The Impact of Industry 4.0 on Business Models

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Abstract. The main aim of this paper is to describe the major changes caused by Industry 4.0 in the implemented business models (and their elements) in business organizations. The paper presents a number of theoretical business model concepts and explores the connection and impact of Industry 4.0 and the technologies behind it on organizations' business models. The impact of Industry 4.0 is analyzed and described based on the four-box business model framework making references to real case examples of companies vastly using Industry 4.0 based technologies. Finally, the paper highlights characteristics of the Industry 4.0-based business models and presents conclusions regarding the changes that Industry 4.0 might introduce to the processes of value creation, delivery and capture.

Keywords: Industry 4.0 · Business Model · High Technologies · Digital Transformation

1 Introduction

In recent years, the term "high tech" has often been associated with the technologies behind the term "Industry 4.0". The Fourth Industrial Revolution (also called Industry 4.0) is a technological trend that makes a "promise" to fundamentally change the way companies produce and create value [1] using a range of technologies such as: the Internet of Things, machine learning, cyber-physical systems, augmented reality, Big Data, cloud computing and many others. The listed technologies create prerequisites to provide a number of advantages for the companies which manage to harness their potential, such as:

- *Firstly*, transparency along the value chain thanks to communication and traceability of products/services in all processes. In the context of Industry 4.0, we are no longer talking about communication between people (H2H), but about communication between people and machines (M2H) and especially between machines and machines (M2M) using intelligent sensors and in real time. This allows the implementation of timely changes to the products/services offered in order to maximize adaptation to customer requirements;
- *Secondly, a* high degree of personalization of product/service offerings through the collection, analysis and processing of Big data using intelligent algorithms that contributes to the identification of customer requirements;
- *Thirdly*, shortening the production cycle and minimizing costs through self-optimization and autonomous decision-making within the smart factory [2].

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Based on the aforementioned, it can be concluded that Industry 4.0 based technologies are not only changing the processes along the entire value chain, but also the products and services offered as well as the ways of reaching and communicating with customers, or in other words, these technologies will inevitably lead to changes in existing business models. A business model represents the logic of a business and provides data and other evidence that demonstrates how that business creates and delivers value to customers. It also outlines the revenue, cost and profit architecture associated with the business organization delivering that value [3]. By impacting the ways in which value is created for the customer, value is captured and all the internal processes associated with this, Industry 4.0 also has a significant impact on organizations' business models, as according to Gudiksen et al. [4] these are the main concepts defining the term "business model". Many companies perceive the term "Industry 4.0" as a set of high technologies including machine learning, sensors and connected assets, but the truth is that the changes that these technologies bring will have an effect not only from a technological point of view, but also from organizational and structural one, and this effect will be mostly observed on the business models of established companies [5]. In the short term, companies might have some success through process optimization, but taking into account the impact of high technology based on Industry 4.0, in the long term, a robust strategy is required, including the development of new products and services as well as new business models that exploit the potential of digitalization in a new way and add value in the process. In this regard, this paper will look specifically at the potential changes that Industry 4.0 could create in terms of how value is created, delivered and captured within business organizations.

2 Research Methodology

The main objective of this paper is to describe the main changes in the implemented business models (and their elements) in business organizations caused by Industry 4.0.

In order to achieve the defined objective, the paper sets the following three research objectives:

- To conduct and present a targeted research of various information sources to outline a theoretical business model in business organizations and identify potential changes in each of its components resulting from the impact of Industry 4.0;
- To identify potential impacts of Industry 4.0-based technologies and interpret them through real case examples in the framework of the chosen business model framework;
- To identify characteristics of Industry 4.0-based business models and draw conclusions on the potential impact of Industry 4.0 on organizational business models.

The research of relevant literature was carried out by analyzing articles indexed in Web of Science, Scopus, Science direct, IEEE Xplore and Directory of Open Access Journals (DOAJ) as well as business literature. The literature review was focused on papers and articles in the following thematic fields:

1. Papers focused on managerial theory with focus on business model concepts;

2. Papers revealing the impacts of Industry 4.0 across the value chain;
3. Papers related to Industry 4.0 and/or its impact on at least one of the components of the four-box business model framework;
4. Papers and articles revealing real cases of the practical application of Industry 4.0 solutions.

The words used for the search were "Industry 4.0", "Fourth industrial revolution", "Smart factory", "Smart manufacturing", "High technology", "Industrial Internet", "Business model" and other words that present in the titles and abstract of this paper combined with the Boolean operators "AND" and "OR". The total number of reviewed papers was 225, out of which 52 were taken into account and used to draw further conclusions on the impact of Industry 4.0 on organizational business models presented in the next sections of this paper.

