

BUILDING A MODEL FOR ASSESSING THE MATURITY OF POLISH ENTERPRISES IN TERMS OF LOGISTICS 4.0 ASSUMPTIONS

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Abstract

The major reason for creating presented maturity assessment model related to Logistics 4.0 assumptions is the growing importance of using Industry 4.0 tools and increase level of digitalization of logistics processes performed in activities of many global companies. A review of industry literature proves that Logistics 4.0 is a much less raised topic than the Fourth Industrial Revolution, hence it was considered that examining the level of maturity in relation to Logistics 4.0 assumptions can contribute to the development of the concept in Poland towards global enterprises successfully implementing digitalised processes. The constitutive aim of this paper was to build the model which should be used for investigating the level of maturity and implementation readiness of Polish enterprises from the TSL and manufacturing industry in relation to assumptions of Logistics 4.0. Enterprises were evaluated on the basis of research carried out in a pilot form. The article included indicating the assumptions of Logistics 4.0, tools used within its concept, as well as creating a maturity assessment model based on the analysis of a group of Polish enterprises. The conducted research indicated a small number of Polish companies effectively implementing solutions in the field of IV Generation Logistics, hence reasonable becomes the necessity of extending the research sample so as to improve the maturity assessment process, which will translate into an increase in the awareness of Polish companies regarding the requirements of digital transformation what will translate

into an increase in their competitiveness and solutions used by them in the global logistics market.

Key words: Logistics 4.0, Supply chains and networks, Industry 4.0, Maturity assessment model

1. INTRODUCTION

In the industry digitisation era, it is unimaginable to have enterprises develop with no innovative solutions within modern technologies. The competitive advantage source becomes the ability to adapt final products to exact customer's requirements and to adjust to the unlimited customisation of created products or services. However, these effects are possible to be achieved only if there is a continuous improvement of processes fulfilled in factories by increasing the integration of actions performed both between particular enterprise processes and within supply chains. Only the factories, which are fully integrated with their business partners, will be able to respond to their recipients' needs in the future and will even obtain the ability to predict their requirements. These actions will be accompanied, among others, by real-time full access to data, full production robotisation or the integration of information exchanged between supply chain links which are the Fourth Industry Revolution components at the same time. The Industry 4.0 concept mostly refers to manufacturing factories in contrast to Logistics 4.0 which is focused on the entire supply chain integration. As the Industry 4.0 concept is of much bigger interest, authors decided to describe the most significant Fourth Generation Logistics features and elements that play a crucial role for contemporary supply chain participants (Gubán & Kovács, 2017).

With reference to literature overview the authors found that Industry 4.0 concept is discussed more often than Logistics 4.0, which prompted the authors of this article to examine the level of maturity of a selected group of Polish enterprises in relation to the Logistics 4.0 implementation. In addition, in the literature on the subject, you can find publications on the level of enterprise maturity in relation to Industry 4.0 while attempts to assess the maturity of factories in relation to Logistics 4.0 are not equally developing. In addition, the previously presented and used maturity assessment models related to Industry 4.0 indicate that the level of development in relation to the concept is quite low. Many enterprises are unable to fully adapt to the of the concept assumptions, which is required to increase the use of Industry 4.0 solutions and increase the efficiency of many processes performed by companies (Schumacher et al., 2016).

The major purpose of this paper is building a model for assessing the maturity level in relation to Logistics 4.0 assumptions in order to investigate the level of Polish enterprises' development. Created model can also contribute to the growth level of maturity of Polish enterprises with reference to components of the Logistics 4.0 concept. On the basis of the assessment of a selected group of Polish companies, a maturity assessment model for the processes implemented by them in relation to the Logistics 4.0 assumptions was created. Companies were investigated in relation to

Management, Information processes and Material flow. Presented in this paper model was created according to pilot research and will be developed in the future.

