Concept of SME Business Model for Industry 4.0 Environment

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***Abstract* – Ongoing technological development pushes industry towards the so called fourth industrial revolution. Considering new technology as a determinant of future business environment, we find it necessary to examine how platforms such as Industry 4.0 will change enterprises organization and business models. Designed model should serve as guidance for new and also already existing enterprises for implementing of Industry 4.0 required attributes especially in early stage. Main emphasis is given on software and cloud solutions that will become necessary despite the fact that in recent industrial SMEs they do not play significant role. Such transformation will raise crucial questions about funding new technologies.**

***Keywords* – Industry 4.0, SME, IoT, Business Model, Mass customization.**

1. Introduction

Small and medium enterprises (SMEs) are considered as a backbone of the economy because of their strong position as employer; hence they attract attention both from policy makers and scientists.

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Over the last decade there have been many studies examining variety of factors and implications affecting SMEs and their performance. While having robust research done on the SMEs and their contribution to employment and economy as a whole, studies often lack ex ante point of view considering inevitable changes in business environment that will be caused by technology [1]. As technology keeps advancing at fast pace, SMEs must be prepared to adapt to new technology environment, in order to, at least, stay competitive. Moving towards the so-called 4th industrial revolution, several challenges are being raised. Importance of this topic is expressed in Figure (1), showing projected share of different parts of businesses.

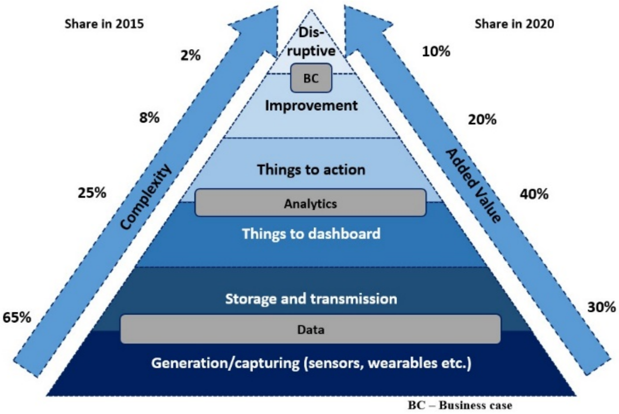

Figure 1. Maturity model; Source: own elaboration according to Zilch and Schalla (2015)

As shown in Figure (1), Industry 4.0 (I4.0) gives companies the opportunity to acquire important information about methods that should be implemented in the company's internal processes, resulting in an increase in value added for companies. Zilch and Schalla [2] analysed a number of processes and cases of Industry 4.0 application in multiple companies, creating a six-grade maturity model that includes three important layers: “data”, “analytics” and “business cases”. The authors also estimate the added value of processes in 2020 in the layers by implementing I4.0 based on the data obtained from the analysed companies.

Considering extensive possibilities that are covered by Industry 4.0 concept, or "Internet of Everything" topic, enterprises could become more effective with reducing costs [3], [4], [5]. However, SMEs could see some troubles in implementing new technologies, and also in modifying and adapting their business models. Especially for industrial SMEs with significantly limited sources, compared to large enterprises, some guidance could be good starting point for determining strategy of implementation elements of I4.0 concept. Among the literature we find solid description of business models, considering variety of factors, while the aim of this paper will be to implement characteristics and requirements of I4.0 environment into already customary business models, and therefore provide some business and organizational architecture of industrial SME with respect to I4.0 environment. Firstly, we provide theoretical background for wide-spread topics including business models, mass customization, I4.0 concept and its main precondition – Internet of Things (IoT). Then we derive logical characteristics and requirements for new business models, concluding with the proposed design of reference industrial SME organizational/business model.

2. Theoretical background

Based on ongoing technology development, globalization, raising dynamic competition and higher demands from customers, challenges regarded to product and process complexity, capability of flexible and fast delivery of customized products, flexibility, mass customization, efficiency and adaptability raised [6], [7], [8], [9], [10], [11], [12], [13]. Aware of these challenges, several future projects came up all over the world, for example the Germany´s "High Tech Strategy 2020" or the US´s "Industrial Internet Consortium" [14]. The aim of these projects is to develop and implement concepts (Industrial Internet of Things – IoT or Industry 4.0) in order to make industries more competitive and effective [13]. The concept of future production systems will require completely new approaches to the organization of work in production. They will use all the good of past production approaches and combine it with the latest advanced technologies. The latest technologies, often referred to as breakthroughs, will make it possible to change existing production principles. The future production will produce product which will be tailored for the needs of the customer. Future production will produce products that are tailored to the needs of a particular customer, highly sophisticated, comprehensive, capable of offering new functionality, and will therefore require a completely new production environment. In order to design architecture of business model for reference SME, firstly we provide some theoretical background of the business models and modern concepts stated above.

2.1 Business models

We find many definitions and characteristics of business models across the literature [15], [16], [17], [18], [19]. Pigneur [20] mentions basic questions that should be answered by business model are mainly fundamental questions same for all businesses: what to offer to customers, who are customers, and how to operate to create value in profitable and sustainable way. One of the most cited definitions according to Timmers [21] sees business model as architecture of products, information flows and services, including all involved actors, their roles, value crated and source of revenue. Osterwalder and Pigneur [20] suggest that business model describes a rationale of how enterprises create, deliver and capture value. According to Zott and Amit [22] business model design is represented by a set of interdependent organizational activities through which human, physical and/or capital resources are brought together in order to achieve enterprise´s goals. In this, and also other traditional definitions of business models there are cyber resources or elements missing. Elvesæter [23] sees business model more simplified, as a description of process of creating value, or simply making money, however, this description does not take a form of structural model.

But as Glova [24] suggests, business model can have two different shapes or approaches; value model and process model. Value model focuses on how value is created, by whom and for whom. It is mainly strategic tool that helps enterprise to define its positioning in order to achieve maximum benefits from current, new or emerging opportunities. On the other hand, process model provides an architectural overview of processes with regards to business strategy, or simply it provides guidance how things should be done in particular business in order to achieve its goals. Considering the mentioned traditional definitions of business model, we will focus in this paper to design architecture of process-business model, with emphasize on IoT and Industry 4.0 platform.