3 Results of the Literature Review

The results from the conducted literature review were systemized into the following sections: (1) Business model concepts; (2) High technologies as a determinant of the business model; (3) Analysis of the dimensions of the impact of Industry 4.0 based on the four-box business model framework; (4) Characteristics of the Industry 4.0-based business models.

3.1 Business Model Concepts

A business model is a representation of *how* a company conducts business [6]. Also a business model is an interrelationship between processes and methods that create the business itself [7].

Many authors define a business model as an interrelationship of a different set of elements. Table 1 presents a brief analysis of these elements and how they overlap.

According to Johnson et al. [11], a business model has four main components (see Table 1) that create and deliver value: a value proposition to the customer; a profit formula including revenue and cost structure, resource turnover; key resources and key processes. This model is also referred to as the four-box business model [10]. Baden-Fuller and Haefliger [8] define the business model as a system that answers the question of who/what customers are (customer identification), engages with their needs (customer attraction), creates satisfaction (value creation) and monetizes value (monetization). Osterwalder [12] defines nine building segments of a business model, or what is called the Business Model Canvas, which includes: key partners; key activities; value proposition; customer relationships; customer segments; key resources; channels; cost structure and revenue structure.

Chesbrough and Rosenbloom [9] view the business model as a logical framework that mediates the development of technologies, taking technologies as inputs that, through customers and markets, convert into economic value. They define the following business model elements: market segments, value proposition, value chain, value network (including suppliers, customers, partners and competitors), competitive strategy, cost

Table 1. Business model elements according to different authors (own systematization based on [3, 8, 9, 11, 12]).

Johnson et al. [11]	Teece [3]	Osterwalder and Pigneur [12]	Baden-Fuller and Haefliger [8]	Chesbrough and Rosenbloom [9]
	Clients	Customer segments	Customer identification: Who are the customers?	Market segments
Value proposition to the customer	Value	Value proposition	Customer Engagement: What customers value	Value proposition
Key resources and processes	Creating and delivering value	Key Partners Key Activities KeyResources Customer Relations, Channels	Links in the value chain: Integrated, hierarchical or networked?	Value chain Value network Competitive strategy
Profit formula	Capturing value	Revenue and cost structure	Monetization: When and how is money collected?	Cost structure and profit potential

structure and profit potential. It is noteworthy that, unlike the other authors listed, Chesbrough and Rosenbloom [9] also perceive competitive strategy as part of the business model, making the clarification that the business model emphasizes value creation while strategy emphasizes value capture.

Taking into account these definitions, it can be concluded that a business model is the way in which a company conducts its business, including all the relationships and processes within it that mediate the creation, delivery and capture of value by the company.

Value creation is the combination of activities, resources, processes, and partners (suppliers, distributors, etc.) required by an organization to create a product or service. The value proposition, in turn, represents the distinctive characteristics of the product/service offering that actually generate value for customers [1]. Hence, for a business model to be successful, it is not enough to simply create a product or service, they must satisfy certain customer needs, which is the source of their potential value to the customer.

Delivering value refers to how a business serves its customers or how it provides customers with access to the value created in the form of products and services. This component encompasses the products and services offered, the distribution, communication and sales channels, the customer segments and the relationships established [13].

Value capture is the process of securing profits from the creation and distribution of value from these profits to those involved such as suppliers, customers and partners [14]

or in other words value capture is expressed through the company's revenue and cost structure.

Taking into account the presented definitions of value creation, delivery and capture, we could conclude that all presented models and their elements have some similarity and could be related to these concepts.

3.2 High Technologies as a Determinant of the Business Model

The development of new technologies, in particular ICT, over the last two decades has led to the launch of a new technological trend - Industry 4.0. The fourth industrial revolution is believed to be a powerful driver of innovation over the next few decades, sparking the next wave of business innovation. Thus, the new distinctive features associated with Industry 4.0, such as real-time capabilities, interoperability, and horizontal and vertical integration of production systems through ICT systems, are considered to be the answer to the current challenges that companies need to face to remain competitive in terms of globalization and increasing competition, volatility of market demands, shortened product life cycles, and increasing complexity of products/services in demand [13]. Industry 4.0 blurs the boundaries between the physical and digital worlds and unites companies with their partners, contractors and customers in a comprehensive value creation network, the participants in which are in constant contact thanks to the Internet of Things, cyber-physical systems, cloud computing and other state-of-the-art technologies. In this respect, the expectation is that the fourth industrial revolution will completely change the way companies create (production, value proposition to customers), deliver (relationships with partners and customers and related processes) and capture value (the structure of their cost and revenue cash flows). Hence, Industry 4.0 will completely change the existing business models of companies that embark on the digital transformation path.

