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Transition of SMEs Towards Smart Factories: Business Models and Concepts

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9.1 Introduction

The term Industry 4.0 originates from the final report of the Industrie 4.0 Working Group (Kagermann et al. 2013), and indicates the subset of the fourth industrial revolution (Marr 2016). According to Drath (2014) for the first time an industrial revolution is predicted a-priori, not observed retroactive. This also clarifies whether Industry 4.0 has to be considered as revolution or evolution, respectively. Logically, it depends on which perspective we are looking at. If we concentrate on differences between Industry 3.0 and future trends of Industry 4.0, then Industry 4.0 clearly covers all features of industrial revolution. This standpoint articulates a retrospective view of the future, i.e., operates with projective

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interpretation of the past. On the other hand, each industrial revolution can be considered a separate milestone that takes some decades from beginnings to a substantial reworking the economy (Stearns 2015). Thus, transformation towards digitization and smart manufacturing is evolutionary in its nature.

Industry 4.0 is frequently discussed from a technological perspective, since advanced technology is indispensable for success of this strategy. In spite of this, only few representative roadmaps for Industry 4.0 technologies adoption are available (Qin et al. 2016) and most of them are not well suitable for SMEs. However, issues that are no less of importance in context of this conception are concerned with *advanced business models* and *human-centred manufacturing* conception.

This chapter aims to analyse implementation success factors of Industry 4.0 especially from business models perspective, and also to address some features of human-centred manufacturing in terms of small- and medium-sized enterprises (SMEs). The motivation of this research is awareness of the importance that just a combination of the selected decisive success factors can significantly help businesses to become more competitive and improving their performance.

When focusing on business models in the context of Industry 4.0 transformation, it is quite obvious that such models will need to adopt new businesses trends, such as mass customization, platform-based businesses, networking manufacturing or creativity-based businesses, respectively. The most related ones are platform-based businesses and mass customization business models. While mass customization practice is relatively well supported by existing methodological frameworks (see, e.g., Pine 1993; Modrak 2017), platform-based business models such as sharing businesses present rather new disruptive approaches, which are not easy to define and categorize. Therefore, the main part of this chapter presented in Sect. 9.3 is devoted to a systematic review on platform-based business models literature using quantitative and qualitative approaches in order not only to map its rapid growth, but also to analyse relation between platform-based business models and traditional business models. The findings of this analysis are summarily presented in Table 9.2. Subsequently, in the same section, existing traditional business models will be analysed how they can be adopted by implementing

features of advanced business models. As the result of this analysis for SMEs, the two possible strategies for implementation of platform-based business models are proposed and described also in graphical form, see in Fig. 9.6. Then, in Sect. 9.4, some related aspects of human-centred manufacturing approach will be outlined. Finally, in the Conclusion section, we summarize main ideas from the chapter and provide general findings.

In order to emphasize a comprehensive view of this complex problem, the next section aims to point out the importance of systems approach in implementation of Industry 4.0 concept for SMEs. The necessity to start from high conceptual understanding of the problem is quite clear, but often underestimated. For this reason, the next section can be useful at least for giving an example how systems approach can be used to capture a general conceptual model of the systems thinking for better understanding the relationships between main elements of the smart factory model.

9.2 Importance of Systems Approach in Transforming Organizations

A successful organization transformation, in generally, requires at least an enterprise strategy, executive leadership, a series of decisions and also change in mindset. In addition, an enterprise strategy has to be viewed comprehensively, i.e. as a set of mutually interactive subsystems, components or parts. One of powerful way to see things mutually influential to one another offers system approach, which is also called the structured analysis and design technique. This approach can be also effectively used for understanding of decisive factors influencing transformation of enterprises into smart organizations. The range of the critical success factors (CSFs) depends on specifics of each company, but at least the three of them, identified in previous section, can be considered as crucial elements. These elements are more specifically represented by *advanced manufacturing technologies* including advanced information communication technologies (ICTs), *advanced business models* using online platforms and *human-centred manufacturing* conception.