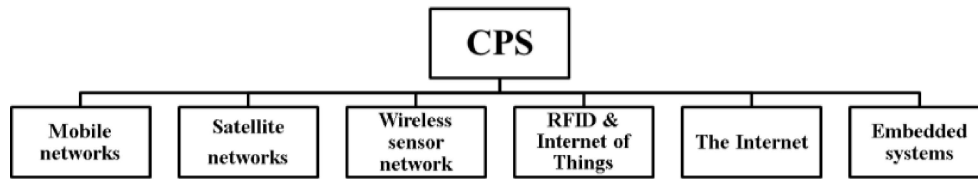
The presented article contains the most important aspects comparing and diversifying the concepts of Industry and Logistics 4.0. In the further part of this paper, the reasonableness of the maturity assessment model creating was determined in the context of the system's maturity models used in the literature. In the subsequent stages, the methodology of the conducted research was indicated, as well as their results and conclusions, indicating the necessity of further development of the model based on a larger test sample.

2. INDUSTRY 4.0

The development of particular industry branches would not be possible with no access to an unlimited amount of data. The required information availability led to improving the production planning methods and managing human resources, materials, or the material flow in a production process. The industry development that has been taking place in recent years is called the Fourth Industrial Revolution (Gubán & Kovács, 2017).

When defining the Industry 4.0, it should be noticed that the concept is intended to decentralise the course and control of production processes what ensures the possibility of their self-regulation. The Industry 4.0 task is to provide a digital support to products during all their life cycles. This support is referred not only to designing, manufacturing and management processes but is also related to the product reuse processes and thus, to reverse logistics and recycling (Bauer et al., 2018). As part of the objectives fulfilled as accompanied by the Fourth Industrial Revolution, it should be might additionally distinguish: communication between all the system participants, exact adaptation of production and provided services to a customer's requirements, fulfilment of highly efficient processes in terms of their elasticity and ecologicality or the application of self-learning machines that fulfil processes in an enterprise (Odważny et al., 2018). It is an idea that envisages the full automation of manufacturing processes, data analysis and information exchange between machines and employees and the use of modern digital technologies that make it possible to form Cyber-Physical Systems (Stăncioiu, 2017; Piątek, 2018). The CPS system controls physical processes that are fulfilled in the enterprise and enables communication among employees, machines and products. The system also makes it possible for individuals to make autonomous decisions (Gubán & Kovács, 2017; Stăncioiu, 2017). Such systems connect the virtual world with reality which leads to full synchronisation of information flow related to both physical manufacturing processes and virtual data processing (Hofmann & Rüsçh, 2016). In Figure 1, there are CPS components presented.

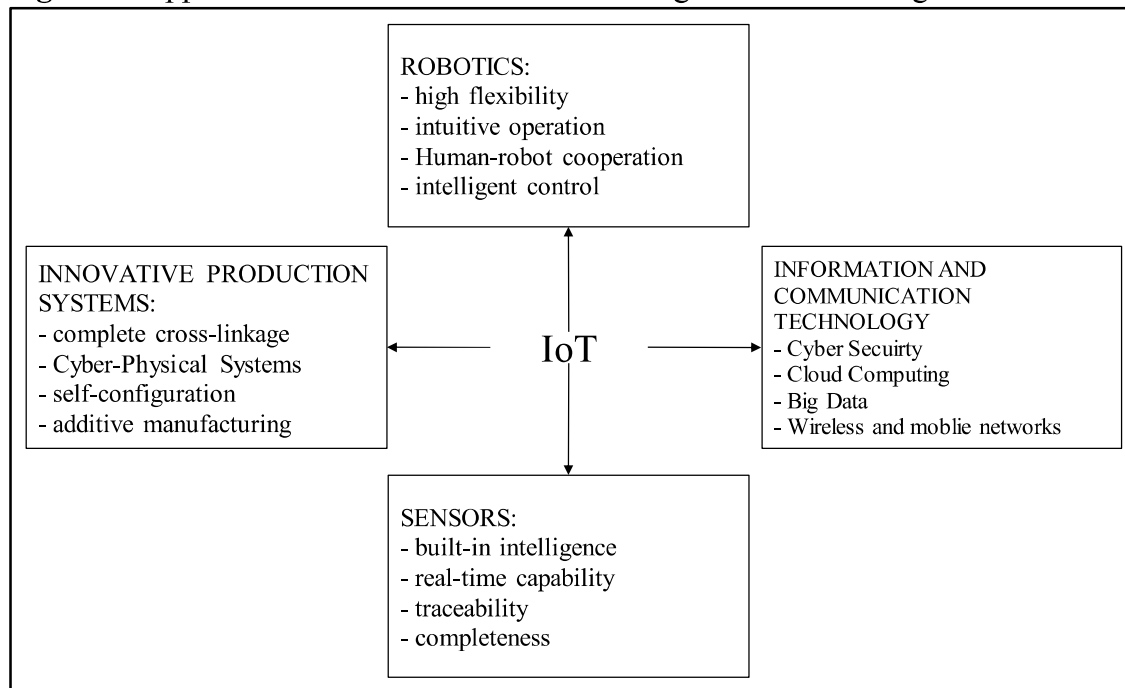
Figure 1. The main components of Cyber-Physical Systems