It is important to note that simply implementing Industry 4.0 based technologies will not be enough in the long term to ensure the competitiveness and sustainability of companies, as competition between companies in business ecosystems will not only be through new products, services or technologies, but also through innovative business models. Business model innovation is a type of innovation that has the potential to have a strong impact on the market and competitors [15] and can help establish a differentiated competitive advantage. However, it is necessary to distinguish between technology innovation, as Industry 4.0 is associated with, and business model innovation. Technology innovation takes place in specialized laboratories and R&D centers, while business model innovation takes place within companies, with the aim of optimizing how value is created, delivered and captured. A technological innovation can create a competitive advantage for a business organization, but with mass commercialization and or deployment in many other competing companies, what can differentiate and sustain a company's competitive advantage, even with similar technologies, is an innovative business model. Hence, it can be concluded that competition in the context of the fourth industrial revolution will be fought not only on technological but also on organizational levels - who has managed to adapt their business model to a greater extent so as to optimize their value proposition to the customer, their profit formula and their key resources and processes.

According to Vils et al. [16] innovation in companies' business models can be driven by one of the following objectives: (1) satisfying existing but unmet market needs; (2) bringing new technologies, products or services to the market; (3) improving, challenging or transforming an existing market with a better business model; or (4) creating an entirely new market. As already mentioned, the opportunities offered by Industry 4.0 are undoubtedly associated with the emergence of new technologies, which in turn leads to the emergence of new smart products/services, all of which in the long run will change customer requirements and expectations, forcing companies to change their value proposition to customers. Demands for more personalized and sophisticated products and services [17] will also force companies to change the way they capture the value created or structure their revenue and cost streams. Industry 4.0 is a technological trend that will change the ways of production and consumption, and changing the ways of consumption will result in shifting customer requirements and perceptions of a high value-added product/service, and this will create a need to change the ways of creating, delivering and capturing value or business models, which clearly illustrates the importance of the fourth industrial revolution from an organizational perspective.

3.3 Analysis of the Dimensions of the Impact of Industry 4.0 Based on the Four-Box Business Model Framework

For the purposes of this paper and to illustrate some of the changes that Industry 4.0 based technologies are making, the four-box model of Johnson et al. [11] will be used, which is presented in Sect. 3.3 of this paper. The four-box model is preferred as it is more compact compared to the Canvas business model and the other models presented in Table 1, while clearly illustrating through its elements the ways in which value is created (the value proposition to the customer), value is delivered (through the key processes and resources) and value is captured (through the profit formula) by the company. According to Johnson et al. [11], the business model has four elements or "boxes": value proposition to the customer; key resources; key processes and profit formula, which are discussed in the next sections of this paper.

In Sect. 3.4 some of the main characteristics of Industry 4.0 based business models are outlined, as the concept is still evolving and most companies are in the process of adapting such technologies, therefore outlining a specific and concrete business model is not possible, but some potential characteristics of Industry 4.0 based business models can be outlined.

Value proposition to the customer. A value proposition to the customer, which is defined as a product or service that helps customers solve a problem in a more efficient, convenient and affordable way [16]. An example can be given with the Tesla Inc. Corporation, which offers advanced electric cars covering from low (e.g. Tesla Model 3 car) to high (Tesla Model S) price range customer segments. After its founding in 2003, the company was among the first to work on introducing advanced electric vehicle technology, characterized by a battery providing maximum range to charge; building a network of fast-charging stations; and making its patents available to other manufacturers to improve the technology [18]. Tesla's proposal is unique in terms of its environmental focus (due to the fact that it is 100% electric) compared to petrol/diesel cars, coupled with an exquisite

design and with the same and even higher comfort and extras compared to competitive products. Tesla's EVs require less maintenance than diesel/gasoline-powered cars, and Tesla's models are as easy to control via touchscreen as a smartphone. Last but not least, these EVs can be characterized as so-called intelligent products that communicate with the manufacturer through embedded ICT systems and send information in real time, thus through machine learning algorithms that process big data from all Tesla's EVs, the manufacturer is able to remotely fix errors that occur in the use of their products through regular updates to the EV software [19], optimizing the customer experience and in the process of use. All of these features - ease of use, exquisite design, innovative technology of the EV itself, eco-friendliness, optimized customer experience are the value sources on which Tesla's value proposition is based.

