engineer-machine, engineer-M2M,
– the ability to adapt to changing conditions,

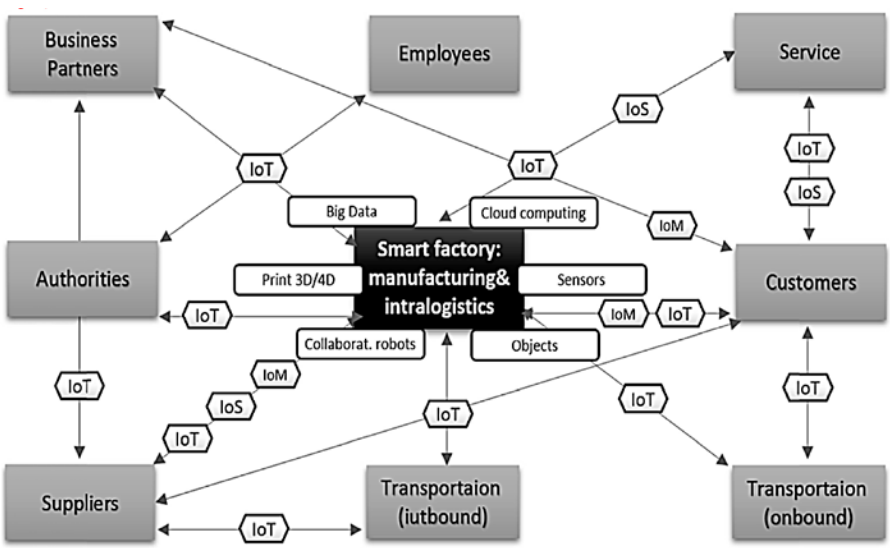

Fig. 1. The main subsystems of Industry 4.0 based on the architecture of the Internet of Things (personal design on the basis of Schoenthaler 2015; LG SNC 2015)

– resource efficiency and ergonomics,
– the possibility of integration of customers and business partners at various levels,
– link the extended supply chain and distribution to create dynamic workflows,
– high level of security against cyber sabotage.

The development of Industry 4.0 affects the development of countries in specific areas of its economic activity (see Table 1), cyclicality of economic development and emergence periods of crises in which there is an increased need to take risks and seek new technological solutions to ensure growth of enterprises productivity (Badurek 2014).

Table 1. Industry 4.0 data spotlights, top and bottom positions of the 15 EU countries with highest GDP in 2012 (Dujin *et al.* 2014)

Industrial robots (per 1,000 employees)		*Mobile connections to the Internet for business use (% of enterprises)*		*Employment in technology and knowledgeintensive sectors (% of total employment)*		*Patent applications (per 1,000 population)*		*Exports of goods (% of GDP)*		*Value added per employee (EUR '000)*	
Germany	273	Finland	44	Finland	8	Germany	59	Netherlands	69	Denmark	88
Portugal	35	France, Italy	20	Portugal	3	Portugal	0,6	UK	19	Poland	21

Key determinants of new industrial landscape (see Fig. 2) (Dujin *et al.* 2014) are the following:

1. Cyber-physical systems and marketplace in Industry 4.0 – todays IT systems will be far more connected to all sub-systems, processes, internal and external objects, the supplier and customer networks;
2. Smart robots and machines in Industry 4.0 – robots and humans will work hand in hand, so to speak, on interlinking tasks and using smart sensored human-machine interfaces;
3. Big Data – innovative methods to handle big data and to tap the potential of cloud computing will create new ways to leverage information;
4. New quality of connectivity – machines, workpieces, systems and human beings will constantly exchange digital information via Internet protocol;
5. Energy efficiency and decentralization – climate change and scarcity of resources are megatrends that will affect all Industry 4.0 players. These megatrends leverage energy decentralization for plants, triggering the need for the use of carbon-neutral technologies in manufacturing;
6. Virtual industrialization – Industry 4.0 will use virtual plants and products to prepare the physical production. Every proces is first simulated and verified virtually

The main changes for companies connected to Industry 4.0 (Dujin *et al.* 2014) refer to:

1. Final results – mass customization based on local production. Industry 4.0 will be characterized by greater flexibility in the production process. It will be possible to create products for-fitted to the needs of a single client at a relatively low marginal cost. Physical production will be able to be done locally, without having to use the services of subcontractors, for example through the use of 3D printers.