Source: Abosaq et al., 2016.

The next Industry 4.0 component is the Internet of Things which uses means of communication network (mostly frequently the Internet) so as to exchange and process data between objects, devices and machines which collect information on performed processes. (Stăncioiu, 2017). The Internet of Things makes it possible not only to exchange data within an enterprise but is also responsible for communicating with the supply chain partners (Tsuguio Okano, 2017). In Figure 2, there are the Internet of Things application areas presented.

Figure 2. Application areas of the Internet of Things in relation to logistics activities



Source: Hülsmann, 2015.

The IoT technology application ensures that it is possible to control the processes fulfilled by the enterprise which results in increasing the effective resource use (Gubán & Kovács, 2017).

In the Industry 4.0 concept, it should be additionally distinguish a variety of technologies that support the Fourth Industrial Revolution development. These technologies include: machine-to-machine communication, artificial intelligence, horizontal and vertical system integration, big data, cloud services or cloud computing, cyber security and virtual reality (Gubán & Kovács, 2017; Schlund & Baaij, 2018).

3. LOGISTICS 4.0

To define Logistics 4.0, it is necessary to notice similarities in both concepts. The Fourth Generation Logistics is based on the Industry 4.0 rules but certain significant differences should be noticed as they are necessary to identify the Logistics 4.0 assumptions correctly. The Logistics 4.0 notion is focused on moving away from logistics oriented only to IT equipment and logistic infrastructure in order to concentrate on ensuring customers so-called smart services within supply chains, while Industry 4.0 concept is mainly referred to production area (Timm & Lorig, 2015).

With reference to changeable customers' requirements and a higher complexity of fulfilled processes, it was also necessary to improve and develop the processes of planning, control and performing such actions as warehousing, transport, production, resource management and inventory management (Barreto et al., 2017).

Logistics 4.0 aims at ensuring all customers products and services exactly adapted to their needs in the possibly fastest way. In this concept, one used Industry 4.0 tools supported by modern technologies that are purposefully developed for digital logistics. It is essential to have a permanent interconnection of the IT systems of suppliers, producers, logistics operators and transport enterprises what enables constant monitoring and real-time data exchange ensuring the supply chain processes to be efficiently fulfilled (Kunz, 2016). The Industry 4.0 development also had an influence on forming new functioning rules of logistics itself and particular supply chain elements (Bujak, 2017).

In principle, Logistics 4.0 means a continuous exchange of very large amounts of data between enterprises in the supply chain. In a slightly narrower scope, a number of autonomous and mutually cooperating and communicating systems within fulfilled processes are specified in this concept. According to the process approach, Logistics 4.0 means all processes fulfilled within the supply chain. But in the technical approach, this concept means all kinds of devices and technologies that facilitate the processes taking place between companies in the supply chain (Szymańska et al, 2017). The Internet of Things utilization makes it possible to have easier and autonomous communication between the system machines, devices and users. This also leads to transferring part of employees' duties to the functioning of modern machines (Barreto et al., 2017; Goosens, 2017).

The Logistics 4.0 concept is linked to such notions as Smart Services and Smart Products, which might be generally named as Smart Logistics. Smart Logistics is a logistic system that is capable of improving the conducted action elasticity and synchronising them with market requirements in order to improve the relationship with customers.