2.2 Internet of Things

Over the past years we faced strong advance of technology among almost all sectors. New applications and business propositions in the business systems were enabled thanks to new technologies.

As Thestrup [25] earlier mentioned, approaches to collecting and managing both virtual and physical data collected from devices, users, sensors etc. emerged. So called "Internet of Things" then represents world-wide network of such objects able to communicate and operate via standardized communication protocols. This term (IoT) was firstly used by Brock [26]. However, IoT became recognized just after a report from ITU[1] [27] was published, stating that IoT refers to ability of connecting everyday objects, meaning that those objects will be able to communicate between themselves same as people will be able to communicate with objects. This communication will be enabled by advanced wireless technology (sensors and identification technologies). The IoT we can diversify to Commercial IoT and Industrial IoT, while I4.0 expects all those spheres to connect and communicate.

The goal of IoT infrastructure will be enabling participants (objects and people) to react more flexible and therefore appropriate and autonomously, as a result of information sharing in particular network. Harbor Research[2] [28] suggests, that in the beginning of the 21st century two major strands of development in technologies emerged; the already mentioned IoT and "Internet of People" (IoP, also called social networking). To add on, Smith [29] concludes significant efforts to create smart environment via well-funded research and development, which supports Harbor Research´s expectations of future manufactured objects, with data processing capability and potential to be networked. These interconnected machines, products, devices etc. will have significant impact on enterprise functioning, efficiency, and consequently to an economy as a whole.

To conclude, we adopt complex definition of IoT from Sundmaeker et al. [30]: "Internet of Things is an integrated part of ´Future Internet´ and could be defined as a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual ´things´ have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network". To add on, Gubbi et al. [31] state that wireless sensor network (WSN) enables ubiquitous sensing and computing, which provides ability to understand measure and infer particular processes and environments. "Internet of Things" idea is also partially adopted by households, in order to create a "smart house", even though particular gadgets are not appropriately connectable yet [32]. The same phenomenon we can expect in enterprises, but a step into new technologies will require more sophisticated approach, having solid preview of ideal processes managing. We assume that the main obstacle both for households and industries to become "smart" will be funding.

2.3 Concept of Mass Customization

The process of globalization and the 4th Industrial Revolution force researchers to look for new flexible business-organizational structures. It is clear that the classical vision of the business and its activities no longer corresponds to the economic reality. Today's manufacturing businesses must have a high degree of specialization in different areas of work and a flexible production system that listens to and adapts to customer needs [33].

2.3.1 Advantages of mass customization

For mass customization, it is imperative that the operating network is flexible and dynamic because the main purpose for mass customization is to adapt to individual customer requirements. The goal is to give the customers the opportunity to design their own specific products [34].

Main advantages of mass customization:

- Better position and market share - customer satisfaction, better references;
- Lower cost of material waste and inventory - it is a contract production, it is not necessary for the company to have a stock of finished products;
- Faster cash flow: quick production - quick turnaround;
- Reducing delivery time ensures flexible production and information flow enables manufacturers to quickly adapt to customer requirements;
- The manufacturer's ability to offer a wide range of products with low production costs - various product types with the same basic components but different final design will allow manufacturers to offer a whole range of products to satisfy every customer.

2.3.2 Mass customization approaches

According to Pine [35] there are Four Approaches to Applying Adaptation in Mass Customization:

- Collaborative customizers: these organizations offer customers the opportunity to participate in the resulting design to meet their needs (size, colour, functionality), as can be seen in Figure (2).

[1] ITU - International Telecommunication Union

[2] Harbor Research – strategy and technology research company discovering and designing smart systems and services, established in 1984 in San Francisco, California, USA.

- Adaptive customers: customers buy a standard product but can customize it according to their needs (software, programming language);
- Cosmetic adaptations: these companies (mostly suppliers) offer a standard product but present it differently from different customers (different packaging);
- Transparent adaptations: these companies offer customers customized products without knowing it (e-shops).

2.3.3 Modular product design

In the modular design of products, products are designed within some modules or processes, so they can be used for different types of products. For example, Boeing Co. has thousands of components for its standardized aircraft, configured for different finite aircraft types. This system enables companies to simplify ordering, engineering and production. Modular product design can be built on "project shop" models or workspaces with required throughput [36].

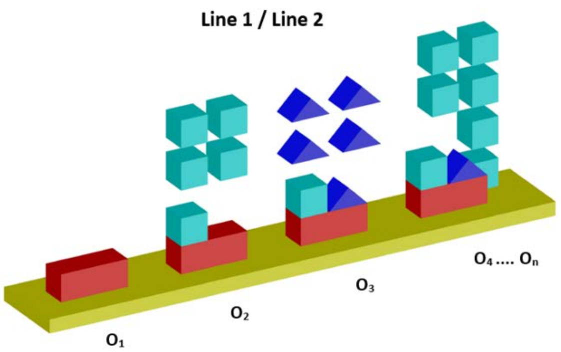

Figure 2. Collaborative model of customized production (Own elaboration)

Requirements for the modular system:

- enough input standardized components (the need for reliable suppliers);
- skilled, highly educated employees with excellent technical qualifications;
- relevant organizational structure that improves coordination between modules.

Benefits:

- the ability to use standardized components for different product types;
- shorten production time - modules can be run simultaneously, thereby reducing production time;
- simple problem diagnostics, possibility to isolate individual errors, quality problems, easier control.

2.3.4 Industry 4.0

The term Industry 4.0 was firstly introduced in 2011 on Hannover-Messe[3], and points to 4th industrial revolution, also it indicates German government´s initiative to improve manufacturing environment with respect to new technologies and efficiency. As ZVEI[4], BITKOM[5] and VDMA[6] suggest, so called 4th industrial revolution will redefine organization and control the entire value stream along the life cycle of a product. Considering the IoT components as prerequisites, industry 4.0 environment would mean cyber and physical levels to merge [3]. As Sanders et al. [37] state, the fourth industrial revolution applies the principles of cyber-physical systems (CPS), smart systems and future oriented technologies with respect to human-machine interaction. There are also several studies [3], [4], [5], [38] concluding that I4.0 environment will enable every entity among the value stream to identify itself and communicate leading to mass customization in manufacturing, with respect to efficiency focused on cost-savings and complexity reduction.

