

THE CONCEPT OF UTILIZING SMES NETWORK E-BUSINESS PLATFORMS FOR CUSTOMISED PRODUCTION IN THE INDUSTRY 4.0 PERSPECTIVE

Sebastian SANIUK

University of Zielona Gora, Faculty of Economics and Management; s.saniuk@wez.uz.zgora.pl,
ORCID: 0000-0002-9014-036X

Abstract: The Industry 4.0 era results in changes in both the way of company function and changes in customer expectations for products offered on the market. The use of modern ICT has allowed the creation of cyber physical systems based on intelligent machines and devices that communicate with each other in real time and are the basis for the development of the Industry 4.0 concept. The modern consumer expects products of high quality and low price tailored to his/her needs and wants. These expectations can be met by using the potential of specialized enterprises, centered around e-business platforms, which will be able to combine their resources to produce personalized products. The main aim of the article is to present the concept of utilizing e-business platforms for supporting the creation of temporary networks of enterprises capable of implementing personalized products in the Industry 4.0 environment.

Keywords: Industry 4.0, Cyber Industry Networks, customization, e-business platform.

1. Introduction

Western Europe's concerns about marginalization of industrial production and capital outflow problems were the main reason for the Fourth Industrial Revolution. It is not like its previous three revolutions that came about as a result of groundbreaking inventions, but it came to be by only making best use of existing ICT technologies and intelligent machines in Cyber Physical Systems. The main assumption of the Industry 4.0 concept proposed by German experts is making best use of: broadly understood automation of production processes; intelligent devices and machines; means of transport that communicate with each other using modern information; communication technologies (ICT) that are capable of collecting, processing and exchanging huge amounts of IT data during the entire production process, while reducing high labor costs. In addition, Industry 4.0 includes utilizing Big Data and Cloud Computing technologies that allow production processes in real time to be monitored.

Furthermore, the combination of ICT technology and Manufacturing Execution Systems (MES) in Industry 4.0 helps to reduce scheduling and control of production, to solve quality problems on an ongoing basis, and above all to reduce the number of employees in the manufacturing processes (Windelband, 2014; Hirsch-Kreinsen, 2014; Pape, and Rannenberg, 2019). Equally important in the development of the Industry 4.0 concept are managerial competences, which are particularly important in the decision-making processes regarding innovation or in changing the modus operandi so that it is focused on business cooperation (Grzybowska, and Łupicka, 2017).

Enterprises operating on the modern market are beginning to understand the need for changes, especially in the area of applying modern ICT technologies and building competitive advantage on the market. A completely new, more modern and innovative approach to production and business management, which will radically increase flexibility, productivity and orientation on customer is needed. Nowadays, customers expect products strictly tailored to their personal preferences, tastes, needs and lifestyle. They want to influence the configuration of manufactured products, but at the same time require a price similar to the products offered in mass production (Yi, et al., 2017; Silveira, et al., 2001). The production paradigm is, thus, changed in favor of customized production, tailored to the needs of individual customers (Lampel, and Mintzberg, 1996).

The need to offer customers highly personalized products at low prices forces enterprises to change their current way of functioning. As a result, there is a greater level of interaction between the company and the customer. Customers are, for example, involved in the process of creating or even final assembly of the product (e.g. IKEA). The effect is the need to build e-business platforms which allow a better interaction between the customer and the producer to be built and to bring about a reduction of production costs which can be obtained thanks to e.g. changing the strategy to make-to-order production, making better use of resources of cooperating enterprises in the network and shifting some tasks to the customer (e.g. co-design, assembly, etc.).

The research conducted in the article concerns the sector of small and medium industrial enterprises, which require special support during the implementation of the Industry 4.0 concept, unlike large enterprises with high development potential. Therefore, there is a requirement to conduct research that leads to the creation of e-business platforms and also to new models of modern networks to realize customized production. The need to organize e-business platforms, gathering on one hand, enterprises capable of joint implementation of customized production and, on the other hand, customers expecting products tailored to their needs is highlighted. The main aim of the article is to present the concept of e-business platform providing support for the creation of temporary networks of SMEs capable of implementing personalized products in the Industry 4.0 environment. To prove the need to develop the platform, selected results of two surveys presenting the orientation of the modern customer to personalized products and listing key problems that may occur when implementing the Industry

4.0 concept in the SME sector were presented, especially in considering the creation of network forms of cooperation.