As accompanied by technological changes related to the process digitation, it is required to change the method of providing logistic services in designing, planning, managing or fulfilling logistic processes. This is a response of Logistics 4.0 to the Fourth Industrial Revolution (Maslarić et al., 2016).

The logistic process digitization is predominantly linked to the possibility of localising and gaining information related to goods in transit. The transparency of data disclosed by particular enterprise activity areas is a very significant factor that

influences the digital transformation fulfilment possibility what enables goods to be autonomously transported by respective transport units. This predominantly enables almost immediate satisfaction of customers' needs and the competitive advantage obtainment at the same time. With respect to organisational processes in logistics it should be also mentioned that the digital transformation ensures a greater autonomy of decisions made by particular companies in the supply chain (Schuh et al., 2017).

The tools used by enterprises in the Logistics 4.0 concept might include:

- RFID (Radio Frequency Identification), a technology that uses radio signals to wireless reading of information on goods or services put on labels (Palonka, 2007),
- RTLS (Real Time Locating Systems), real-time localisation systems used to identify objects at a given moment (Cyplik & Patecki, 2011; Dźwiarek, 2015),
- Cyber-Physical Systems that make it feasible to be fully integrated as in case of Industry 4.0 where two worlds: the real and virtual one are integrated. In Logistics 4.0, the CPS system consists of such elements as: machines, devices, objects, products, users and systems of warehousing, transport and picking that digitally cooperate with each other based on the ICT (Bauer et al., 2018; Basl, 2016),
- The Internet of Things and Services that makes it feasible to constantly monitor and control each products or service in the entire supply chain. A constant data exchange between the logistic supply chain participants is favourable to conducting analyses and measures that have an influence on making accurate decisions (Oleśków-Szlapka & Lubiński, 2016; Cedeño et al., 2018).
- Big Data is a source of analyses conducted without human intervention what enables increasing the fulfilled actions efficiency and prevent problems that might interrupt the processes performed in the supply chain (Oleśków-Szlapka & Lubiński, 2016).

The specification of tools applied in Logistics 4.0 was reflected in the enterprise maturity assessment model presented in this article as one of the factors that determines the degree of how its assumptions are fulfilled.

In this article, it should be also mentioned advantages and disadvantages of Logistics 4.0 shown in Table 1. The main Logistics 4.0 advantage is the possibility to adjust a product or service exactly to their customer's requirements in the shortest time by applying the latest technologies, such as 3D print or a Digital Twin that enable production of a ready-made product with no time-consuming phase of preparing prototypes. This seems to be a breakthrough factor that determines the final consumer's satisfaction from the viewpoint of elasticity and lead time (Domingo Galindo, 2016; Gubán & Kovács, 2017).

Table 1. Advantages and disadvantages of Logistics 4.0

The advantages of Logistics 4.0	The disadvantages of Logistics 4.0
Full integration of reality and virtual world	High implementation cost
Opportunity of real-time communication between system users, machines and other systems	Strict requirements concerning advanced IT hardware implementation

Improvement of all the processes performed in supply chain	Strict requirements concerning implementation of process-oriented management methods (i.e. Just in Time or Lean Management)
Opportunity of lead times decreasing for products and services directly responding to customers' needs	Requirements concerning implementation of Industry 4.0 technologies
Decrease in cost of product design thanks to implementation of Digital Twins	Problems with availability of data with no methods to process them with
Decrease in risk of structural or organizational mistakes in processes performed	
Availability of advanced technologies for analysis of unlimited amount of data	Novelty of the approach and low level of awareness among companies
Increased performance and availability of machines and operators	
Opportunity to make autonomous decisions by all the system users	Strict requirements concerning integration of company's sub-systems or supply chain elements
Increased visibility and flexibility of supply chains	

Source: Oleśków-Szłapka, Stachowiak, 2018.

The benefits related to the Logistics 4.0 concept implementation include the optimisation of all fulfilled processes, the increase in the efficiency of conducted actions, the increase in the time availability of machines and employees by autonomous actions undertaken by each system user and also the increase of efficiency of actions conducted in the enterprise. Logistics 4.0 concept creates the opportunity to transfer part of employees' duties to autonomous machines and this leads to increasing the quality of produced goods or provided services (Gubán & Kovács, 2017).

