OPPORTUNITY FOR DEVELOPMENT OF SMALL AND MEDIUM METALLURGICAL ENTERPRISES WITHIN THE CONCEPT INDUSTRY 4.0

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Abstract

The new Industry 4.0 concept gives new development opportunities to large enterprises. It allows you to build a competitive advantage in the market and significantly increases their competitiveness. However, a question arises as to what about small and medium enterprises? They have incomparably less opportunities to raise capital to modernize and automate their infrastructure. They are unable to create together fully automated factories of the future.

The article attempts to identify the possibilities of building production networks by small and medium-sized enterprises, which will be able to jointly create modern factories as part of the Industry 4.0 concept. This creates many new opportunities for the development of small and medium enterprises, but it is also a huge challenge. The aim of the article is to identify the most important problems that SMEs have to overcome in order to build modern production networks together.

Keywords: Cyber Industry Network (CIN), metallurgical production network, Industry 4.0, SME's

1. INTRODUCTION

The dynamic development of information technology and modern trends in the management of metallurgical enterprises have contributed to the growth of competition in the global market. Modern companies are forced to continually adapt to growing customer requirements for product quality, shorter lead times for production orders, reduced costs and prices and introduced innovative solutions to gain a competitive advantage in the market [1,2]. Currently in the metallurgical industry there is a very strong competition from developing countries such as China or India. The products which they offer have very low prices compared to European companies. It is not possible very often to produce such cheap products in Europe primarily due to the large labor costs. In order to gain a competitive advantage in the market, a completely new, incomparably more modern and innovative approach to manufacturing and management of a company is needed which dramatically increase productivity and also to help building very fast, efficiently managed supply chains [3,4].

The answer to this challenge may be the concept of the Industry 4.0, which is based on the Internet of Things (IoT), cloud computing and big data. As a result, large, very modern smart factories are created with a very high degree of automation, using the Internet for communication. However, it is a solution dedicated mainly to large enterprises with significant capital, because the costs of modern machines that are able to communicate with each other and automatically respond to received information are very high. Equally large expenditures require specialized software and personnel composed of high-class specialists. Thus, the question arises: What role can small and medium-sized enterprises play in the development of the Industry 4.0 concept in metallurgical industry?

The article attempts to identify the possibilities of building production networks by small and medium-sized metallurgical enterprises, which will be able to jointly create modern factories as a part of the Industry 4.0 concept. This creates many new opportunities for the development of small and medium enterprises, but it is also a huge challenge. The aim of the article is to identify the most important problems that SMEs have to overcome in order to build modern production networks together.

2. MAIN ASSUMPTIONS OF THE INDUSTRY 4.0 CONCEPT

The concept of the Industry 4.0 means that production is dominated by Internet-connected machines. Production data is collected in real time by machines equipped with advanced software and provides real-time error correction. Self-monitoring of machines enables the design of automated supply chains in which delays are detected and regulated so quickly that they hardly ever appear. The combination of all devices with the Internet ensures that the machines and devices are immediately used by the monitoring software and the correct service time is determined. The human influence on the production process is very limited. Machines play a dominant role in all aspects of product manufacturing. The life cycle of products is radically shortened [5,6].

The integral parts of the Industry 4.0 are: automation, Internet of Things, cloud technology, big data, connection and system integration (see **Figure 1**). Internet of Things (IoT) is a system in which all the machines, devices and other physical objects are connected to a central or a cloud-based server though a network (Internet) and has a ability to monitor and control its functioning [7,8]. It is a kind of a network of smart devices or objects which either has built-in wireless connectivity or embedded external sensors, actuators or other mechanism that can collect and transmit information about the objects or the devices. Furthermore, the collected data can be analyzed and processed using big data analytics techniques to optimize any product, services, etc. [8,9].