Another important idea about successful improving efficiency with respect to I4.0 is product lifecycle management (PLM), where Le Duigou [17] argues that PLM is underdeveloped especially in the SME environment. We find consensus among the authors, that Industry 4.0 will lead to reducing costs and more efficient environment and processes, however we would like to point out main obstacle from our point of view – costs of necessary equipment to implement I4.0 vision in to manufacturing and every day processes. E.g. Schröder et al. [39] also put similar question whether it is worth the effort implementing Industry 4.0 especially for SMEs.

3. I4.0 starting points for designing business model

Accepting previous research in Industry 4.0 field, we highlight some important suggests and proposals necessary for conducting basic architectural business models for SME. Also we put proposed characteristics of reference SME and traditional business models. All those models and information

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[3] Hannover-Messe – one of the biggest international trade fairs oriented on new and smart technologies.
[4] ZVEI – one of most important manufacturers´ associations in Germany, interested in high-tech.
[5] BITKOM - Germany's digital association, founded in 1999 as a merger of individual industry associations in Berlin, we represent more than 2,500 companies in the digital economy, among them 1,000 SMEs, 400 start-ups and almost all global players.
[6] VDMA - represents more than 3,200 member companies in the SME-dominated mechanical and systems engineering industry in Germany and Europe.

we consider as main inputs for designing new reference business model architecture.

3.1 The Reference Architectural Model for Industry 4.0

The Reference Architectural Model for Industry 4.0 – RAMI 4.0 – was conducted by BITKOM, VDMA and ZVEI with the aim to represent complex manufacturing chains connected only manually. In Figure (3) we present the original model, which consists of a three-dimensional coordinate system that describes all crucial aspects of I4.0 platform.

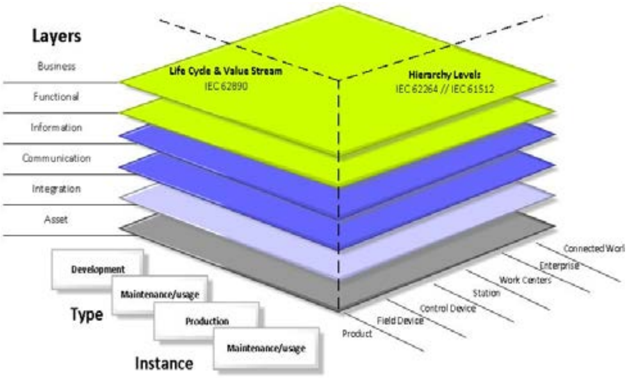

Figure 3. RAMI 4.0
Source: own elaboration according to Henkel (2015)

Left horizontal axis represents product lifecycle and value stream. Implementing new technologies will allow flexible, real time, and appropriate interferences into whole cycle at any level, based on IEC[7] 62890 for life-cycle management. This axis contains processes such as gathering data throughout whole lifecycle, enabling PLM work more effectively. Horizontal right axis describes functions of any Industry 4.0 component, while specifications for implementation are not included, in other words hierarchy levels from IEC 62264[8] and IEC[9] 61512, the international standards series for enterprise IT and control systems, while these hierarchy levels represent the different functionalities within facilities or factories. Vertical axis shows layers – decomposition of the subject into its properties, or simply provides virtual mapping of the subject [40], [41].

As Hankel and Rexroth [40] suggest, all crucial aspects of Industry 4.0 can be mapped within shown three axes, classifying subjects according to the model. Integrating different user perspectives, also providing common understanding of Industry 4.0 requirements and technologies, RAMI 4.0 is solid base starting point for further development. Besides being 3D map for Industry 4.0 solutions and providing orientation in sectors with respect to national and international networks, RAMI 4.0 provides starting point also for standardization committees and industry associations. Logically, with the mentioned new technologies and networking, new standards and standardized requirements would come. In Figure (4), adopted from Fraunhofer Institute, we present all proposed "Industry 4.0 standards", that will be necessary part of implementation Industry 4.0:

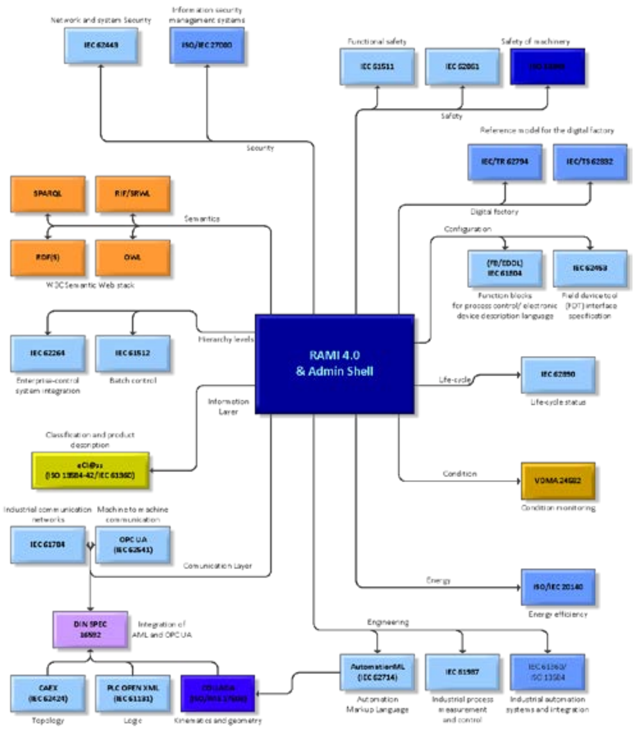

Figure 4. Industry 4.0 standards
Source: Fraunhofer-Institut für Intelligente Analyse und Informationssysteme IAIS (2017)

For purposes of required unification of processes, measurement, controlling, configuration, safety, security and other aspects of businesses, besides the already existing standards (such as ISO), additional standards will be required. Fraunhofer Institute already brought new standards for Industry 4.0 environment (some of them are still developing) in order to provide guideline for all future internet participants. Logically, without unified structure of data, the network would not be able to cooperate and communicate on all levels. Meeting all of the standards showed above will be crucial for new and the already existing business, in order to participate on future global markets.