4. THE ENTERPRISE MATURITY MODEL IN RELATION TO LOGISTICS 4.0

The sake of presenting the maturity assessment model in relation to Logistics 4.0 in this article the notion of maturity should be defined. The maturity is defined as "a systematic improvement of the organisation abilities and its internal processes in order to obtain higher efficiency in a given period of time" (Kosieradzka & Smagowicz, 2016). A mature system is a perfect organisation, an enterprise that is able to fulfill all processes in line with previous plans. This results in increasing the efficiency of conducted actions at a satisfactory level for the enterprise (Wójcik, 2016; Kalinowski, 2017).

It should be mentioned here that the maturity of the organization is often considered in relation to the models of process maturity. Models of process maturity are used to determine the ways of implementing processes that enable achievement of goals set by the company and which support the organization in increasing the efficiency of performed activities. Maturity models also allow for an analysis of the current state of maturity of the enterprise along with an indication of future status (Kalinowski, 2017). According to another source, the maturity models consist of appropriate tools and actions to assess the company's skills in relation to management processes. System maturity can be defined as gaining of consecutive levels of its

development. These models also allow to improve processes affecting the implementation of the intended goals. The concept of maturity models can also be understood as the process of implementing the most important activities under various activities carried out by the enterprise (Kosieradzka & Smagowicz, 2016). Maturity models enable a comprehensive assessment of the company's operations, and also allow to identify the most important processes whose correct implementation affects the increase of the organization's efficiency. The organization's maturity model should indicate solutions that contribute to the greatest extent to profits, as well as allowing to take a significant competitive position on the market (Kosieradzka & Smagowicz, 2016).

According to the literature review there are many maturity models created for different purposes. The most commonly used models are CMM (Capability Maturity Model) and CMMI (Capability Maturity Model Integration) models (Kalinowski, 2017). CMM and CMMI models are often the basis of many other models. CMM supports the increase in the efficiency of enterprise processes by determining the level of maturity and indicating activities leading to higher levels. The CMMI model is an extension of the CMM model, it is a tool used to assess the maturity of all business processes implemented by enterprises. Both models assume the creation of five maturity levels, where under the lowest level processes are characterised by low degree of structuring, while in the case of the fifth level, the processes are fully structured and improved continuously (Paulk et al., 1993; Gałuszka, 2011; Kosieradzka & Smagowicz, 2016).

In addition, it should also be mentioned that the CMM model assumes the indication of key areas of the company's activity due to the level of maturity achieved. These areas vary depending on the stage of maturity and the company's activity. However, it is important that increasing the effectiveness of actions in each of the key areas contributes to achieving the objectives set by the organization (Kosieradzka & Smagowicz, 2016).

The previously created maturity models were mostly related to the Industry 4.0 concept (Schumacher et al., 2016; Schuh, et al, 2017; Bibby & Dehe, 2018), however, also those related to Logistics 4.0 can be found in the literature (Oleśków-Szlapka & Stachowiak 2018; Gajšek & Sternad, 2018).

Referring to the commonly used models of system maturity as well as available in the literature on the subject models that refer to the concept of Industry and Logistics 4.0, it was decided to build a model with five levels of maturity defined on the basis of three groups of criteria. Created model is dedicated to both companies that implemented Logistics 4.0 assumptions with a success and also to that enterprises that do not perform highly integrated processes. Maturity assessment model created in relation to pilot research ought to be improved in the future so as to allow not only Polish but World Companies constant development contributing to logistics processes effectiveness and customer satisfaction increase.

With reference to the model created for this paper, subsequent levels of maturity refer to the level of enterprise development due to specific criteria required for effective implementation of the Logistics 4.0 assumptions. Authors decided to use the constructed model to assess the maturity level in relation to Logistics 4.0 due to the fact that the system readiness to implement innovations in new technologies and

management might be stated when the system has become mature. It should be mentioned in this place that the implementation of the Fourth Generation Logistics rules is based not only on implementing the latest technologies but also on modern information exchange and decision-making processes (Tetlay & John, 2009).