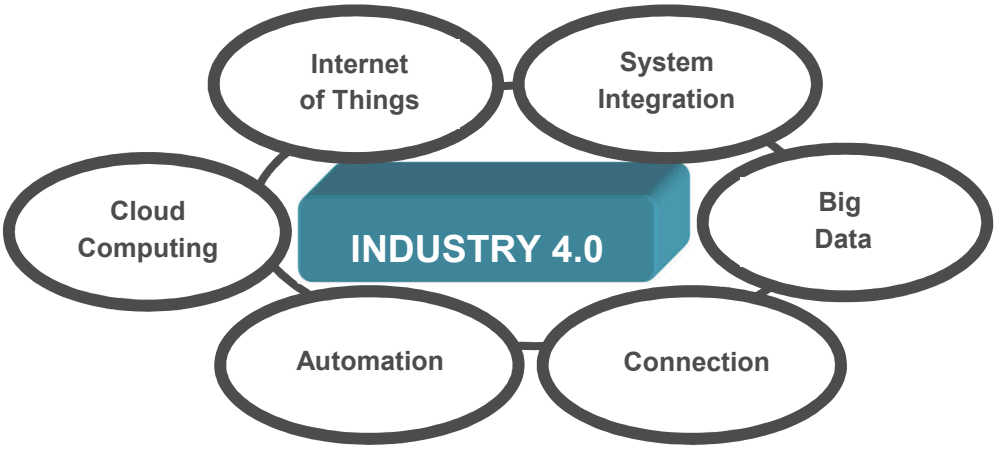

Figure 1 Integrated elements of Industry 4.0

The Internet of Things consists of two key elements: Sensor Network and Cloud Computing. A sensor network is connected with the object or embedded within the object. It is used to monitor, transmit, analyze and record different conditions, which are detected by a sensor node. Each sensor node includes a transducer, microcontroller, transceiver, and a power supply. Such the physical sensations like temperature, pressure, humidity, vibrations, or any vital body functions are detected by a sensor. Then the transducer converts them to an electrical signal and transmits to a microcontroller which processes and stores these all signals. The transceiver receives a command from the central server and send stored information to the central server for analyzing. All the information and data from these devices are stored in a central cloud server. In this place they can be also shared, computed, and analyzed according to the needs. This information can be accessed from any place in the world by using laptops, smart phones, tablets, etc. [8,10-11].

3. CHARACTERISTIC OF PRODUCTION NETWORKS

The functioning of production networks has been observed on the market for several years, most often in the form of clusters. Business partners establish long-term or temporary cooperation with other stakeholders, thus creating network organizations to reduce costs and exploit business opportunities unachievable for each of

these enterprises separately. The largest clusters on the market are companies from the industry sector, such as automotive (Detroit, Toyota City, southern Germany, Slovakia), pharmaceuticals (Basel, New Jersey), watchmaking (Switzerland) and aviation (Seattle, Montreal, Toulouse). The most well-known is the Silicon Valley cluster in Northern California, where thousands of companies operate in the high tech sector. Clusters are becoming increasingly popular also in Poland and other European countries. Very often they are created in the vicinity of strong academic centers, which have adequate resources of human capital and research facilities. Very often, clusters have a cross-sectoral character, i.e. include both production companies as well as specialized institutions providing services to a cluster of entities such as research and development institutions, capital funds, corporate marketing, analytical, training, etc. [12].

The cluster concept is an important element of the European Union's economic policy - the priority strategy 'Europe 2020', which includes [13]:

- smart development - development of the knowledge-based economy and innovations;
- sustainable growth - supporting a more resource efficient, more environmentally friendly and more competitive economy;
- inclusive growth - supporting a high-employment economy that ensures social and territorial cohesion.

The creation of clusters and their subsequent functioning is associated with many problems. In Poland, these are mostly soft barriers (nature of mentality). One of them is the low tendency of Polish enterprises to cooperate with each other and with the sphere of science and the business environment. Such reluctance is mainly due to the lack of trust between business partners and the dominant culture of misunderstood predator competition. Companies do not see the possibility of joint development or cooperation opportunities as an opportunity to improve the competitive position of a single company [14,15].

In the current situation, when the Industry 4.0 concept gives completely new opportunities and pressure to introduce its assumptions is growing, the approach to creating production networks can change significantly. SMEs in metallurgical industry have a problem to adapt their technical infrastructure to the needs of large modern smart factories. For this reason there is a good chance to create new production networks. They will be much more willing to try to enter into completely new supply chains and will create production networks for future exclusion. The experience related to cluster forms can be used to build smart factories in the form of production networks.

4. THE IDEA OF THE SMART FACTORY BUILDING AS A PRODUCTION NETWORK - PRELIMINARY RESEARCH RESULTS

The Industry 4.0 concept can be a great opportunity for development for small and medium enterprises. However, they must cooperate together and jointly build modern factories in the form of production networks. Technologies and technical infrastructure used by Industry 4.0, give much greater opportunities to create production networks. Such a solution primarily enables the specialization of SMEs in the performance of individual processes and, despite the small capital, it can guarantee participation in a modern, fully automated supply chain [16].

The idea of a production network called the **Cyber Industry Network (CIN)** means the manufacturing of joint production orders using fully automated processes of individual network partners, in which communication takes place via the Internet, and the necessary data is stored in the cloud (cloud technology) [17,18]. This enables constant access of all participants of the network to selected, necessary information from anywhere in the world. Thus, the chance for development arises in creating a partnership consisting in the combination of specialized competencies and ability to change in order to better meet customer expectations and enable effective acquisition of competitive advantage in the market. The schema of the Cyber Industry Network (CIN) is presented in **Figure 2**.