Based on the study of various information sources, it can be concluded that Industry 4.0-based technologies can contribute to improving and optimizing the value proposition to the customer as follows:

- *Firstly*, facilitating the product design and development process and reducing the technological time to market. Technologies such as 3D printing and augmented and virtual reality are expected to significantly support and reduce the cost of designing and prototyping new products, as well as facilitating their customization. Visual technologies are thought to be one of the devices with the greatest potential for growth in the coming years, with a projected market value of $153 billion in 2022 [20].
- *Secondly*, big data analytics capabilities, both on customer preferences and within the production/delivery of the product/service. Currently, corporations and large manufacturers store customer information on one or more online and offline databases that contain interaction history, order history, customer relationship management (CRM), etc. Companies are beginning to merge this online and offline data to gain a more complete view of their customers' preferences. This broader view can help create a demand barometer working from the beginning of the sales cycle (such as an initial website visit) to purchase (such as order data), discovering patterns in purchase intent and facilitating more effective product recommendations [21]. Furthermore, in the context of Industry 4.0, smart products are able to provide information on usage patterns through consumer mobile applications, sensors, etc., which contributes to improving companies' future products and increasing their alignment with customers' requirements and, respectively, their added value. Processing big data from multiple databases on consumer habits, behaviors, etc. through intelligent algorithms contributes to easier and faster identification of opportunities to enhance the value for customers and respectively optimization of the value proposition to them.
- *Thirdly*, opportunities to customize products and services to customer requirements. In the future, it is expected that Industry 4.0 will drive the demand for *ultra-customized products.* These are products fully tailored to a user's needs that can be produced in small batches or even in single units [22]. Customization of products and services and business models based on this concept are not new, but technologies such as cobots and additive manufacturing that will contribute to boosting this trend are expected to be much more affordable in the future than they have been in the past, allowing this business model to be implemented at lower costs than before.

Taking into account the aforementioned changes that high technology can offer, it can be concluded that Industry 4.0 will offer the technological enablers to carry out a more precise analysis of customer requirements and needs and, consequently, to determine their value; to implement these requirements (value) more easily and quickly in new and/or improved products and/or services and to reach the market faster. However, in order to effectively exploit the technological opportunities that the fourth industrial revolution offers for value proposition improvement, these opportunities must also be linked to the other three key elements of the business model - the profit formula, key processes and key resources.

Key resources. An organization's key resources are assets such as people, technology, products, facilities, equipment, distribution channels, brand, partnerships, alliances, and financing [23] needed to deliver the value proposition to the target customer. The concept does not refer to all the resources needed for the company to function, but only to those key elements that create value for the customer and the company, and how these elements interact [11]. For example, in the case of Tesla Inc., these elements are:

- *Firstly, the* Tesla *brand*, which is a luxury electric car brand that in 2021 is ranked 17th in the Brand Finance US Top 100 | 2021 and is valued at about $32 billion [24].
- *Secondly*, Tesla is among the automakers that are making the most use of *Industry 4.0-based technologies.* For example, the production line of the Model 3 electric car is 95% automated, including the processes of transferring, charging, and welding parts [25]. Quality control of the vehicles is also fully automated and is performed by 47 robots located in scanning stations throughout the production line. They measure 1,900 points in each Model 3 to match them to design features - with an accuracy of 0.15 mm. All this data is stored with the vehicle's unique identification number so service centers can trace any problem back to the root cause at the factory [25]. Through this information, Tesla can improve and debug their cars even after they have already been purchased by customers. The company's success is also largely due to the Big data [18] that Tesla collects from all of its cars (even after they have been sold) through built-in software, and which it processes using a variety of algorithms and thanks to which it fixes bugs and problems in its products even after they have been sold, and avoids in the production of its subsequent models.
- *Thirdly*, Tesla has *strategic partnerships* with Daimler to produce original parts and equipment. Another strategic partner is Toyota, the alliance with which is aimed at optimizing and improving the technology of electric vehicle production, parts and accessories. In 2014, Tesla, Inc. Joined the investment in Osaka Batteries (Japan) to develop and improve its battery designs [2, 18]. Tesla's strategic partnerships are directly aimed at maintaining and strengthening the company's competitive advantages and improving its value proposition to customers, whose main source is precisely the multifunctionality and design of the electric vehicles produced by the corporation, as well as the durability and technology of the batteries that power them. Another source of Tesla's value proposition, which is optimized through strategic partnerships, is the network of fast-charging stations that the corporation has built for the convenience of its customers through partnerships with hundreds of hotels, restaurants,

supermarkets, and others. The company also maintains partnerships with its key suppliers such as AGC Automotive: windshield manufacturer; Brembo: brakes; Fisher Dynamics: power seats; Modine Manufacturing Co. Battery chiller; Sika: acoustic dampers; ZF Lenksysteme: power steering mechanisms, etc. [18].