Nevertheless, the question can arise of why an a priori systems approach in transforming enterprises into smart organizations has considerable potential for success in this effort. The main advantage of this approach lies in the fact that the CSF elements have to be perceived by transforming companies as whole, not merely as a collection of parts, especially at the first stages of the projects. On the contrary, if this approach is not explicitly neither implicitly employed, it usually leads to an atomic way of thinking that is perceived as a syndrome of cognitive immaturity (Maslow 1981). Systems approach can be regularly defined through systems thinking definitions, e.g. as "a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static snapshots" (Bahill and Gissing 1998). According to Halecker and Hartmann (2013) "systems thinking requires a holistic, interdisciplinary and integrated approach". Directly applicable definition for the purpose of our study states that systems thinking consists of the three kinds of conceptual resources, which are: elements, interconnections and a purpose (Fig. 9.1a).

Then, model of systems thinking can be converted for identifying of decisive factors influencing transformation of enterprises into smart factories, as it is shown in Fig. 9.1. The meaning of this model is to emphasize that the three specified basic elements are neither complementary nor alternative to each other, but they are mutually related in a complete causal structure. In order to show their importance, the

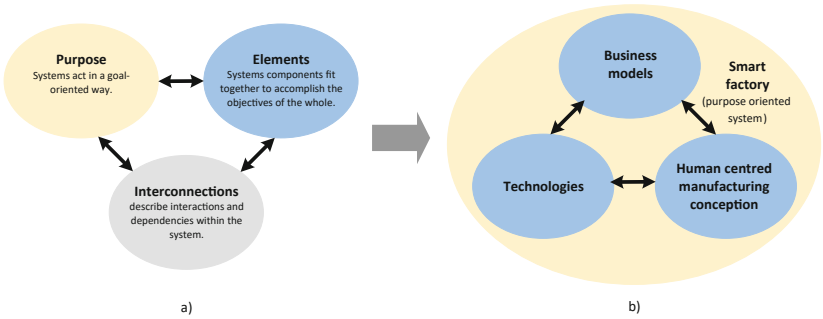

Fig. 9.1 **a** Basic components of systems thinking, **b** Systems model of smart factory with its main elements and interconnections

following two sections are dedicated to describe two of these elements in more detailed way.

9.3 Transition of SMEs Towards Platform-Based Business Models

As this topic of platform-based business models is widely studied in recent literature, we firstly map different approaches to sharing economy practice and structurally analysed them. Subsequently, in Sect. 9.3.2, qualitative analysis of studied literature sources will be provided. The next Sect. 9.3.3 summarizes typical features of platform-based business models.

9.3.1 A Quantitative Analysis of Platform-Based Business Models

Due to the fact that platform-based business models are widely discussed in literature, the quantitative review is an efficient way to analyse research directions and anticipated tendencies. In this order, we started with mapping of number related publications by years. For the purpose, the Web of Science (WOS) database was chosen. Firstly, a research strategy was chosen by finding literature sources related to the term "sharing economy" as part of title, abstract or as keyword on WOS portal searched on July 26, 2020. Then, a total of 2166 potentially relevant papers were found through this database, while 632 publications are open access. Distribution of papers by years of publication is graphically depicted in Fig. 9.2.

The literature sources from Fig. 9.2 consist of journal articles (1571 papers); conference proceedings articles (440 papers); book chapters (76 items); review articles (71 papers); editorial materials (66 papers); book reviews and books (28 papers).

In the next step, the top ten journals, where related papers are published, were selected. Subsequently, they are arranged by number of the papers published in these journals in descending order, namely:

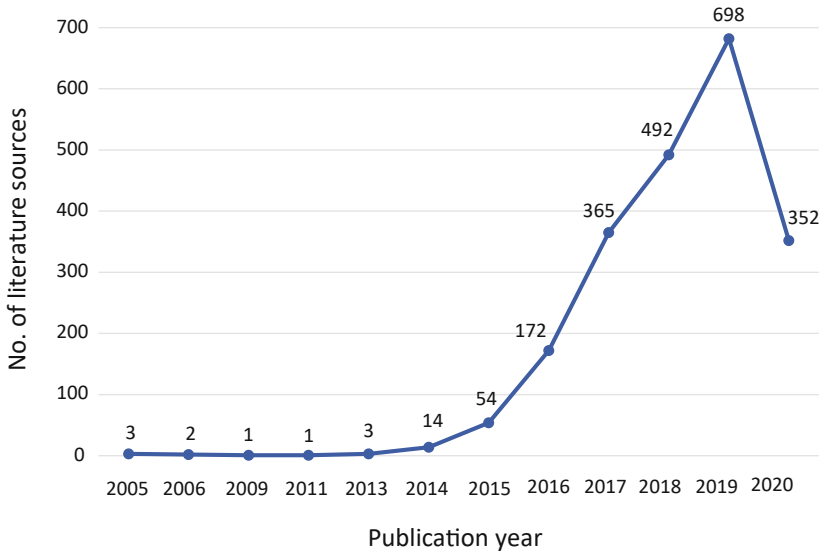

Fig. 9.2 Distribution of papers by years of publication

Sustainability (105 papers); International Journal of Hospitality Management (50 papers); Journal of Cleaner Production (50 papers); International Journal of Contemporary Hospitality Management (32 papers); Current Issues in Tourism (30 papers); Advances in Social Education and Humanities Research (27 papers); Technological Forecasting and Social Change (25 papers); Tourism Management (22 papers); Annals of Tourism Research (20 papers); and Cambridge Handbook of the Law of the Sharing Economy (20 papers). A distribution of the journal papers according to this categorization including journal impact factor (IFs) is shown by graph in Fig. 9.3.

Finally, distribution of literature sources is provided with respect to the top 15 research areas. Based on that, it can be stated that 792 papers are related to Business Economics; 404 papers to Social Sciences; 318 papers to Computer Science; 299 papers to Environmental Sciences Ecology; 284 papers to Engineering; 225 papers to Science Technology; 128 papers to Government Law; 85 papers to Operations Research and Management Science; 79 papers to Transportation; 76 papers to

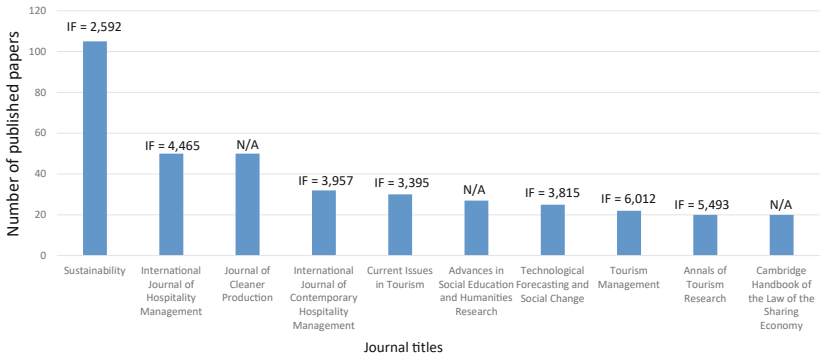

Fig. 9.3 Papers distribution published in the selected journals

Sociology; 73 papers to Information Science and Library Science; 71 papers to Geography; 68 papers to Public Administration; 59 papers to Telecommunications; and 53 papers to Urban Studies. Categorization of the analysed publications from the view of research areas is presented in Fig. 9.4.