As regards to the most significant Logistics 4.0 elements, not only technological innovations as self-dependent machines which make autonomous decision but above all information technology systems play an essential role. The information technology systems are responsible for communication among employees and making common decisions in supply chains. The application of modern Cyber-Physical Systems supported by such tools as the Internet of Things is necessary for communication purposes. These tools make it possible not only to have full communication between users but also to make common decisions in the entire supply chain. In addition, it seems to be significant to make use of methods to analyse large amounts of data that autonomously indicate the possibly best decision. A crucial matter is also to use modern solutions related to data storage and processing which make it possible for users to access their own data at any place with the Internet access and the entitled business partners' insight into certain information. At this point authors also mentioned the enterprise management supportive systems that support the management of all its departments and particular systems responsible for warehousing and supply chain management processes. It is necessary to ensure a full integration of management systems not only within one company but also in the entire supply chain. This will certainly lead to the possibility to autonomous decisions making adapted to their customer's needs and contribute to increasing the elasticity of performed actions.

5. RESEARCH METHODOLOGY

The first stage of the constructed model was linked to assigning a rating in percentages to the investigated enterprises with regard to advancement degree of their fulfilled processes in relation to the Logistics 4.0 assumptions. The values in percentages differ from one another solely in terms of the number and the content of answers to certain questions. If there were only two answers envisaged by a question, 100% were given for answer "Yes" and 0% for answer "No", respectively. Such a situation was in the case of questions only related to implementing certain tools. As regards to the level of automation and robotisation of processes fulfilled in the enterprise activities, there were the following answers to choose: "Lack of automation" (0%), "Partial automation" (50%), "Full automation" (100%). If there were a few answers to a given question to be chosen, 0% was given if none of the answers was chosen, 20% – if one element was marked and 100% – if all elements were marked. In order to enable comparison of all the questions from three analysed areas, weights were assigned to the questions. The sum of weights was 1. The weights were specified in consultation with a group of experts on logistics. A cumulative rating of each investigated area is maximum 100%. If an enterprise got the maximum rating in all the considered areas in the model, it should be acknowledged to be mature in terms of the Logistics 4.0 implementation, and, as a consequence, also ready. It was assumed for the sake of the constructed model that an enterprise is almost fully ready

to have Fourth Generation Logistics tools implemented, if it obtained 75% of points from each area or the obtainment of an average value from 3 investigated problems is at the level of 80%. Thus, it was acknowledged that a cumulative assessment of all areas made it feasible to state whether an enterprise might be considered to be mature in relation to Logistics 4.0 or it is not sufficiently mature with respect to the assumptions of the concept. In Table 2, one presented the issues used in the maturity assessment model with assigned weights within the expert panel.

Table 2. Issues and weights of the maturity model

	ISSUE	WEIGHT
MANAGEMENT AREA	Utilization of ERP systems	0,3
	Utilization of WMS systems	0,1
	Utilization of Just in Time	0,1
	Utilization of SCM systems	0,5
PHYSICAL PROCESSES AREA	Automation of production	0,3
	Automation of warehouse processes	0,1
	Automation of internal transportation	0,2
	Robotization of processes	0,4
INFORMATION FLOW PROCESSES AREA	Utilization of RFID	0,05
	Utilization of RTLS	0,1
	Real-time data access	0,25
	Awareness of concept of Internet of Things	0,05
	Data analysis technologies	0,25
	Awareness of concept of Big Data	0,05
	Cloud Computing technologies	0,25

Source: own work

The model developed in this article was used to assess the maturity of 17 selected Polish enterprises in relation to Logistics 4.0. Cumulative ratings were specified in terms of 3 analysed areas and an average enterprise maturity assessment based on the given ratings and specified weights. This made it feasible to order the enterprises ratings to one of the five maturity levels of the constructed model as presented in Table 3.