- In the context of intensifying competition, increasing customer demands, globalization processes and the impact of Industry 4.0-based technologies, strategic partnerships are becoming increasingly important as they will form the basis of the partnership ecosystems that will be an integral part of Industry 4.0-based business models. In the context of Industry 4.0, companies that rely only on some basic partnership benefits will not thrive. Companies are realizing the need to redefine their offers, accelerate and expand innovation, and deliver results-oriented solutions in collaboration with partners from established ecosystems [26], which is what Tesla Inc. is actually striving for and has so far succeeded in achieving.
- *Fourthly,* unlike other car manufacturers, Tesla relies on its own *distribution channels (direct sales)* in the form of over 200 showrooms and galleries in 34 countries, with the aim of controlling and maximizing the customer experience in the process of testing and buying cars [18, 19]. Furthermore, the company's website serves as an online store through which anyone can order and customize their Tesla car model.

Considering the above with regard to Tesla Corporation, whose business model is not just influenced by, but is based on the high technologies characteristics of Industry 4.0, it can be argued that the main differences with traditional business models can be observed in the following aspects:

- Aiming to *maximize the user experience* and the product experience not only in the purchase process but also in the use process, due to the fact that in the context of Industry 4.0 we are already talking about smart products;
- Increased *importance of strategic partnerships* across the value chain, including joining forces with competitors based on distinctive competencies to optimize the value proposition to the customer;
- Increased product/service *customization*;
- Use of cyber-physical systems, Big data, artificial intelligence, cloud technologies, Internet of Things, etc., for the purpose of: optimizing and shortening the production cycle; improving the customer experience with the products/services offered; information sharing and networking with partners, suppliers, customers, distributors, etc.

Key processes. Key processes represent the way and activities through which a company delivers the value proposition to the customer in a sustainable, repeatable, scalable and manageable manner [23]. These processes may include product/service design and development, planning, sourcing, manufacturing, marketing, staff hiring and training, research and development, customer service, and certain rules, norms, and metrics [11].

The product/service design and development process broadly refer to identifying a market opportunity, clearly defining the problem, developing an appropriate solution for that problem, and validating the solution with real users [27]. Taking into account the

above definition, it can be concluded that this process is in direct correlation with the definition of the company's value proposition, which is fundamental to the business model. In a narrow sense, the concept is associated with the very act of planning, designing and prototyping a product/service. R&D processes can be added to this process, as they are directly related to the development of solutions to satisfy certain identified needs or problems in a new or innovative way. In the context of Industry 4.0, the design and development processes of new products have been significantly accelerated by technologies such as virtual and augmented reality, for example in the automotive industry through the use of virtual reality, the time between initial design and physical modeling can be reduced from weeks to days [27]. Physical prototyping processes are much faster and cheaper thanks to 3D printing technology. Therefore, business models based on Industry 4.0 are characterized by more speed, flexibility and cost-effectiveness in executing these processes compared to companies whose business model does not incorporate such technologies in their key resources.

Thanks to technologies such as the digital twin, which is a virtual representation of a physical object (including entire factories) or system(s), is updated from real-time data, and uses simulation, machine learning, and reasoning to aid decision making [28], all manufacturing processes can be performed much faster and at minimal cost. Returning again to the example of the Tesla Corporation, its manufacturing facilities are the representation of the smart factory where devices, sensors and robots are connected and work together simultaneously within an integrated system to produce cars and batteries more efficiently [29]. According to experts from the corporation, one of the main advantages of the smart factory is based on the possibilities (via a digital twin) for digital visualization and testing of the entire production in the factory, which contributes to a significant cost reduction [29]. Tesla are also planning the use of an 'augmented reality app for manufacturing' as the introduction of such technology will improve the accuracy and build of new vehicles, reduce time and cost, as well as accelerate further development and support the growing relationship between employees and robotics [30, 31]. Given the above, it can be concluded that compared to the traditional product manufacturing processes, high-tech manufacturing based on Industry 4.0 is characterized by:

- *minimizing errors* at all stages thanks to the digital recreation of each process and its results and the real-time updating of information;
- *speed of* process *execution*, thanks to the high degree of automation and integration of digital and physical systems running the processes;
- *lower costs*, thanks to the opportunities to minimize production errors and the predictable equipment maintenance that is characteristic of the smart factory.