2. Process – production based on the web and dynamic clusters. The companies will operate in scattered locations, confessing the idea of "industrial democracy", lowering the barriers to entry for smaller or more specialized companies.
3. Business models – based on distributed value chains. Its importance will gain skills such as design, service processes, customer data management. In such models philosophy of "long tail" should be explored with the traditional Internet to the Internet of Things. Referring to the views of Ch. Anderson can say that the market for niche poducts (created for individual customers) will be more powerful than the market based on very popular mass products.
4. Competition – based on the convergence of the borders. Traditional industry boundaries between the industrial and nonindustrial actions sighting loose the focus. Strong emphasis will be placed on industrial methods of work.
5. Skills – strong emphasis will be placed on interdisciplinary thinking. Companies in the Industry 4.0 will need to have excellent skills in both the social and technical spheres. There will be a shift toward a design thinking instead of production thinking. New job titles will emerge such as data scientist and cyber safety guards. New jobs will be for smart employees who can administrate the smart system and connect it to the produc-tion network, instead of workers for simple factory work (LG SNC 2015).
6. Globalisation – the organization of the future will concentrate on selected hotspots, not the overall global presence. Often it will be cheaper to transfer data and product locally on a small-sized scale. Enterprises 4.0 will be created in a more decentralized and flexible way.

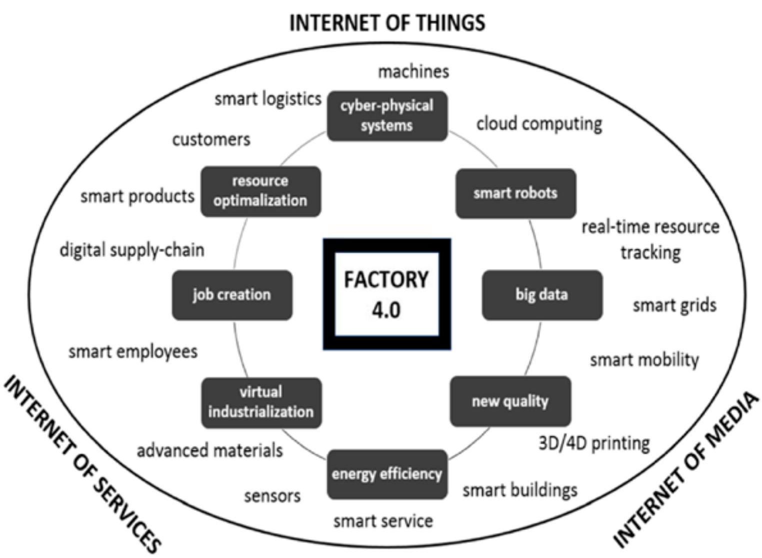

Fig. 2. The main components of Industry 4.0.
(personal design on the basis of Kopp 2014; Dujin *et al.* 2014; LG SNC 2015; Qin 2016)

According to J. Lee, E. Lapira, B. Bagheri, H. Kao the basic definition of a manufacturing is described as a 5M system which consists of (Lee *et al.* 2013):
- materials (properties and functions),
- machines (precision and capabilities),
- methods (efficiency and productivity),
- measurements (sensing and improvement)
- modeling (prediction, optimization, and prevention).

Information system can be further enhanced with a 5C functions, which consist of (Lee *et al.* 2013):
- connection (sensor and networks),
- cloud (data on demand and anytime),
- content (correlation and meaning),
- community (sharing and social), and
- customization (personalization and value).