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[7] International Electrotechnical Commission - International Standards and Conformity Assessment for all electrical, electronic and related technologies - Life-cycle management for systems and products used in industrial-process measurement, control and automation.
[8] International Electrotechnical Commission - International Standards and Conformity Assessment for all electrical, electronic and related technologies - Enterprise-control system integration
[9] International Electrotechnical Commission - International Standards and Conformity Assessment for all electrical, electronic and related technologies - Batch Control

3.2 Reference/traditional business models

For better overview of business models, we present most popular business models stated among the literature, with respect to I4.0 aspects. The Industry 4.0 platform is perceived in six conceptual levels as shown in the following Figure (5). Interoperability points to common communication between machines and people. Virtualization deals with creating a virtual model and smart factory. An important part is dataset that is retrieved in real time. The modularity of Smart factory under I4.0 conditions should be able to quickly adapt to different requirements. Business decentralization is proven through qualified decisions that maximize the optimization of production. It is important to point out the importance of introducing the I4.0 concept. This gives businesses opportunities that may lead to increased competitiveness on the local market but also on the global market [42].

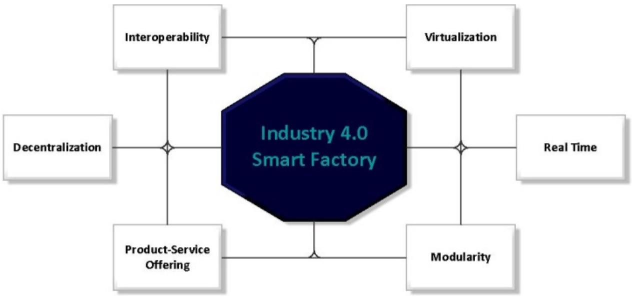


Figure 5. Six conceptual levels in I4.0 platform
Source: own elaboration according to Kuzmišin (2016)

Dorst [43] points to three important components that an enterprise should meet in I4.0 platform. The first is that enterprises should be equipped with detecting devices and sensors that can automatically collect data from machines, production bands, devices, warehouses, and other devices. The second component corresponds to an enterprise that has a good communication infrastructure that is based on machine and device communications and the human aspect. All this communication must also be linked to the company´s IT system. The third important component is intelligent software that serves as a data repository, and the system can then analyse data and deliver results. Thus, enterprise in the I4.0 environment should become "Smart Factory".

The whole concept is built in collaboration with Smart Mobility, Smart Logistics, Smart Buildings, Smart Cities, Smart Products and Smart Grids [44]. The collaboration of all mentioned components in the area of the company should be ensured not only by the well-established PLM software, but also by a well-designed and implemented business and organizational model.

The following table shows the Business Model Canvas key components, which can serve as a template for implementation of individual areas in both todays´ environment and in I4.0 environment. It consists of nine areas that are related and based on the four main parts of this model, which are mainly oriented on fundamentals of enterprise [45]:

- Product - Value Proposition;
- Customer Segments, Relationship and Distribution Channels;
- Key Partners, Activities and Resources;
- Financial part - Cost Structure and Revenue Streams.

We consider Canvas business model as a model dealing with fundamental questions, mainly oriented on purpose of doing particular business. This model does not provide any organizational guidance or overview for implementation of I4.0 platform into enterprises´ environment, however, identifying key fields of business should consider I4.0 environment at all in foreseeable future.

Different type of business model represents Service – Technology – Organization - Finance Model (STOF Model). Bouwman [46], [47] designed the model which has four main parts: service part, technology part, organizational part, and finance part, as can be seen in Figure (6). Service part is focusing on creating the value for customers. Technology part is focusing on technological infrastructure and network of each industrial part, which has significant role especially in I4.0 environment. Organization part is about internal and external processes in industrial company. The last part of STOF model is financial part and it is about cost structure, revenue streams and investments.

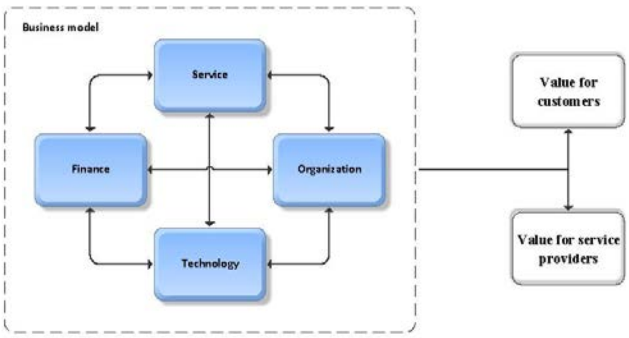


Figure 6. STOF Model; Source: own elaboration according to Bouwman et al. (2008)

Compared to Canvas, STOF structure is simplified, thus easier to deal with especially if small enterprises are considered. Even more simplified approach is presented in Gassmann [48], [49] who developed the triangle type of business model. The magic triangle is about four main questions as is shown in Figure 6., where similarly to Canvas and STOF, fundamental questions are significant:

The main questions are:

- Who? The business should be able to answer the question who is their customer. Responding to this question is considered to be the basis for the whole enterprise and production management policy [50];
- What? The question deals with the options offered to customers, or points out the aspects that the customer brings to the business. Simply, we can talk about the customer's ability to create value for company [20];
- How?; The question points to the creation of the value proposition [50];
- Revenue; this part is about revenue model. Bonnemeier [51] argues that the revenue model is developed based on four important aspects: selling the produced units, duration of provision, performance level and customer consumption on the value creation.

We consider understanding the models stated above as crucial for business decision making in current environment same as in I4.0 environment. Even though above stated models deal mainly with fundamental questions about business, which we accept are crucial for SMEs, in I4.0 environment, these questions will have to be answered in more sophisticated way. However, along already stated attributes of models, I4.0 environment would have additional requirements, which we present in next section, and which will have to reflect in examining the above stated fundamental areas.