Table 3. Logistics 4.0 maturity models

Area rating/Average rating	Level	Characteristics
Under 50% in each area or average under 60%	0	The company is characterised by a lack of maturity in relation to Logistics 4.0 assumptions, it does not perform the requirements in any examined area, it is characterised by low process maturity. The company does not recognize the need of integration in relation to Logistics 4.0. It cannot be considered as ready for the concept requirements.
Over 50% in each area or average above 60%	1	The company is characterised by low maturity in relation to Logistics 4.0 assumptions, the probability of effective implementation is close to zero. The company recognizes the benefits and the need of integration in relation to the Logistics 4.0 but does not take actions towards increasing the level of maturity. It cannot be considered as ready for the concept requirements.
Over 60% in each area or average above 70%	2	The company is characterised by a partial maturity in relation to the Logistics 4.0 assumptions, the probability of effective implementation increases. The company recognizes the benefits and the need of integration in relation to the Logistics 4.0 by implementing some of the assumptions of Logistics 4.0. It cannot be considered as ready for the concept requirements.
Over 75% in each area or average above 80% (both less than 100%)	3	The company is almost fully mature in relation to the implementation of the Logistics 4.0 assumptions. The company implements most of the solutions in the field of Logistics 4.0 effectively. The probability of implementation effectiveness is close to 100%. The company can be considered ready for the concept.
100% in both (each area and average)	4	The company is fully mature in relation to the implementation of the Logistics 4.0 assumptions. The company implements most of the solutions in the field of Logistics 4.0 effectively. The probability of implementation effectiveness is 100%. The company can be considered fully ready for the concept.

Source: own work.

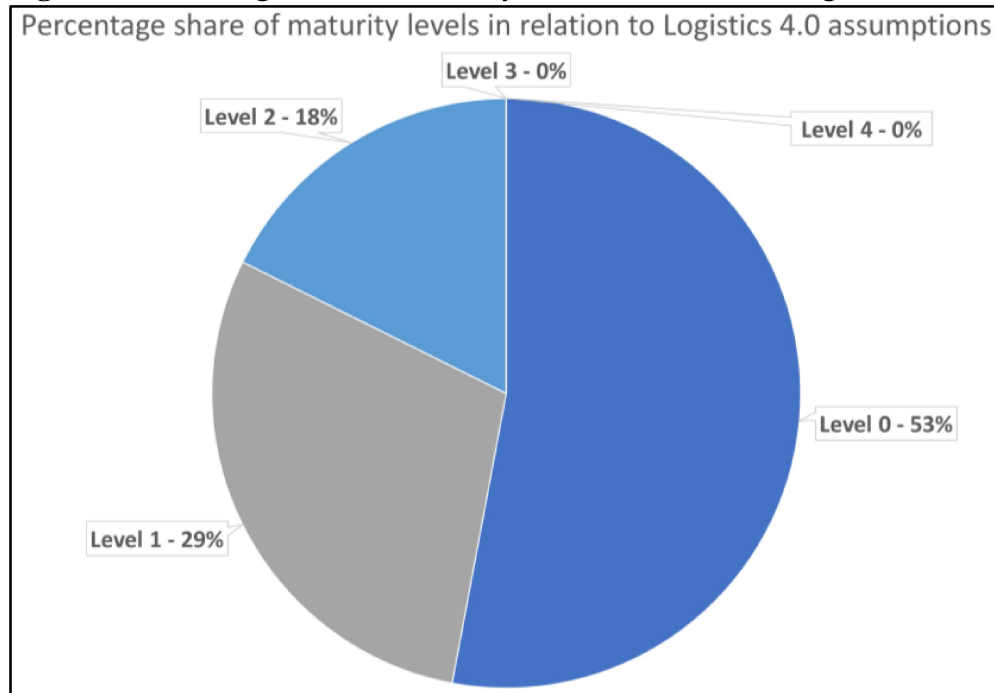
The enterprises, which were given a rating over 75% in each of the investigated areas or an average rating at the level of 80% were considered to be nearly fully mature and those which were given an average rating (as well as in each of the investigated areas) 100% were considered to be fully mature. Contrary to them, the enterprises, which were given a rating below 50% in each of the investigated areas or an average rating below 60%, were considered to be immature.