According to S. Weyer, M. Schmitt, M. Ohmer, D. Gorecky (2015), central aspects of the Industry 4.0 can be specified through three paradigms:
1. The smart product.
2. The smart machine.
3. The augmented operator.

The smart product will receive a memory on which operational data and requirements are stored directly as an individual building plan. The paradigm of the smart machine describes the process of machines becoming cyber-physical production systems. The augmented operator, targets at the technological support of the worker in the challenging environment of highly modular production systems (Weyer *et al.* 2015).

3. The Uncertainty and its dimensions

Uncertainty as a cognitive category manifests itself in a lack of information necessary to make decisions, inability to predict the effects of decisions and the inability to assess the impact of events occurring in the environment (Jędralska, Czech 2011).

The multidimensional nature of the uncertainty and the determination of its complexity and dynamic changes, make should be viewed from different perspectives.

Depending on the examined contexts the phenomenon of uncertainty focuses on different aspects (Table 2).

Primary trend in research of uncertainty is represented by A. H. Willett and F. Knight. According to the first author. uncertainty is a subjective measure which is correlated with the objective risks and concerns changes that are difficult or impossible to estimate (Janasz 2009). According to F. Knight when the probability of certain events is measurable then it should talk about the risks. Otherwise, there is uncertainty in the strict sense (Wawiernia 2013).

Table 2. Dimensions of uncertainty (personal design on the basis of Bombola 2014; Jędralska, Czech 2011; Wawiernia 2013)

Dimensions of uncertainty	Types of uncertainty	Classes of uncertainty	Divisions of uncertainty
PRIMARY TREND IN RESEARCH OF UNCERTAINTY	subjective		
	probabilistic	as a risk	
		uncertainty in the strict sense	
HUMAN MIND AS A FILTER TO INFORMATION	temporal		
	causative		
COGNITIVE PERSPECTIVES	behavioral	internal	deduce
			experienced
		external	singular
			distributive
	structural	subjective (based on cognitive limitations)	based on obtaining information
			based on information processing
			based on the storage information
		objective	
		relational	
	processual	zero (confidence)	
		objective (alternate futures)	
		Knight's type	
		ambiguity	
BINARY WAY TO DESCRIBE OF UNCERTAINTY BASED ON DECISION-MAKING THEORY	Knight's type		
	ignorance		
	volatile		
	as indeterminacy		
EVALUATIVE DIMENSION	probabilistic		
	stochastic		
	strategic		
POSSIBILITY OF UNCERTAINTY QUANTIFICATION	general		
	specific		
	based on subjective logic		
DIMENSION OF INFORMATION	static		
	dynamic		
UNCERTAINTY AS A DETERMINANT OF COGNITION PROCESS	passive		
	active		
BASED ON SOURCES OF UNCERTAINTY	subjective		
	objective		
ANOTHER	random		
	nature		
	developmental		
	marketplace		

According to the second approach, the human mind is seen as a filter for environmental information. The filtration process may be considered in terms of temporal and causal (dynamic). Temporal uncertainty is a future category. knowledge gap concerning incomplete recognize the reality in the present tense is treated as indeterminacy. Causative type of uncertainty is dynamic and is manifested by the fact that the gap of knowledge stimulates the exploration activity which is active in finding new information (Bojarski 1984).

In terms of behavioral internal uncertainty stems from the awareness of subjective cognitive limitations and takes the form of deduced/analytical uncertainty (impeding selection of specific behaviors) or experienced uncertainty (based on intuition and associated with a deficit of information). External uncertainty resulting from gaps of knowledge can have singular character, in the case of unique or unusual events or distributive character – by analyzing one of the components of the distribution, it can be applied to other similar to it. Mutual assembling uncertainty of external and internal uncertainties may be described as complex or generalized uncertainty (Jędralska, Czech 2011).