In terms of customer service, it can be said that Industry 4.0-based technologies contribute to the formation of customer-centric business models and customer value creation. Technologies based on artificial intelligence and big data in the form of various platforms and/or applications collect information about customer preferences and behaviors, thus enabling manufacturers to create customer-centric products and improve services [32]. The use of artificial intelligence enables round-the-clock customer service with the help of chatbots, etc. and through the data that is collected from all the systems and equipment in the smart factory with the help of IoT, opportunities are created for

predictive analytics or in other words, catching defects/problems in products/services before they reach the customer, which contributes to a higher level of customer satisfaction. Virtual and augmented reality technologies, in addition to manufacturing, are also applied in the product/service offering process, thanks to which customers can get close to the product and "try it out" virtually, thus making the purchase experience much more realistic and immersive and building trust in the manufacturer and the product [32], creating prerequisites for customer loyalty.

In the case of Tesla Corporation, the cars it produces are intelligent products i.e., apart from the production process, they send information and communicate through sensors, IoT, etc. with the manufacturer even in the consumption process - after the car has been purchased by the customer. According to Tesla, 80% of their car repairs can be done outside a service center, and mobile service repairs are free. They also perform software updates overnight and their repairs are 4 times faster than conventional service [33].

Taking into account the aforementioned, it can be concluded that Industry 4.0-based technologies directly contribute to the formation of a fully customer-centric business model, creating additional value for the customer by offering a service characterized by a high degree of personalization (fully tailored to the customer's needs), awareness, transparency, interactivity (e.g. offering through virtual reality, etc.) and continuity (chatbots, automated Q&A sections available 24/7).

Profit formula. The profit formula in the four-box model is used to determine the margins that the organization requires to sustain and grow its operations and reward owners or shareholders [16]. This formula illustrates how the company, in addition to creating value for the customer, also creates value for itself or the so-called value capture. This element of the four-box business model includes the following aspects:

- *Revenue model* which is determined by the price of goods/services by their volume i.e. the revenue from the company's operations;
- *Cost structure*: direct costs, indirect costs, economies of scale. The cost structure is mainly determined by the cost of the key resources through which the company creates value for the customer.
- *Margin model*: takes into account the expected volume and cost structure as well as the required revenue from each transaction to achieve the desired profits.
- *Asset turnover*: this element considers how quickly inventory, fixed assets and other assets need to be turned over - and generally how well resources need to be used to produce the expected volume and achieve the expected profits [11].

According to PwC's 2016 survey, The Global Industry 4.0, conducted among more than 2,000 respondents from firms in 26 countries, companies that successfully used Industry 4.0-based technologies expected to increase their revenues by 2.9% per year and reduce their costs by 3.6% per year, amounting to $421 billion in reduced costs and $493 billion in increased annual revenues over the next 5 years [34]. Among the sectors that were expected to grow the most was specifically the automotive sector, where the expected growth was equivalent to $28 billion.

The business model of the high-tech automotive corporation at focus, Tesla, is based on three main segments from which its revenues come: EVs; services and energy. Table 2

presents the revenues from these three segments and the company's spending directions for the purpose of offering products and services.

Table 2. Revenue model and cost structure of Tesla Corporation [35].

Revenue model (2019)	Cost structure (2019)
(1) Revenue from car sales: $20.8 billion (85% of total revenue)	(1) Materials, labor and production costs: $17.4 billion (equivalent to 81% of revenue)
(2) Service revenue: $2.2 billion (9% of total revenue)	(2) Sales, general and administrative costs: $2.64 billion (10.7% of total revenue)
(3) Energy revenue: $1.5 billion (6% of total revenue)	(3) R&D expenditure: $1.34 billion (5.6% of revenue)
(4) Total revenue in 2019: $24.6 billion	(4) Restructuring costs: $149 million (less than 1% of revenue)
	(5) Interest, tax and other expenses: about 3% of revenue

In 2019, Tesla's revenue was $24.6 billion at a cost of **$20**.51 billion, however the company had a net loss of -$775 million [35]. The company made a loss of about $1 billion in 2018 as well [35], but this is due to the huge technological investments that will lead to the reduction of production and customer service costs and margin improvement respectively in the long run. In support of the conclusion, the following trends are observed in the corporation's revenue and cost structures between 2017 and 2019:

- Tesla's revenue grew 109% or about **$11**.8 billion in 2017 to **$24**.6 billion in 2019.
- As a percentage of revenue, expenses decreased from 111% to 103% over the same period.
- Cost of sales is Tesla's largest expense item, contributing 77% of revenue generated in 2016 and 81% of revenue in 2019 due to the launch of the Model 3 sedan. However, as revenues are expected to increase in the near future, driven by the ramp-up of Model 3 and Model Y production, cost of sales as a percentage of revenue is expected to decline to 78%, leading to improved operating margins [36, 37].