2. Industry 4.0 and mass customization

The ubiquitous digitization, development of the Internet and the possibility of collecting and processing huge amounts of data in real time generates a situation in which modern enterprises have to increase their competition and introduce digitally supported manufacturing technologies, such as Data Mining, Big Data Analytics or ICT systems that enable machine-machine and human system-machine communication inside a virtual environment of the entire supply chain. According to (Lasi, et al., 2014), Industry 4.0 describes the increasing digitization and automation of the manufacturing environment, as well as the creation of digital value chains to enable communication between producers, their environment and business partners. Using of advanced digitalization, the combination of Internet technologies and intelligent objects (machines and products) in Industry 4.0 results in a new fundamental paradigm shift in industrial production. The vision of future production contains modular and efficient manufacturing systems in which products control the systems (Lasi, et al., 2014). This means the use of intelligent mechatronic products (machines, devices, robots, means of transport, etc.) throughout the entire PLM (Product Life Cycle Management) chain, starting from the creation of a new product concept, to virtual documentation, printing 3D models, laboratory tests, manufacturing product in a virtual production environment and its testing, production of a product in a real environment, development of computer-aided production and assembly documentation, logistics, product delivery to the customer and its service up to product recycling (Olszewski, 2016).

Lu Y. claims that “Industry 4.0 can be summarized as an integrated, adapted, optimized, service-oriented, and interoperable manufacturing process which is correlated with algorithms, big data, and high technologies” (Lu, 2017). The Industry 4.0 concept is oriented towards high resource productivity and guarantees a number of benefits. Its use can lead to reduced production costs, increased production flexibility and greater competitiveness of the company on the market. The Industry 4.0 concept meets customer expectations without degrading the profitability of the production process due to the dynamic adaptation of the autonomous modules of the entire process of preparation, production and delivery of the product to the customer. The basis for achieving this goal is the application of production automation based on the use and exchange of data in real time, using artificial intelligence (AI) (Pieriegud, 2016; Ślusarczyk, 2018; Chui, et al., 2010; Olszewski, 2016).

An important competitive advantage for enterprises is the ability to meet individual customer requirements. Companies have been striving for this competitiveness by applying mass customization (MC) since the 1980s. The term "mass customization" was coined by Stan Davis in his book "Future Perfect" in 1987 (Silveira, et al., 2001). According to Kaplan and Haenlein, MC is a strategy that creates value by the company–customer interaction at the product design, manufacturing and assembly stages to create customized products (Kaplan, and Haenlein, 2006). The MC strategy should ensure sufficient product variety and customization so that almost any customer can find exactly what they want (Pine, 1993). MC requires a lot of flexibility and efficient organization of the production planning and process implementation. However, the problem of meeting growing customer expectations becomes more difficult to solve as the product gains complexity.

Lampel and Mintzberg perceived customization as a particular strategy depending on the degree of customer influence on the product. They proposed pure customization, tailored customization, customized standardization, segmented standardization and pure standardization. Pure standardization means no customization. In case of segmented standardization, firms respond to the needs of different clusters of buyers, but each cluster remains aggregated. Thus, the products offered are standardized within a narrow range of features. Customized standardization means that the assembly is customized. A customer can select from a list of option that are made from standard components. Tailored customization exists when the company presents a product prototype to a potential customer and then adapts it to the individual's wishes or needs. In this case, customization occurs in the fabrication, assembly and distribution phases of the production process. The highest degree of customer interference, at the same time, the most expensive and the most difficult to organize, exists in pure customization. In this case, the customer participates in the design process of the product, and in fabrication, assembly and distribution (Mintzberg, et al., 2003; Lampel, and Mintzberg, 1996). The end result is that the customer receives a unique product.

The last presented strategy is expected by both the customer and the creators of the Industry 4.0 concept. In addition, currently used technologies allow interaction with the customer at every stage of the production process. In these times, the most commonly used strategy on the market is tailored customization and customized standardization. In the first case, the customer has an impact on the manufacturing phase of standard parts, assemblies, components, especially in terms of their dimensions or shapes. In the second case, the customer influences the final assembly by selecting product configuration items. In all cases, it is important that the price of the product is close to the price of products manufactured in mass production or in series production.