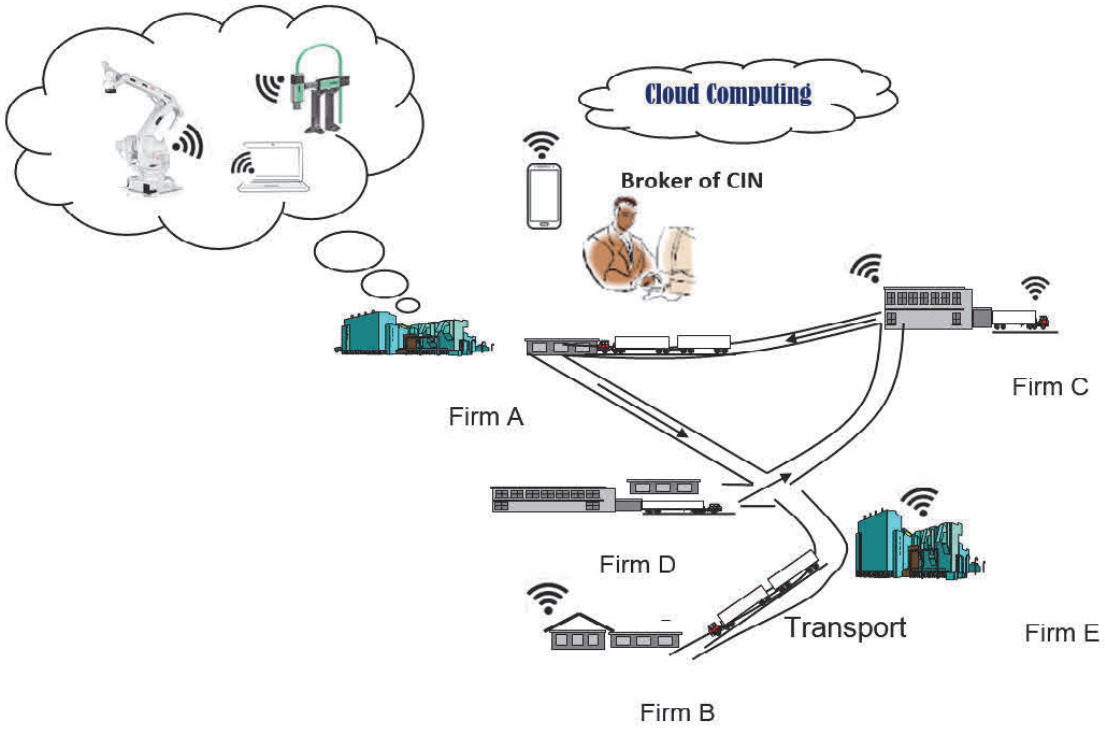

Figure 2 Schema of the Cyber Industry Network (CIN)

The main goal of research is to develop a procedure for creating Cyber Industry Networks (CINs). The current preliminary research stage consisted in identifying barriers related to the creation of CIN. Therefore, an survey was conducted among the management staff of randomly selected enterprises belonging to the metal clusters in Poland. The results of preliminary study are presented in **Table 1**.

The authors of the article propose to develop the standards which help to create and manage of the Cyber Industry Networks on the basis of simple rules. The broker is a person which is responsible for complying with such standards. He also deals with the organization, management and eventual liquidation of the CIN. The broker accepts and acquires orders for the network and distributes tasks for individual network partners. Each order is treated as a separate project.

Table 1 Main barriers of the Cyber Industry Network building - results of preliminary research (own study)

Position	Barrier	Percent of answers
1	The lack of technical infrastructure required in the Industry 4.0 concept	92%
2	No specialized software	78%
3	The risk associated with unfair partner practices	48%
4	No entry and exit procedures from CIN	46%
5	No specific procedures of settlement for network partners	42%
6	Unclear rules of the network functioning	38%
7	No ethical rules regarding the flow of information and their disclosure	21%
8	No clear rules for cooperation with non-network partners	11%

On the basis of the conducted survey results six standards of creation CIN were identified:

1) technical solutions which allow communication and functioning as a smart factory of several partners;
2) clearly defined procedures for joining and leaving CIN;

3) settlement within CIN;
4) the organizational structure of CIN;
5) applying good practices (ethical rules of cooperation and counteracting unhealthy competition);
6) principles of cooperation with non-CIN partners.

5. CONCLUSION

Implementation of the Industry 4.0 concept is associated with the need to have significant capital for technologically advanced infrastructure, specialized software and highly skilled personnel. For the group of small and medium enterprises, this is an important barrier that prevents creation of smart factories independently. However, this sector can create production networks and jointly execute production orders as a group of specialized independent entities using the competences and capabilities of each partner.

The article proposes the creation of the Cyber Industry Networks, in which a group of small and medium-sized metallurgical enterprises can jointly execute production orders, which far exceed the capabilities of each of them. The broker plays an important role in CIN. His main task is organization of the network, its management and eventual liquidation.

CIN uses the high specialization of its partners and enables the creation of alternative units for smart factories. Network partners communicate with each other using the Internet, cloud technology and big data. The development of CIN operating standards increases the trust of joint manufacturing partners and creates clear, simple rules of functioning as a network. The barrier resulting from the inability to acquire large capital needed to implement the Industry 4.0 concept disappears by combining the possibilities and competences of many small and medium enterprises.

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