Given the above, based on the expectations of companies back in 2016 and the example of Tesla Corporation, it can be concluded that Industry 4.0 based technologies, in the long term, for companies that integrate them successfully, will lead to the following changes in the profit formula:

- Increase in revenue due to higher degree of product and service customization and a customer needs-based approach; increased productivity in smart factories, etc. It is also possible to change the revenue structure - for example, not from selling products but from offering Products as a Service (PaaS) or increasing the share of services in

the total revenue of companies. In the case of PaaS, products combined with software to monitor the consumption process and with a range of services provided by the manufacturer in the form of subscriptions, thus extending the consumer lifecycle and making the transition from a product to an all-encompassing duration of service commitment [25].
- Cost optimization and reduction of cost as a proportion of revenue and increase in margins/operating profit.
- Acceleration of asset turnover due to the shortened production cycle and, in general, the cycle from product/service development to market realization.

In conclusion, it can be said that the integration of design flexibility into the manufacturing process, the flexibility of modern manufacturing resources, the increasing role of maintenance and IT, and greater connectivity to customer needs, require sophisticated modelling to manage costs and determine profitability [38]. To provide a clearer picture of the cash flows associated with creating value for customers (costs) and capturing value for the firm (revenue), new cash flow models need to be integrated to provide a clear and timely picture for corporate managers.

3.4 Characteristics of the Industry 4.0-based Business Models

Given the fact that the concept of Industry 4.0 and its impact on existing business models is still new and evolving, and the fact that even large corporations that have the resources to implement such technological solutions are not yet able to fully assess the impact and changes in their operations, it is not yet possible to outline a clear vision of the business model based on Industry 4.0, but some of characteristics can be defined as follows:

5. The value proposition to the customer involves *a higher degree of personalization of products and services*. Industry 4.0-based technologies (cloud computing, Internet of Things, big data, etc.) provide a number of advantages such as connectivity across the entire value network (customers, manufacturer, suppliers, distributors), which creates the prerequisites for process continuity (through predictive analytics); real-time monitoring and communication (between network participants and with products through sensors, etc.); and making timely changes and improvements to products and services according to customer requirements at lower
6. *Business models based on open innovation and crowdsourcing*. Cyber-physical systems, the Internet of Things and the smart factory concept in general contribute to enhancing communication inside the enterprise and outside - in the ecosystem, which creates prerequisites for open innovation and crowdsourcing. Global competition, rising R&D costs, new technologies and shorter product lifecycles require companies to open up their innovation processes, moving from closed innovation to open innovation [39], as for example Tesla Corporation, which shares all its patents in order to ensure a rhythmic supply of essential parts for its EVs and to secure its production, enabling the company to focus more on R&D.
7. *Product Service Systems (PSS)* or Product-as-a-Service (PaaS) offer to make consumption more sustainable. Industry 4.0 shifts the focus of companies from the product to the services that accompany it. In the long term, corporate manufacturers

are expected to expand their role in the value chain, enriching their products with services so that they do not have to compete solely on the basis of production costs [13]. The value proposition in the context of Industry 4.0 will involve the development, realization and offering of specific product and service offers representing a complete solution with high added value for the customer, with manufacturers, suppliers, customers and other partners collaborating in an ecosystem (network) for value creation purposes. Tesla Corporation's electric vehicles are such a complete package, for which the company has built a fast-charging network in collaboration with various partners and provides remote technical (software updates) and physical support for the electric vehicles offered.