In structural term subjective uncertainty due to the cognitive limitations of decision-maker. They are the result of the following three sources (Jędralska, Czech 2011):
1) obtaining information – conditioned by fragmentary sense of observation and the emerging difficulties while understanding the structural properties of the system and its dynamics;
2) information processing – relating to the fact that the human mind can process a finite amount of information per unit of time;
3) storing information – indicating that remembering all the events and circumstances is beyond the reach of the human brain.

The objective uncertainty is associated with the dynamics, finite, excess and loss of controlled resources, skills and competencies.

Relational uncertainty arises at the interface between the organization and dynamics of an environment. It is shaped by the hampered predictability of behavior of different groups of elements that are interdependent with it. In processual term uncertainty can take four forms (Jędralska, Czech 2011):
1) uncertainty at zero or full confidence;
2) uncertainty as one of alternative scenarios – the range of available information does not allow to make conclusion which of these scenarios will be realized;
3) the type of Knight uncertainty when you understand the possible states of the environment, but it is unknown probability distribution of their occurrence;
4) uncertainty as ambiguity when it is impossible to determine the range of potential outcomes (Jędralska, Czech 2011).

In the case of decision-making theory we are dealing with two groups of binary way of describing uncertainty:
1) the type of Knight's uncertainty otherwise known as structural uncertainty (analogously to processual uncertainty); b) ignorance (total/deep uncertainty) occurs when there is no possibility to build a proper chain of cause-and-effect relationships (Mesjasz 2008);
2) Volatility – Is created by the dynamic and unpredictable changes in the environment; b) indeterminacy – applies to the present – refers to the absence of full knowledge of the cause and effect relations occurring between variables (Jędralska, Czech 2011).

Evaluative dimension is associated with the ability to quantify uncertainty. In this perspective A. Wawiernia by J. Teczke distinguishes between 3 types of uncertainty (Wawiernia 2013):

1) probabilistic whose value can be determined based on a known probability distribution;
2) stochastic, for which it is known function probability distribution, but this can be inferred from the distribution of the sample;
3) strategic, for which is known only set of limit values.

Quoting W.G. Schoroeck A. Wawiernia proposes to turn a distinction in the evaluative dimension of general and specific uncertainty. The first is analogous to the theory of ignorance in the case of decision-making processes. While specific uncertainty allows to make objective or at least subjective the possibility of appointing a probability of potential outcomes, and thus allows their quantification (Wawiernia 2013).

In the information dimension in static term uncertainty can take three forms (Wawiernia 2013):
1) total certainty,
2) certainty at zero – that is ignorance,
3) indirect certain or unawareness to the possible changes in states and directions of reality development. In a dynamic term uncertainty is a decision-making situation in which the decision maker does not know all the paramaters its making.

In the case of uncertainty as determinant of cognition process we can distinguish uncertainties: passive/objective one, which exists independently of its knowledge, as well as active one, which arises only at the time of initiating the process of cognition. Completion of the cognition process causes subsequent conversion of active in the passive uncertainy (Zawiła-Niedzwiecki 2007).

Referring to the sources of uncertainty it can be distinguished subjective uncertainty as derivative competencies of individual entities theoretical and methodological knowledge of the subject and the objective uncertainty associated with the object of cognition (Wawiernia 2013).

Other possible types of uncertainty, for example, the random uncertainty as a result of the random events, undergone operation of the law of large numbers and quantifiable using probability theory. In turn, the natural uncertainty is associated with the change of management in natural conditions including changes in climate and atmospheric conditions (Wawiernia 2013).

4. Characteristics of selected potential elements of uncertainty in relation to the Industry 4.0

Development of Fourth Industrial Revolution, involves three, not fully defined, phenomena which from today's point of view, are associated with large areas of ignorance (Paprocki 2016):

1. Universal digitization (as one of the megatrends) and ensuring constant communication between the people themselves, people with devices and machines to each other.

2. Increasingly implemented disruptive technological innovations (Fig. 3), which affect the abrupt increase the efficiency and effectiveness of the socio-economic system.
3. The achievement of such a development machine that gain the ability to autonomous behavior through the use of in the process of controlling artificial intelligence.