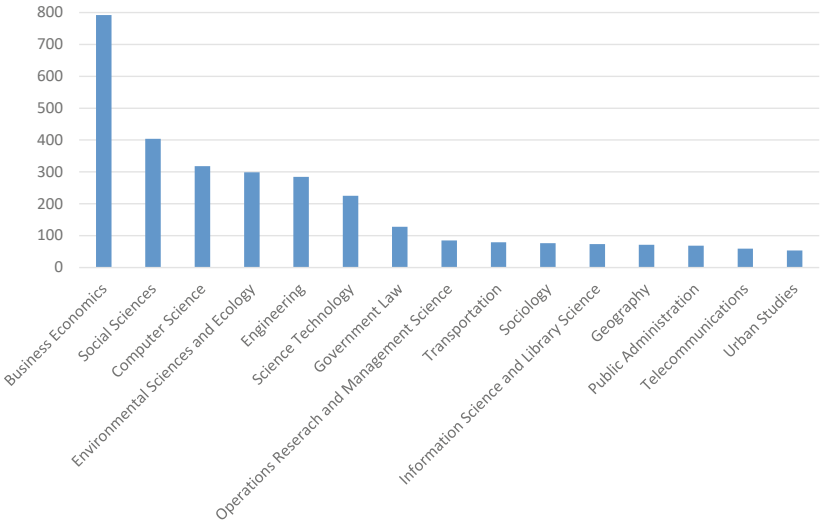

Fig. 9.4 Papers distribution according to research areas

The literature sources shown in previous figure are distributed according to the most frequent research areas. Publications in the research area of *Business economics* are focused on, e.g., analysis of selected marketplaces; analysis of the influences of Airbnb on hotels; business models for the sharing economy; sustainability of sharing economy (see, e.g., Belk 2014a). Related papers to area of *Social sciences* are oriented on, e.g., analysis of the future of the sharing economy; description of customers' satisfaction with accommodation; analysis of customer´s perspectives; analysis of review comments; mapping Airbnb in countries (see, e.g., Ert et al. 2016). Publications related to *Computer science* research area are addicted on, e.g., analysis of blockchain technologies for an advanced and cyber-resilient automotive industry; framework for sharing economy based on Internet of things (IoT); designing markets with a focus on exchange platforms (see, e.g., Hawlitschek et al. 2018). Research are of *Environmental sciences and ecology* contains publications focused on, e.g., analysis of motivation for intended sharing economy participation; examination of sustainable business models; sustainability analysis of sharing economy (see, e.g., Lan et al. 2017). In *Engineering* area, we can find papers oriented on, e.g., marketing research on product design; exploration of sharing economy opportunities in the electricity sector; strategies based on sharing economy to manufacturers (see, e.g., Luchs et al. 2016). Publications in *Science technology r*esearch area concentrated on, e.g., creation of framework adopting the multi-level socio-technical transition theory (see, e.g., Martin et al. 2017). Literature sources in area of *Government law*, e.g., explore conflicts between business and government related to sharing economy; describe new regulators in cities; compare home sharing and sharing economy (see, e.g., Posen 2015). In area of *Operations research and management science*, papers are mostly oriented on, e.g., optimal investment strategy for sharing platform; development of analytical framework to select business modes under the sharing economy; description of classical operations management theory and models, which can be used to study applications of sharing economy (see, e.g., Bellos et al. 2017). Publications related to *Transportation* area are focused on, e.g., uncovering motives of business-to-consumer and peer-to-peer car sharing adopters; offering of vehicle-to-vehicle wireless power transfer; description of

sharing economy implications in transport sector (see, e.g., Birdsall 2014). *Sociology* area consists of publications related to, e.g., analyse impact of sharing economy on exchange of moral values; analysis of ethnic discrimination in the sharing economy; explore tourists' willingness in providing negative reviews online to express poor experiences (see, e.g., Shuqair et al. 2019). *Information science and library science* contains paper related to, e.g., sharing economy literature reviews; framework for future research, study the role of big data analytics in sharing economy (see, e.g., Sutherland and Jarrahi 2018). Publications in the field of *Geography* are focused on, e.g., digital reputation issues and platform-based tourism; description of sharing economy usage in diverse countries; exploring the regional impact of Airbnb on urban environments (see, e.g., Lima 2019). Publications related to *Public administration* area are oriented on, e.g., examination of consumers' value co-creation in sharing economy; description of civil opportunities in collaborative economy based on sharing economy (see, e.g., Nadeem et al. 2020). In the area of *Telecommunications*, papers are focused on, e.g., description of cloud-based sharing platforms; collaborative consumption through mobile apps; exploring service quality among online sharing economy platforms (see, e.g., Li et al. 2017). In relation to *Urban studies*, there are papers oriented on, e.g., study the understanding the spatial distribution in ride-sharing; exploration of the ride-sharing adaption in urban areas of cities; study the understanding the spatial distribution in ride-sharing; exploration of the ride-sharing adaption in urban areas of cities (see, e.g., Ferreri and Sanyal 2018).

It can be stated that, sharing economy phenomena presented as the exchange relation in the leading world economies is based on the increasing use of innovations and technologies related to Industry 4.0. And thus, brief description of selected publications with identified research domains related to the sharing economy and Industry 4.0 conception is depicted in Table 9.1.