8. Business models *based on big data analytics, processing, scalability and availability.* Business organizations operating in the context of the Fourth Industrial Revolution not only want to sell a product to the consumer, but also want to collect information about product usage (product intelligence) throughout the product lifecycle so they can tap into additional revenue streams by offering data-driven services and also get feedback on how to improve their product [23] and thus optimize their value proposition in line with customers' needs.
9. *Networking (ecosystem) to create value. The* processes of globalization, increasing competition and ever higher customer demands in terms of quality, time, degree of customization of products/services, force companies to work in an inextricable network/ecosystem to remain competitive. Industry 4.0 - based technologies provide the technical capability (through horizontal and vertical integration and interoperability) for efficient and timely collaboration of all value chain actors including the customers themselves, who as an ecosystem/network actor contribute significantly to the value proposition optimization processes of companies. All this is expanding the traditional boundaries of the company, resulting in new ways of creating and offering value through ecosystems that go beyond individual value chains, which will effectively force companies to revise their existing business models in response to the new dynamic competition [13].

4 Conclusions

The high technologies associated with the Industry 4.0 concept could at first glance be categorized as simply one of the key value creation resources in an organization's business model (exemplified by the Canvas business model and the four box model), but this key resource has a number of specifics that have the potential to change all other foundational elements of the business model as follows:

- The technologies related to Industry 4.0 in the long term will place specific demands on the employees who use and operate them, which is another key resource of business organizations, therefore *one resource will affect another resource* in the context of the business model and will bring changes in terms of work organization and requirements to its performers. In this regard, one of the main recommendations to corporate managers would be to assess the available human resources in the corporation and their skills and qualifications to operate with the technology solutions based on Industry

4.0, in order to identify gaps and possibly address them through training employees to operate with the selected high technologies;

- The various technologies related to Industry 4.0, depending on their functionalities, purpose and degree of integration with other systems*, can partially or fully impact all key activities and processes in the organization*- from product/service design and engineering (augmented and/or virtual reality; 3D printing, digital twin, etc.); through manufacturing (cyber-physical systems, digital twin, cobots, etc.); planning, maintenance, logistics, monitoring (artificial intelligence, IoT) to customer service (augmented reality, artificial intelligence, IoT) [40, 41]. In this regard, the main recommendation to corporate business managers is that when implementing specific technologies, careful planning should be done to identify which processes will be implemented and what changes this will cause, as well as a detailed benefit-cost analysis to identify the economic and operational feasibility of the investment.
- Industry 4.0 based technologies are contributing to *changing the value proposition* to the customer in several aspects: by changing the products and services offered - we are already talking about ultra-customized products/services; products as a service (Products as a Service) and adding value to products by offering a wide range of accompanying services; smart products that can be improved by the manufacturer and in the process of consumption by the customer, etc. With regard to this category of change, a key recommendation for business managers is to clarify the vision of competitive strategy and market positioning in order to formulate a unique value proposition and select technology to support this vision.
- In the short term, investments in Industry 4.0 based technologies may increase the cost share of revenues, but in the medium and long term, once the investments made have been fully recovered, they will lead to an optimization of both the cost structure (through cost reduction and economies of scale) and the revenue structure (through increased productivity and higher value-added products/services). All this in turn will contribute to improving the operating margins of business organizations in the long run, similar to the example of Tesla Corporation, where there has been a gradual reduction in realized net losses, an increase in revenues, a reduction in the share of costs in the share of revenues over the last 3 years. The main recommendation to corporate managers regarding changes to the profit formula is to conduct a detailed assessment of the effectiveness of planned investments in high technology and their returns, combined with an analysis of the changes that will occur with respect to key processes (to identify potential cost savings) and with respect to the value proposition (to forecast revenues) in order to gain a clearer picture regarding expected future changes in the formula.

In the light of the aforementioned, it can be concluded that if business organizations want to harness the technological potential of Industry 4.0, they must be open to changes in their business models, or in other words, the attitude of corporate business managers must be in line with a famous thought of Peter Drucker, namely "If you want something new, you have to stop doing something old". Therefore, if companies want to maintain competitive positions on the markets in which they operate, implementing a set of technologies without a clear vision of their coherence and impact on the overall business logic (model) and the ways in which value is created, delivered and captured would not

be sufficient. This paper has provided a number of examples of how Industry 4.0 based technologies can contribute to an overall change in the customer value proposition, value capture and delivery. The expectation that simply adopting high technology will bring long-term benefits is not justified in the context of Industry 4.0, which is why many authors talk about a transition to Industry 4.0 [42, 43], as it is a complex process and a transformation of the way we do business. Implementing and financing the technology is only the first step, which if taken also by other competitors, will no longer represent a competitive advantage. The optimal use and creation of value for the customer and for the company through the newly emerging high technologies, or in other words the adaptation of the business model, is the next and more difficult step and it is the step that will bring long-term benefits and competitiveness to business organizations in the future.

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