Such complex phenomena prevent create simple deterministic models that would simulate a future development of the Industry 4.0. In this case, must be use other approaches that use expert, intuitive and probabilistic approach. A description of such methods is the summary of this article.

The concept of disruptive innovations introduced in 1997 C. Christensen. This term refers to the effectiveness of market take-up of breakthrough technologies by enterprises. Figure 3 presents the scheme so-called "Valley of death" by F. Diana. Image shows a skeleton to build relationships between the introduction of breakthrough technologies and megatrends (disruptive scenarios) for the creation of a new potential paradigm in economics. The shape of the curve in the form of the letter "U", symbolizes that the breakthrough technologies, in the absence of their adaptation, can lead to the collapse of existing economic models. Valley of death may be able to understanding of opportunities, uncertainties, and potential responses (Zaręba 2016).

Due to the complexity of the components of Industry 4.0 all the processes undergoing in it will become very complex and therefore will be subject to a high degree of uncertainty.

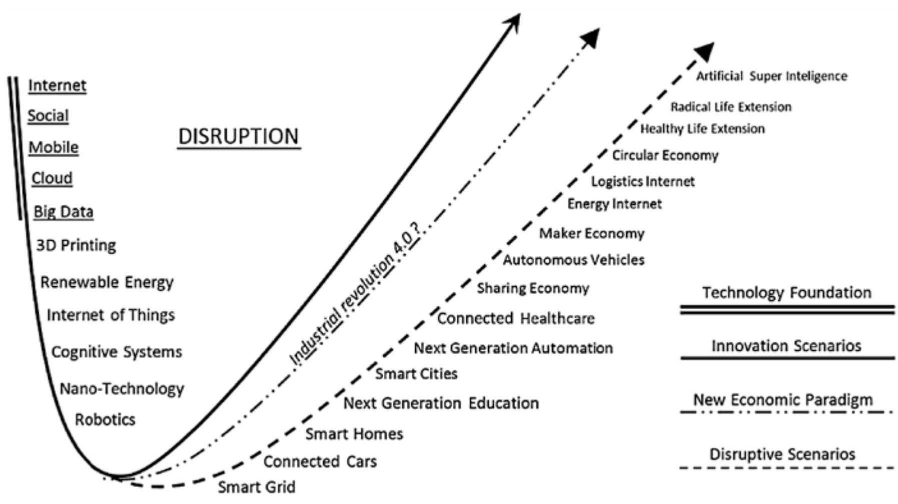

Fig. 3. "Valley of death" of innovative disruptive technologies (Diana 2015)

The list below presents selected determinants generating the phenomenon of uncertainty in the area of Industry 4.0 (Maślanek 2014; Albert 2015; Dujin *et al.* 2014; Lee *et al.* 2014; Dmowski *et al.* 2016; Ślązak 2015):

- communication between the main network components of Industry 4.0 based on massive amounts of data based on self-control, beyond a secure internal network;
- creation of new, not previously known business models of cooperation and new values chains, based on a very extensive scale relationships between all parties setting up the ecosystem of Industry 4.0;
- change the basic conditions for doing business;
- the need to analyze structured and unstructured data;
- excessive attention paid to the traditional ways of production;
- integration of new IT systems with the old system not designed for the Internet of Things;
- level of progress of actual production and material technology;
- the current lack of resolution of the following issues: 1) What data to collect? 2) Who will get the in-formation derived from the data? 3) How will this information be used? That the Right Decisions were made?
- determination of Industry 4.0 as a revolution – at the initial stage – burdened with many unknowns;
- very high complexity and dynamism of Industry 4.0 environment's;
- the lack of smart analytic tools in many manufacturing systems to manage big data;
- replacement workers by new solutions such robots;
- creation by Industry 4.0 jobs with other qualifications than those which replaces;
- implementation in other countries more favorable solutions, which will result in the transfer of production right there, and do not develop it on the spot;
- loss strong position in the export markets of countries that are characterized by a current cost advantages;
- significant delay in the economic development of some countries can cause a big advantage of foreign suppliers at the start;
- increase the complexity of the manufactured parts;
- uncertain fate of leaders in the mobile technology market – such as failure of Yahoo and drop list of Twitter
- digitization of business processes goes beyond the boundaries of the closed facilities (factories), in the form of eg. virtual fleets and covers the activities of "anywhere, anytime";
- equipment must meet much higher demands on the reliability of their actions in the context of changing weather conditions.