4. Design of business model for SME 4.0

For the purposes of this paper, we adopt European Commission definition of Small and Medium Enterprise, which is dominantly based on headcount and turnover or/and balance sheet; enterprises with headcount up to 250 and turnover up to 50 million euros and/or balance sheet size up to 43 million euros.

According to Katona [52] using information from European Commission, 99.8% of businesses in the European Union belong to the SME sector, while 92.2% of which are actually micro-enterprises. However, mostly used terminology is SME, which includes these micro-enterprises and therefore leads to misclassifies sometimes, but we do not consider this as a crucial fact for our business model design, neither number of employees, since the aim of this paper is to give supportive guidance for potential or ongoing businesses how architecture of business in I4.0 environment should look like with respect to new technologies and requirements.

Therefore, as a reference industrial SME, we will consider manufacturing, independent, centralized enterprise, localized in one manufacturing hall/building/object, with customers´ payments as a main revenue stream, and suppliers as a crucial and key partner. Implementing I4.0 requirements into our model, we will attempt to provide solid guidance for building or rebuilding SMEs in order to become I4.0 networkable.

4.1 Requirements and characteristics for SME 4.0 Business model

In this section, we would like to point out what the business model should meet under I4.0 platform conditions. Throughout the study of SME and I4.0 literature, we found many characteristics and conditions that should merge in I4.0 environment, thus we present the following selected proposed characteristics in the Table 1. below:

Table 1. Business model characteristics

Value proposition	
Characteristics	***Implementation in Industry 4.0***
A. Variance and customization in production	Customization for end-user-oriented and one of a kind production.
B. Product-service offering	Original Equipment Manufacturer as deliverables provider for end user.
Value creation	
C. Data collection	Smart network of sensors, Radio Frequency Identification, clouds and integration to manufacturing execution system.
D. Data efficiency, availability and usage	Autonomous equipment and prognostics with self-optimized possibilities.
E. Innovation	Innovation in product lifecycle management using data.
F. Value network ecosystem	Creation and design, sharing of goals and responsibilities.
G. Networking (horizontal integration)	Functional cooperation network.
H. Vertical integration to CPS	Production management and control, manufacturing, planning and organizational systems.
Value capturing	
I. Revenue sources	Revenue model as a service.
J. Smart contracts using Blockchain	Using Blockchain for synergy of dataset, monetary and physical flows.

Source: own elaboration according to Montanus (2016)

To add on, Osterwalder [20] argue that business model in Industry 4.0 should include and support three valuable elements: value proposition, value creation and value capturing. Along the traditional approaches to value proposition, creation and capturing, Table 1. shows in the second column description for better understanding characteristics stated by authors among the literature linked to I4.0 environment. We would like to point out, that requirement of functional cooperation network will be met using central cloud, data storage or server actively connected to every other object. Secondly, using block chain technology we mention only as a suggestion for future communication and transactions, while we do not incorporate block chain as a prerequisite for our designed model. Stated characteristics are shown as a diagram in Figure (7):

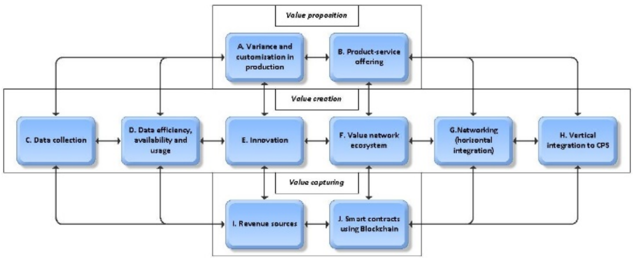
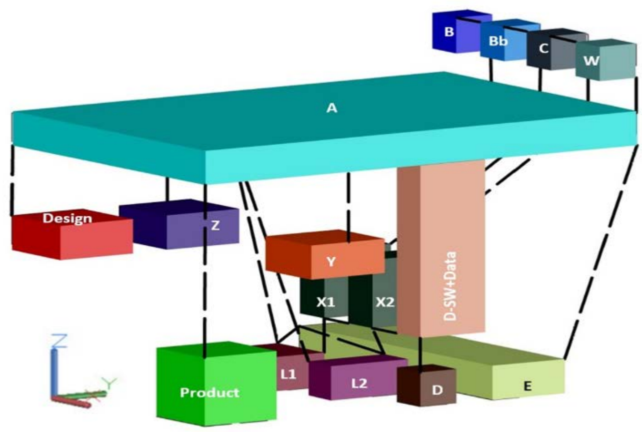


Figure 7. Business Model Characteristics network
Source: own elaboration according to Montanus (2016)

Realizing difficulty of implementing all requirements to existing or new SMEs on required level, we simplify all the mentioned attributes in our model, with emphasize on main prerequisite which is communication inside the enterprise and to the external world, with aim to maximize the contribution for SMEs.

4.2 Designed architecture

Bringing together main I4.0 platform requirements, traditional business models, future expectations of smart environment and basic structure of manufacturing enterprise, we provide design of SME architecture, which should represent backbone for planning new businesses in I4.0 environment or rebuilding the already existing businesses. We present our own model in Figure (8) with objects described in a legend.



A	Cloud/Data Storage	Y		Supply Software
B	Managerial Unit	X1; X2		Internal Software 1,2
Bb	Accountancy Unit	L1	L2	Station/Line
C	Sales Unit	D		Controlling Unit
W	Delivery Unit	D-SW+Data		Controlling Software and Data
Z	Order Software	E		Inventories/Store
Design	Design Software	Product		Outcome

Figure 8. Business model for SME 4.0 with object legend
Source: own elaboration

Our model consists of main objects, main subjects, optional subjects and data storage. As main objects we consider the physical necessary parts of a manufacturing enterprise, such as stations/lines, where products are constructed, the software needed for developing and maintaining products. The software for external communication with customers and suppliers, the software for other objects and control unit are also considered as main objects. The main subject is managerial unit, and optional subjects can be accountancy unit, delivery unit and sales unit. The most important is data storage, the cloud respectively, where all data gathered from smart objects, subjects, and units will gather, and from where data can be extracted.