3. Research Aim and Methods

The main goal of the research was to assess consumer needs in the area of personalized products and to develop a concept of network production in small and medium enterprises, taking into account these requirements. Critical analysis of the literature and the survey research methods were used to achieve this goal. Selected results of two surveys conducted in 2018/2019 by the author were presented. The first study was conducted on a group of 492 potential consumers – students and family members in various age categories of both the Silesian University of Technology and the University of Zielona Gora. The respondents represented the population of the Lubuskie, Dolnośląskie and Śląskie Voivodships. The main aim of the surveys was to establish current customer needs related to the offered products and also to assess the level of product personalization required by customers. The research looked for the answer to the following question: What are the consumers' expectations in terms of personalized production?

The main goal of the second survey was to identify the major problems in implementing the Industry 4.0 concept as oriented to creating networks of small and medium enterprises. The second survey research was conducted on a selected group of 50 industrial enterprises operating within the SME's sector in Poland. In addition, the purpose of the research was to answer the following questions: What are companies afraid of in establishing network cooperation? What are the technical possibilities of information exchange? What methods of searching for network partners do they prefer? In both cases, the surveys were carried out using the CAWI (Computer-Assisted Web Interview) method.

4. The industry networks based on the Industry 4.0 concept

In the situation of the mass customization and development of the Industry 4.0 concept, each company is perceived as offering an intelligent module for certain opportunities to be used in the production and delivery of the product to the customer, and the size of the enterprise, therefore, ceases to matter. This means great potential for small and medium enterprises that need to invest in new technologies and to strengthen the qualification levels of the employed staff. Small and medium enterprises must also be open to unlimited communication using telecommunication networks and the Internet of Things. In addition, by combining the potential of partners as a network organization, it will be possible to offer more complex, innovative products and services tailored to customer needs (Walters, Buchanan).

The survey we conducted on a selected group of potential consumers brought to light the expectations of modern customers. Over half of the respondents from the total number of respondents declare interest in personalized products. The largest group of respondents showed interest in personalizing clothes and footwear (61.8% of respondents), electronic devices in (39.4%), ordering personalized dishes in restaurants (36%), personalized various types of accessories (31% of respondents), jewelry (24.9%) and home and garden equipment including furniture (24.1% of respondents). Detailed data on buyers' preferences are presented in Fig. 1.

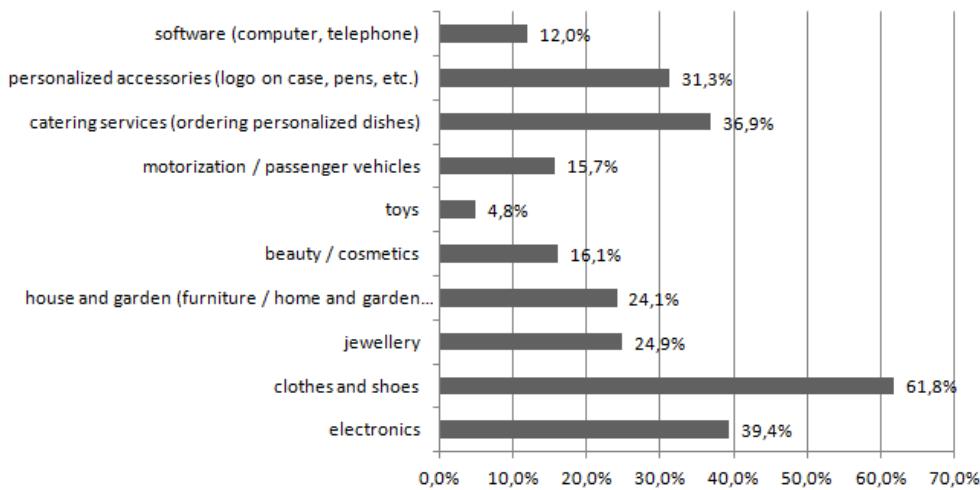


Figure 1. Consumer preferences regarding the type of personalized products. Source: own elaboration.

Only 39% of all respondents were willing to pay more for personalized products, while 57% of all respondents made decisions dependent on the level of price difference between a standard and personalized product and the type of product. Direct contact with the manufacturer's representative (81.6% of respondents) was most often indicated as the preferred channels of contact with the manufacturer, via the use of e-commerce channels (89% of all respondents), while 79.6% of all respondents expected specialized programs for designing personalized products that could be integrated with the manufacturer's system. Less preferred channels were questionnaire, phone or livechat and various types of messengers.

Our research showed the existence of considerable interest in personalized products as created through various customization strategies. Respondents most often, as a reason for purchasing personalized products, indicated they did so because of the uniqueness of the product, their having impact on its final shape / appearance, their having greater satisfaction and gaining greater comfort of use.