Other potential areas of uncertainty referring to the technological (communication) aspects (Control Engineering Magazine 2015):

- decentralized intelligence – is where intelligent drive and control technologies network with other devices with Decentralized autonomy;

– rapid connectivity – immediate vertical and horizontal connectivity, enabling the free flow of data across the corporate structure;
– open standards and systems – how "open" systems could be in terms of support for emerging communications and software standards and in how open individual components are to make Industry 4.0 a reality;
– context of real-time integration – this will equip manufacturers and machines with details to execute the rapid process and production changes to fulfill the vision of profitably making products for specific customer needs;
– autonomous behavior – technology helps the production line to become autonomous.

These mentioned above areas for their correct understanding, can be associated with the following dimensions of the theory of uncertainty (Jędralska, Czech 2011; Wawiernia 2013):

1. Uncertainties in behavioral terms – as a composite, which is the result of internal factors (relating to the Industry 4.0) and external (situational), induced by the complexity and dynamics of the environment (suppliers, customers, network security, etc.).
2. Subjective uncertainty (in structural terms) results from cognitive limitations of policymaker refering to information management generated in the system and subsystems of Industry 4.0, in particular, in terms of its acquisition, processing and storage.
3. Relational uncertainty (in structural terms), formed at the interface between the organization and environment through a complex web of interaction between companies 4.0 and their stakeholders. This uncertainty will shaped by dynamics of business environment and difficult predictability of behavior of different groups of stakeholders.
4. Structural uncertainty (in terms of a binary way of describing uncertainty) will occur when there will be the opportunity to identify the chain of cause-and-effect relationships regarding the analyzed events (in contexts: economic, technological, social, legal, etc.), but, due to the a huge dynamic development of the Industry 4.0 will not be possible to determine probable future events based on conditions of present.
5. Indeterminacy (in terms of a binary way of describing uncertainty) concerns the present and includes mainly countries such as Poland where there is a lack of clear information about the validity of changing ambient-tion, lack of full knowledge of the cause and effect relations occurring between the variables and uncertainty, the available courses of action and their consequences.

Building a new generation enterprises based on modern machine production is impossible without integration of these machines in the Internet of Things. In addition, it is necessary to education policies. Repatriation of manufacturing from developing countries to Europe may require investment programs or incentives (Dujin *et al.* 2014).

5. Conclusions

The notion of Industry 4.0 is not yet precisely defined. Uncertainty thus relates to a technological boundary of the concept that is the scale and complexity of future systems and to determine which technologies are within the Internet of Things range, and which are excluded from it.

Mastering the technology (for example, by its estimate) from the Industry 4.0 will give a chance to occupy the appropriate position in the market, both in the enterprise, research unit, region and country (Gudanowska 2014).

Examples of ways to overcome the uncertainty in Industry 4.0 (Kopp 2014; Albert 2015, Dujin *et al.* 2014; Ślązak 2015; Stein 2016; Paprocki 2016; Zaręba 2016; Szulewski 2016; Lee *et al.* 2014):