The model is constructed in three dimensional scheme, so it could reflect to RAMI 4.0 dimensions. Left horizontal (x) axis represents product lifecycle, from the design of the product throughout manufacturing and maintenance. Right horizontal (y) axis represents the hierarchy of the enterprise, from the whole enterprise down to product throughout the production lines stations and other necessary components of manufacturing enterprise. Vertical (z) axis represents interconnection between physical and cyber worlds in particular enterprise, however simplified compared to RAMI 4.0, because this design should serve as an early guidance, especially for manufacturing SMEs. While hierarchy of enterprise, we consider as well understood with respect to our model, in product life cycle we point out that, design and proposition of product start when customer gives transforms his needs and requirements to inputs via customers´ software.

We then give emphasize on the horizontal axis – merger of physical and cyber world, from SME perspective. In top layer are illustrated the main subjects – managerial unit and three optional subjects – accounting unit, sales unit and delivery unit. Managerial unit as a main subject is above all other objects and subjects, thus it controls the whole enterprise and sets internal rules and plans. We consider other three subjects as optional, because SMEs could have those units or simply outsource accounting and deliveries. Sales unit can be formed but it is not inevitable. However, all three optional subjects are above the physical process, and they operate only with data collected and provided from manufacturing process or external subjects, same as the managerial unit.

All data necessary for those four units we suggest should be gathered from and sent to “A” layer, which represents data cloud/storage/server. We suggest that cloud/storage/server should be the first step for implementing I4.0 platform for the following reason: having machines with ability to communicate directly to each other and to management in several ways is harder to implement, while incorporation of “A” could be less expensive and faster option viewed as an intermediate step on the way to I4.0 environment. This “A” should be able to gather data from every object and subject of enterprise, and also from external subjects. In this way, the condition of interconnected unit will be met. Between "A" and bottom layer, which represents inevitable physical objects, such as inventories (storage), stations and manufacturing lines (L1, L2)[10], the physical quality and process control (controlling unit - D) and the product – units that are already key part of manufacturing enterprises, we illustrate software solutions (X1, X2)[11].

In other words, instrumentation should be incorporated properly, in order to be able to gather data from physical layer via various software. Even though in most todays´ SMEs there are machines without the ability to be controlled digitally and provide digital information, implementing I4.0 platform will require this. Every physical object should be covered by software with ability to collect, unify (according to standards or demands both from external and internal subjects, based on decision made by managerial unit) and send data to "A", also collect data from "A" (also product and intermediate products). With this data-well-funded "A", the managerial unit would be able to create virtual map of all processes and whole enterprise, and consequently control or change processes or identify unhealthy events. Another object in a layer between "A" and the physical layer, represents software that provides controlling on virtual level, based on data gathered from physical layer, and rules given by managerial unit, while these quality, time or process tests´ results will be also available in "A" layer. This form of controlling we consider as more complex, requiring less time and allowing to control every product or process avoiding common used sampling. In traditional enterprises, physical layer and management are crucial, however, communication is also in physical or partially digital way. Thus we give emphasize in our model on the "A" layer, which represents cloud or data storage solution, and software solutions to cover all physical objects of enterprise, in order to effectively collect and unify data, and also to control physical objects. These two are main suggestions that should be considered by new and already existing SMEs, in order to be able to be part of future I4.0 environment.

As we implement IoT perspective of view into enterprise, which creates Industry 4.0, we expect same or similar smart environments also in the external world. Hence, communication with customers, suppliers, banks, insurance groups, even legal authorities such as tax office will become standardized, using objects (standardized software) and cloud/data storage, while we expect significant part of this communication to became automated. As customers represent revenue stream, we can expect in future smart environment that payments will be provided only in electronic way via banks. However, customers are expected to take more significant part in development of product. I4.0 environment should allow easier mass customization, where specific inputs about desired product will be given directly by customer. For that purpose, we illustrate order software (Z), where customers´ requirements should be input. Direct inputs from customers or management should be then transformed into virtual product design in product design software (Design Software). Data provided and collected from customers and design software then can be available to inventories unit in order to secure everything needed for product and production lines to set them up for manufacturing exact product. Even if mentioned resources are provided physically, possible shortage could be signalled in advance, therefore communication with suppliers could be more time efficient – for which reason we propose also unified suppliers´ communication software, where external "partners" could be contacted automatically when shortage in supply is detected. These two external communication software we consider as optional, adding that they would probably require unified communication environment. Future communication network could therefore decrease costs, and reduce time of especially legal issues. Figure (9) below then provides complex scheme also with external and internal communication streams from initial customization by customer, throughout variable production process, which incorporates external suppliers, to expedition and back to customer:

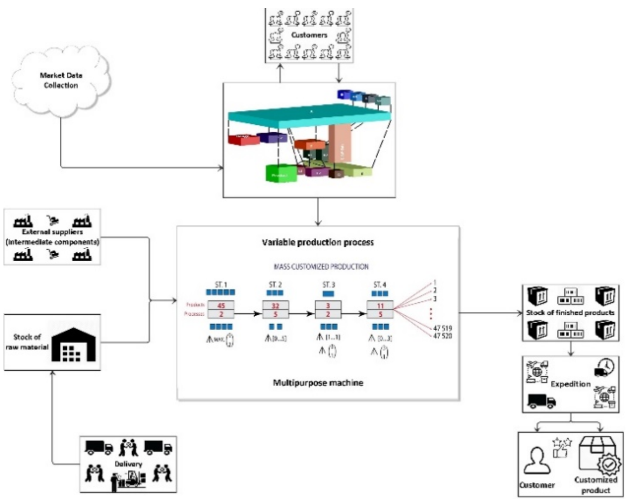


Figure 9. Communication network of business model for SME 4.0; Source: own elaboration

We also incorporated results from Kiel [14] in our model, which suggest that main emphasize among SMEs regarding I4.0 is on key resources and customers. In future environment we expect automatized and fully digitalized communication with other external subjects such as banks, insurance

[10] Number of stations/lines varies based on particular enterprise.
[11] Number of software varies based on particular enterprise.

groups, or legal authorities such as tax offices. Model presented in this study incorporates every inevitable part of manufacturing enterprise, explaining requirement of communication on internal and external basis, giving emphasize on projected future smart environment. The aim of this model is to serve as guidance for manufacturing SMEs in order to start with successful transformation and adaptation to I4.0 platform.