That this customer need requires the development and use of new business models (mainly based on e-business platforms), supports the formation of temporary production networks involving small and medium enterprises. This type of production allows an improvement of production efficiency by using material, manufacturing and employee resources of cooperating network partners with unused production capacity (Saniuk, Grabowska, Gajdzik, 2019; Grabowska, 2018). In addition, more complex, innovative products and services tailored to

customer needs can be placed on offer by combining the potential of partners as a network organization (Walters, and Buchanan, 2001).

Industry 4.0 is a big challenge for small and medium enterprises and their future development. Companies must completely change their strategy, create new business models based on network collaboration and overcome many operational and technological barriers. However, in the survey conducted by the author on 50 selected enterprises of the SMEs sector that was related to industrial production, as many as 75% of all respondents stated that they are afraid of too low a return on investment in new Industry 4.0 technologies. Moreover, enterprises are afraid of disloyal network partners (45% of all respondents), difficulties in searching for a viable network partner (41% of all respondents) and a lack of security of data shared on the network (79% of all respondents). Unfortunately, the lack of advanced ERP (Enterprises Resources Planning) or MES (Manufacturing Execution Systems) systems, which are very helpful for automating the process of collecting data in real time, is still a significant problem for small and medium enterprises in Poland. Indeed, 65% of all respondents declare the inability to accurately determine the load of machines and people in real time, and 92% of all surveyed companies declare the lack of Industry 4.0-type technical infrastructure. Furthermore, 90% of all respondents declare the lack of secure IT platforms for the exchange of production capacity that will allow finding a network partner. Unfortunately, this means that these companies have considerable difficulties in implementing the Industry 4.0 concept. However, the situation is gradually improving and awareness of the need to put in place new manufacturing and ICT technologies among Polish enterprises is growing. Currently, the company's participation in the network is increasingly a way to obtain new production orders and a way to build competitive advantage in the market.

According to the Industry 4.0 concept, all enterprises are perceived as offering an intelligent module to use in the production process and in delivering the product to the customer. Meanwhile, the level of used technologies e.g. Cloud Computing, Big Data or IIoT (Industrial Internet of Things), the level of highly qualified staff employed and openness to unlimited communication play a significant role. Enterprises can offer much more by combining the potential of partners as a network organization in the form of more complex, innovative products and services tailored to customer needs (Walters and Buchanan, 2001). The progression of network forms of cooperation requires solving a number of problems related to the formation and management of networks and provides the perfect foundation for the rapid implementation of the Industry 4.0 concept.

The development of e-business platforms that allow the implementation of personalized production based on the resources of the small and medium enterprises centered around the platform is a way of offering a solution to the problems declared by SMEs and of meeting customers' expectations. The e-business platform should support enterprises in creating and managing the Cyber Industrial Network (CIN) in the case of emerging business opportunities requiring the sharing of resources, know-how and specialist knowledge of businesses dispersed

geographically (Saniuk, et al., 2019). A general diagram of the platform's operation is shown in Figure 2.