6. RESULT ANALYSIS

In the pilot study for the sake of this article in there have participated 17 random enterprises from the production industry. The ratings and weights applied to the developed assessment model made it possible to give a number of mature enterprises in relation to the Logistics 4.0 assumptions. None of the investigated enterprises achieved the fourth, highest maturity level as well as the third level which also pointed out that the enterprise could be described as nearly fully mature. As many as nine

enterprises achieved the lowest – zero maturity level which was 53% of the investigated enterprises. Only three Polish enterprises achieved the second maturity level which was 18% of the investigated enterprises whereas five enterprises achieved the first level of maturity.

Figure 3. Percentage share of maturity levels in relation to Logistics 4.0 assumptions



Source: own work

It might be stated based on the model constructed for the sake of research that minor part of the investigated enterprises factually knows and fulfills the Logistic 4.0 assumptions. This model needs to be assessed based on a greater number of analysed enterprises what would enable obtainment of more precise results and, as a consequence, would contribute to this concept development in Poland. The research should be developed in order to investigate a broader scope of enterprises based on a stratified sample. Thus, such factors as a brand, enterprise size, involvement of foreign capital should be regarded in order to specify a real maturity level in relation to Logistics 4.0. This would have its impact on the concept development strategy formation.

It should be noticed that construction of this model is a favourable process in terms of enterprises of various industries in Poland due to the fact that it is possible to investigate the real knowledge and awareness of using modern solutions related to technology and also to supply chain integration. It seems to be obligatory to recognise the maturity level of Polish factories and implement modern Fourth Generation Logistics solutions what might be soon decisive about the competitive position held by Polish enterprises compared to foreign enterprises. The existence of some enterprises might be conditioned by the recognition and implementation of the latest technologies that make it feasible to deliver products precisely meeting customers' needs at the required moment. Therefore, it should be stated that the implementation

of modern Logistics 4.0 solutions will soon be a required and decisive condition that will determine the enterprise market position.

7. CONCLUSION

In this paper, one constructed the model of assessing the maturity level of Polish enterprises in relation to the Logistics 4.0 assumptions based on models of system maturity assessment operative in the literature. To investigate its functionality, one analysed a group of random enterprises from the production industry in terms of applying the Logistics 4.0 technology and assumptions. One formed 3 research scopes related to the area of management processes, physical processes and also information processes fulfilled by the enterprises. Based on the given ratings and weights determined by the expert panel, one specified a cumulative rating of each area. The conducted research showed that none of the investigated enterprises achieved the highest maturity level in relation to the Logistics 4.0 assumptions. This results in a small number of Polish factories that efficiently implement and fulfill processes within this concept. It should be also noticed that this model was used to assess the enterprises in the pilot study and therefore, it is necessary to conduct further analyses based on a larger research sample with respect to additional factors. They might considerably influence the enterprise maturity level. The research sample increase is necessary to ensure the tests to be appropriately reliably and objectively conducted.

The model created for the purpose of the paper will be addressed in the future both to enterprises that effectively use the tools in the scope of Logistics 4.0 as well as to those that have not yet implemented the assumptions of the concept to performed processes. The performed research led to drawing a conclusion that it was necessary to know a real maturity level of Polish enterprises. This level would predominantly enable specification of the development stage of the Logistics 4.0 concept and contribute to further concept development. Both the Fourth Industrial and Logistic Revolution seems to be unavoidable and consequently, will soon influence the market position held by particular enterprises. Therefore, it seems that the Logistics 4.0 implementation in industrial and logistic activities will be necessary and have a decisive impact on the existence of particular enterprises in their industry. Moreover, Polish enterprises are required to constantly investigate and advance the technological development level of Polish factories which make it feasible not only to develop and expand the entire market but also to compete with the strongest foreign enterprises which fulfill the Logistics 4.0 assumptions efficiently. The further development through the implementation of Logistics 4.0 tools is feasible only through identification the real level of maturity of Polish enterprises in relation to the concept and adjusting the improvement activities depending on the level achieved by companies as a result of the usage of the created model which ought to be improved in further research

8. ACKNOWLEDGEMENT

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