5. Conclusion

The aim of this paper was to design business organization model for existing or new SMEs, considering traditional approaches to business models and Industry 4.0 requirements, in order to serve as guidance for SMEs in early stage of implementing I4.0. Our model concludes for both new and existing enterprises, that for already well understood main objects and subjects of enterprise, additional software, cloud and gadgets will be required. This should reflect in business decisions and planning from the very beginning. As long as the research supports the idea of becoming more effective after implementing an I4.0 platform vision on enterprises, we point out that enterprise would need potentially higher initial investment to standardized software and high performance hardware, which is resulting as a crucial concluding remark – funding question. Based on expectations of future “smart” external world, where external objects from enterprise´s point of view are “smart”, and capable of real time, semi or fully automated communication, we express our conviction that such an automated communication would reduce production costs and time. Mentioning potential funding problems, we also suggest, that the possibility of legal authorities involved in creating proper Industry 4.0 environment, and real time networking manufacturing chain should be examined. Other market participants, such as banks, tax offices, and other institutions, and also households would need to implement new technologies, in order to participate in global network, simply because if only enterprise will be “smart”, digital and smart communication would stop at the point of reaching mentioned other market participants.

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References

[1]. European Committee.(2013). Improvement of Entrepreneurial Mindset, Publications Office of the European Union..

[2]. Zilch, A., & Schalla, P. (2015, July 29). PAC organizes and assesses projects for Industrie 4.0 and the Internet of Things with new “Innovation Register”. Retrieved from: https://www.pac-online.com/pac-organizes-and-assesses-projects-industrie-40-and-internet-things-new-innovation-register

[3]. Lasi, H., Fettke, P., Kemper, H. G., Feld, T., & Hoffmann, M. (2014). Industry 4.0. *Business and Information Systems Engineering*, *6*(4), 239-242.

[4]. Posada, J., Toro, C., Barandiaran, I., Oyarzun, D., Stricker, D., de Amicis, R., & Vallarino, I. (2015). Visual computing as a key enabling technology for industrie 4.0 and industrial internet. *IEEE computer graphics and applications*, *35*(2), 26-40.

[5]. Valdeza, A. C., Braunera, P., Schaara, A. K., Holzingerb, A., & Zieflea, M. (2015, August). Reducing complexity with simplicity-usability methods for industry 4.0. In *Proceedings 19th triennial congress of the IEA* (Vol. 9, p. 14).

[6]. Sendler, U. (2013). Industrie 4.0–Beherrschung der industriellen Komplexität mit SysLM (Systems lifecycle management). In *Industrie 4.0* (pp. 1-19). Springer Vieweg, Berlin, Heidelberg.

[7]. Soltysova, Z., & Bednar, S. (2015). Complexity management in terms of mass customized manufacturing. *Polish Journal of Management Studies*, *12*(2), 139-149.

[8]. Bauernhansl, T., Schatz, A., & Jäger, J. (2014). Komplexität bewirtschaften–Industrie 4.0 und die Folgen. *ZWF Zeitschrift für wirtschaftlichen Fabrikbetrieb*, *109*(5), 347-350.

[9]. Hirsch-Kreinsen, H. (2014). Wandel von Produktionsarbeit–„Industrie 4.0 “. *WSI-Mitteilungen*, *67*(6), 421-429.

[10]. Ganschar, O., Gerlach, S., Hämmerle, M., Krause, T., & Schlund, S. (2013). *Produktionsarbeit der Zukunft-Industrie 4.0* (pp. 50-56). D. Spath (Ed.). Stuttgart: Fraunhofer Verlag.

[11]. Wirtz, B. W. (2011). Business model management. Design–Instrumente–Erfolgsfaktoren von Geschaftsmodellen. *Auflage, wiesbaden*.

[12]. Botthof, A. (2015). Zukunft der Arbeit im Kontext von Autonomik und Industrie 4.0. In *Zukunft der Arbeit in Industrie 4.0* (pp. 3-8). Springer Vieweg, Berlin, Heidelberg.

[13]. Ramsauer, C. (2013). Industrie 4.0–Die Produktion der Zukunft. *WINGbusiness*, *3*, 6-12.

[14]. Kiel, D., Arnold, Ch., Collisi, M. and Voigt, K. I. (2016). The impact of the industrial internet of things on established business models. In *Proceedings of the 25th international association for management of technology (IAMOT) conference*.

[15]. Clauss, T. (2017). Measuring business model innovation: conceptualization, scale development, and proof of performance. *R&D Management*, *47*(3), 385-403.

[16]. DaSilva, C. M., & Trkman, P. (2014). Business model: what it is and what it is not. *Long range planning*, *47*(6), 379-389.

[17]. Demil, B., Lecocq, X., Ricart, J. E., & Zott, C. (2015). Introduction to the SEJ special issue on business models: business models within the domain of strategic entrepreneurship. *Strategic Entrepreneurship Journal*, *9*(1), 1-11.

[18]. Klang, D., Wallnöfer, M., & Hacklin, F. (2014). The business model paradox: A systematic review and exploration of antecedents. *International Journal of Management Reviews*, *16*(4), 454-478.

[19]. Zott, C., Amit, R., & Massa, L. (2011). The business model: recent developments and future research. *Journal of management*, *37*(4), 1019-1042.

[20]. Osterwalder, A., Pigneur, Y., Clark, T., & Smith, A. (2010). Business model generation: a handbook for visionaries, game changers, and challengers.

[21]. Timmers, P. (1998). Business models for electronic markets. *Electronic markets*, *8*(2), 3-8.

[22]. Zott, C., & Amit, R. (2010). Business model design: an activity system perspective. *Long range planning*, *43*(2), 216-226.