- the adoption of common standards for the different devices and applications;
- mastering of complex systems for suitable simulation and optimization models and software;
- guaranteed data security – development of new systems that are safe from attacks;
- explicit acknowledgment that the individual human being will continue to play an active, engaging role in manufacturing;
- distinguish between what can be considered as known and what is essentially uncertain;
- distinction systems possible related to Industry 4.0 and its surroundings due to their importance and probability of occurrence;
- adaptation of regulation and legislation to the new reality before Industry 4.0 will become commonplace;
- set the conditions for the ecosystem of Industry 4.0;
- a shared vision for policy makers and governments is needed;
- industry 4.0 must be understood by governments and policy makers, and promoted as a priority for Europe;
- in Industry 4.0 we should try to think more systemic;
- legislation should create an "infrastructure" for promoting entrepreneurship;
- the new competency fields required by Industry 4.0 need to be embedded in education. This includes fields such as software programming, data analysis or scientific computing;
- the full integration of machinery and equipment with production management systems;
- the creation of organizations, clusters that deal with the development of standards, eg. communication, used in a-production systems. The composition of these clusters should include the following: projecting and producing control systems, robots, machines and machine tools and software to support them;
- design ruggedized industrial networking infrastructure that will endure in harsh environment;
- other than the current, meet the challenges of the earth inhabitants for the reduction in energy consuming to quasi-zero level through the commercialization of two technologies: 1) electricity production in the "in-finite number" based on renewable energy sources; 2) control over the process of hydrogen storing;

– use more elaborate equipment containing component with higher quality, durability and reliability;
– division of the construction costs for infrastructure among many suppliers of services. An example would be the advanced telematics of cars. The terminal, equipped with multiple sensors can be used simultaneously by the vehicle manufacturer, the insurer, providers of multimedia content;
– ensuring the free flow of data in both vertical and horizontal hierarchical IT structure of the smart factory;
– the individual steps of the manufacturing process should be viewed in holistic and systemic way (in a ful-ly integrated manner) instead of the chain of following processes in chronological order;
– utilization of advance prediction tools.

Helpful in the process of leveling the uncertainty phenomenon in the system of Industry 4.0 may be an attempt to answer the following questions (Lempert, Zmud 2012):

1. To which extent will the system work properly?
2. To which extent will the system be accepted by the government, society, science and other organizations of public life?
3. To which extent to creation of the universal cyberspace will influence policy in the social, legal, economic and technological?
4. What threats will have grappled cybernetic systems?
5. What type of security is necessary to ensure the reliability and safety of Industry 4.0 systems.

Designed by I. Asimov in 1942 three laws of robotics become real meaning and their fulfillment is necessary to minimize possible risks and uncertainty in the Industry 4.0 (Wortal Robotyka.com 2015):

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

Modern inventions, which are attributes of Industry 4.0, provide not longer extension of human muscles and senses, as was the case with previous industrial revolutions, but some of the functions of the brain are responsible for conscious perception and intelligence. You could say that every sufficiently complex system (which is undoubtedly Industry 4.0), whose elements exchanged between each other information, energy or matter has a chance of being promoted to the rank of the conscious. It is worth at this point realize that the dialogue between man and machine in Industry 4.0 may take place only in a common language. If, therefore, do not we force machines to accept human qualities, we will be forced to take over their modus operandi (Magruk 2004).

Industry 4.0 should be considered in the category of complex systems, and like any complex system, according to the principle of indeterminacy, it can not be ever fully understood (Cempel 2002).

According to P. Schwartz uncertainty is the “new normal” in today’s fast-changing times. One of proven approach to navigating through this uncertainty is scenario planning (Schwartz 2012), a well-developed tool in future studies (Kononiuk, Nazarko 2014; Halicka 2016). Keep in mind that the degree of uncertainty existence of a particular scenario to a large extent on the degree of uncertainty of development of individual factors which are components of a given scenario. For example, demographic trends are characterized by relatively low uncertainty of forecasts results. But economic factors such as consumer preferences are characterized by a high degree of uncertainty. One solution is to divide into two groups of factors: 1) consisting of one parameter – a relatively low uncertainty, and 2) composed of a plurality of parameters with a relatively high uncertainty (Delivering Tomorrow 2012).

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