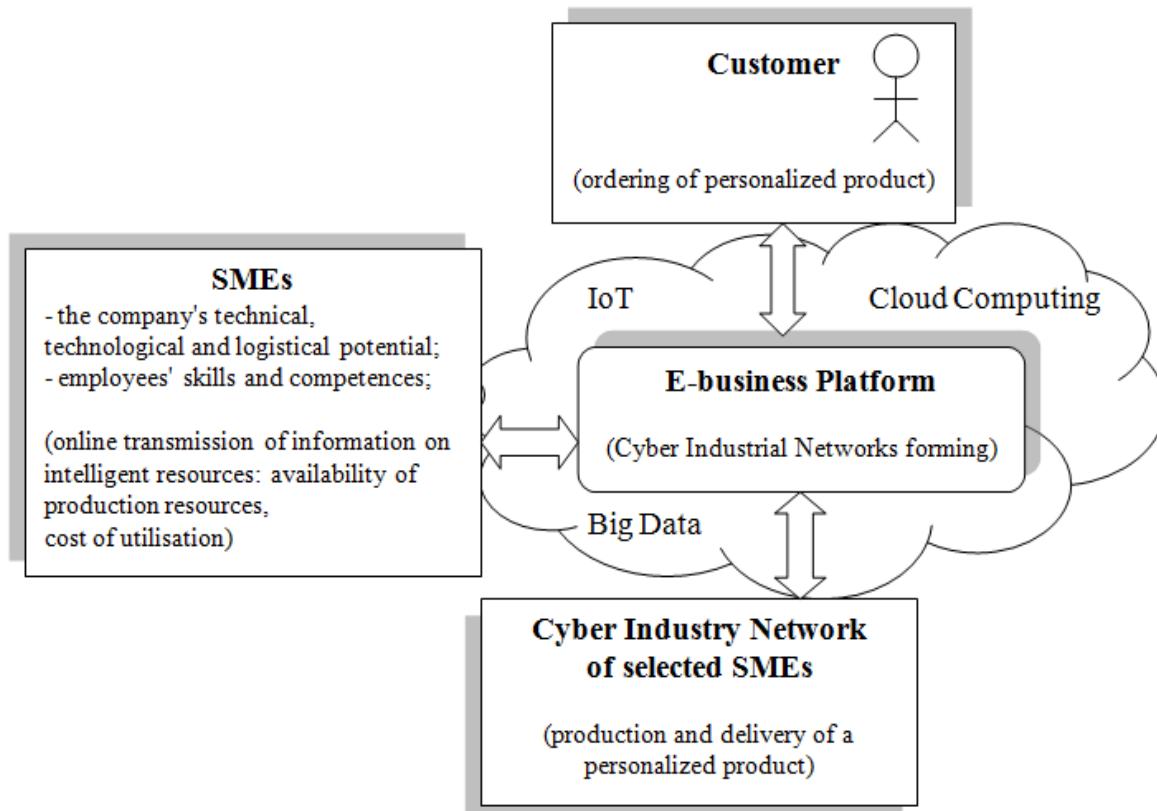


Figure 2. The concept of the e-business platform. Source: own elaboration.

New technologies related to the Industry 4.0 concept allow effective integration of the customer's expectations about personalized products, with the production environment, through the application of integrated B2C e-commerce systems, B2B or various types of dedicated e-platforms to support personalized orders. By these means, the customer will be able to make the specification of the ordered product online. A personalized product will then be designed and manufactured in a network of intelligent resources, and subsequently delivered to the customer. As product delivery time and purchase price will be a decisive element in using this type of service, there is a need to develop algorithms and tools that will allow rapid implementation of the product in the network of available enterprise resources, while minimizing production and logistics costs.

In an Industry 4.0 scenario, data from member enterprises are automatically transferred to the platform from intelligent machines and online devices using advanced ICT technologies, including Cloud Computing, Industrial Internet of Things and Big Data. Using the methodology of rapid network prototyping presented in more (Saniuk, S., and Saniuk, A., 2017), based on the information gathered in the platform system, the resources of individual member enterprises forming a temporary production network are assessed, and that which holds the availability and will guarantee the fastest possible implementation and shipment of the product to the customer, is selected.

Conclusions

The Fourth Industrial Revolution allows better orientation to the customer's needs and offers the possibility of manufacturing personalized products with price similar to mass production. This requires modern production systems to be highly flexible and available resources to be highly productive. Industry 4.0 is a great chance especially for the SMEs sector.

The research carried out by the author shows the need to develop customization in production to varying degrees depending on the type of product. Consumers expect a high level of personalization especially for clothes and shoes. In contrast, the lowest level of product personalization is expected for toys. The most important reason for purchasing personalized products is the appearance of a product that the customer has input into creating.

Small and medium enterprises can play an important role in providing customized production. These enterprises are characterized by high flexibility and a high potential for creating temporary networks of enterprises that can effectively meet high customer requirements by combining their resources through modern technologies. The analyzed enterprises, however, are characterized by a very low level of use of IT systems and indicate many problems related to establishing cooperation with other enterprises. Industry 4.0 expects new business models enabling cooperation and tools supporting the search for network partners and effective functioning in the network. Otherwise, a result of the conducted research was identifying a need to build a trusted, effective e-business platform connecting small and medium enterprises that allows the formation of Cyber Industrial Networks (CIN). A proposed e-business platform supporting the prototyping of Cyber Industry Networks is a kind of a platform where an enterprise's unused production capacity (machinery, equipment, employees) is made available, and specialized production orders of personalized products are commissioned. Efficient functioning of the system would allow an effective level of resource utilization within the cooperating companies, and, at the same time, would enable the level of their productivity to be increased. It must be underlined that due to the simple interface and the ability to be made available through a Web-service, such a system does not require high costs of implementation and use.

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