[23]. Elvesæter, B., Berre, A. J., De Man, H., & Li, M. S. (2010). Networked Enterprise transformation and resource management in future internet enabled Innovation Clouds. *Enterprise Interoperability IV*, 313-322.

[24]. Glova, J., Sabol, T., & Vajda, V. (2014). Business models for the internet of things environment. *Procedia Economics and Finance*, *15*, 1122-1129.

[25]. Thestrup, J., Sorensen, T. F., & De Bona, M. (2006, June). Using Conceptual Modeling and Value Analysis to Identify Sustainable Business Models in Industrial Services. In *Mobile Business, 2006. ICMB'06. International Conference on* (pp. 7-7). IEEE.

[26]. Brock, D. (2001). The compact electronic product code—a 64-bit representation of the electronic product code. *Auto-ID White Paper MIT-AUTOID-WH-008*.

[27]. ITU Internet Reports .(2005). The internet of things. *Geneva: International Telecommunication Union (ITU).*

[28]. Harbor Research .(2011). Machine-To-Machine (M2M) and Smart Systems Market Opportunity 2010 – 2014. Harbor Research, Inc., (online) available at: http://www.windriver.com/m2m/edk/Harbor_Research-M2M_and_Smart_Sys_Report.pdf.

[29]. Smith, I. G., .(2012). The Internet of Things 2012 New Horizons, Halifax, IERC, p. 360.

[30]. Sundmaeker, H., Guillemin, P., Friess, P., & Woelfflé, S. (2010). Vision and challenges for realising the Internet of Things. *Cluster of European Research Projects on the Internet of Things, European Commision*, *3*(3), 34-36.

[31]. Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. *Future generation computer systems*, *29*(7), 1645-1660.

[32]. Cui, X. (2016). The internet of things. In *Ethical Ripples of Creativity and Innovation (pp. 61-68)*. Palgrave Macmillan, London.

[33]. Koren Y. (2010). „The Global Manufacturing Revolution: Product-Process-Business Integration and Reconfigurable Systems", ISBN 0470583770, John Wiley & Sons, New York, USA

[34]. Pollard, D., Chuo, S., & Lee, B. (2011). Strategies For Mass Customization. *Journal of Business & Economics Research*, *6*(7), Available at: https://www.cluteinstitute.com/ojs/index.php/JBER/article/view/2447. Date accessed: 13 dec. 2017. doi: https://doi.org/10.19030/jber.v6i7.2447.

[35]. Pine, B. J., Pine, J., & Pine, B. J. I. (1993). *Mass customization: the new frontier in business competition*. Harvard Business Press.

[36]. Feitzinger E. & Lee, H. L. (1997). Mass Customization at Hewlett-Packard: The Power of Postponement. *Harvard Business Review*, *75*(1), 116-121.

[37]. Sanders, A., Elangeswaran, C., & Wulfsberg, J. (2016). Industry 4.0 implies lean manufacturing: Research activities in industry 4.0 function as enablers for lean manufacturing. *Journal of Industrial Engineering and Management*, *9*(3), 811-833.

[38]. Modrak, V., & Bednar, S. (2015). Using axiomatic design and entropy to measure complexity in mass customization. *Procedia CIRP*, *34*, 87-92.

[39]. Schröder, C., Schlepphorst, S., & Kay, R. (2015). *Bedeutung der Digitalisierung im Mittelstand* (No. 244). IfM-Materialien, Institut für Mittelstandsforschung (IfM) Bonn.

[40]. Hankel, M. (2015). Industrie 4.0: The Reference Architectural Model Industrie 4.0 (RAMI 4.0). *ZVEI: Die Elektroindustrie*.

[41]. Zezulka, F., Marcon, P., Vesely, I., & Sajdl, O. (2016). Industry 4.0–An Introduction in the phenomenon. *IFAC-PapersOnLine*, *49*(25), 8-12.

[42]. Rodríguez-Molina, J., Martínez-Núñez, M., Martínez, J. F., & Pérez-Aguiar, W. (2014). Business models in the smart grid: challenges, opportunities and proposals for prosumer profitability. *Energies*, *7*(9), 6142-6171.

[43]. Dorst, W., Glohr, C., Hahn, T., Knafla, F., Loewen, U., Rosen, R., & Winterhalter, C. (2015). Umsetzungsstrategie Industrie 4.0–Ergebnisbericht der Plattform Industrie 4.0. *BITKOM eV, VDMA eV, ZVEI eV Berlin, Frankfurt*.

[44]. Kagermann, H. (2015). Change through digitization—Value creation in the age of Industry 4.0. In *Management of permanent change* (pp. 23-45). Springer Gabler, Wiesbaden.

[45]. Montanus, M. L. (2016). Business Models for Industry 4.0: Developing a Framework to Determine and Assess Impacts on Business Models in the Dutch Oil and Gas Industry.

[46]. Bouwman, H., Faber, E., Haaker, T., Kijl, B., & De Reuver, M. (2008). Conceptualizing the STOF model. *Mobile service innovation and business models*, 31-70.

[47]. Bouwman, H., De Reuver, M., Solaimani, S., Daas, D., Haaker, T., Janssen, W., ... & Walenkamp, B. (2012). Business models tooling and a research agenda. *The first*, *25*, 1-28.

[48]. Gassmann, O., Frankenberger, K., & Csik, M. (2013). The St. Gallen business model navigator.

[49]. Gassmann, O., Frankenberger, K., & Csik, M. (2014). *The business model navigator: 55 models that will revolutionise your business*. Pearson UK.

[50]. Enkel, E., Gassmann, O., & Chesbrough, H. (2009). Open R&D and open innovation: exploring the phenomenon. *R&d Management*, *39*(4), 311-316.

[51]. Bonnemeier, S., Burianek, F., & Reichwald, R. (2010). Revenue models for integrated customer solutions: Concept and organizational implementation. *Journal of Revenue and Pricing Management*, *9*(3), 228-238.

[52]. Katona, F. (2014). Examination timelines of small businesses marketing planning. *Possibilities for development of business cluster network between SMEs from Visegrad countries and Serbia, University of Belgrade, Technical Faculty in Bor, Engineering Management Department (EMD), Bor*, 99-108.