This quantitative overview of the related literature firstly showed that sharing economy (SE) significantly attracted not only practitioners, but also scholar community in recent several years. This is clear evidence that SE phenomena cannot be perceived only as one of possible business approach, but contrariwise, SE-based business approaches vary

Table 9.1 Brief description of selected publications on sharing economy in context of Industry 4.0

Research domains	Selected papers related to the domains	Brief description
Sensors, IoT, big data, artificial intelligence (AI)	First-mover firms in the transition towards the sharing economy in metallic natural resource-intensive industries: Implications for the circular economy and emerging industry 4.0 technologies (Jabbour et al. 2020)	Paper offers novel implications for the theory and practice of operations management for the sharing economy; and provides case study on two companies transitioning to the sharing economy
Mobile apps, digital platforms	Crowd working: Jobs in the age of digitalization and platform economy (Wefersova 2020)	This paper is focused on structural assessment of these digital crowd working platforms and analyse the situation of crowd workers
IoT, cloud computing, cyber-physical systems (CPS), data analysis, AI, smart sensors and wireless communication technology	Industry 4.0 to accelerate the circular economy: A case study of electric scooter sharing (Pham et al. 2019)	Article is oriented on the exploration of fundamental concepts of Industry 4.0 and the influential factors of Industry 4.0. According to the obtained results, Industry 4.0 can provide an enabling framework for the sharing economy in CE implementation
Networking, data collected using computer assisted telephone interviews, business model	Implementation of the sharing economy in the B2B sector (Grondys 2019)	Paper analysis and assessment of the sharing economy between enterprises in order to identify the way how the exchange of material resources between them is implemented using statistical testing
Data analysis using statistical software, business models	Development of a business model by introducing sustainable and tailor-made value proposition for SME clients (Bolesnikov et al. 2019)	Article provides a systematic statistical analysis of the proposed business model's aspects on the selected SMEs

Research domains	Selected papers related to the domains	Brief description
Cloud platform, data analysis	Entropy maximization-based capability allocation of clothing production enterprises in sharing economy (Zheng and Song 2019)	This article is focused on capability allocation of suppliers´ production resources in order to maximize their utilization. The proposed model promotes the usage of supplier resources in the production system
Blockchain technology, distributed ledger technology, IoT, CPS, cybersecurity, business model	A review on blockchain technologies for an advanced and cyber-resilient automotive industry (Fraga-Lamas and Fernández-Caramés 2019)	This paper proposed recommendations with the aim of guiding researchers and companies in future cyber-resilient automotive industry developments
Digital economy, AI, technological singularity, IoT, big data	Industry 4.0: socio-economic junctures (Budanov et al. 2017)	The paper is focused on analysis of various social transformation scenarios
Digitalization, robots, automation, data analysis	How big is the gig? Assessing the preliminary evidence on the effects of digitalization on the labour market (Eichhorst et al. 2017)	Article analysed the importance of digitalization in selected countries with a particular attention to the potential or actual impact on the labour market
Digitalization, technological platform, cloud infrastructure, ICT	On the evolution of regional efficiency potentials (Kuch and Westkämper 2017)	The present article addressed the challenge of combining and integrating two quite different dimensions of the business organization: its technological and its managerial perspective
IoT, Big data, cloud computing, AI, e-business, distributed computing and control, multimedia processing	The internet information and technology research directions based on the fourth industrial revolution (Chung and Kim 2016)	This paper categorized topics of articles related to the fourth industrial revolution based on the keyword frequency of main issues

(continued)

Table 9.1 (continued)

Research domains	Selected papers related to the domains	Brief description
IoT, CPS, data analysis, cloud computing	Shared manufacturing in the sharing economy: Concept, definition and service operations (Yu et al. 2020)	This paper presents a dynamic shared manufacturing service scheduling method in support of the technologies of complex network analysis
ICT, data analysis	The information flow between enterprises in the context of sharing economy (Grondys et al. 2020)	This paper examines the enterprises exchange information in the area of sharing economy; existing barriers in the process of information exchange, and the directions and ways to exchange information
Mathematical model	Modelling of sharing networks in the circular economy (Jayakumar et al. 2020)	This paper is focused on development and optimization of a mathematical model based on a framework integrating the key concepts related to a circular economy and SE
Data mining, AI, IoT, big data, CPS	Analysing the major issues of the fourth industrial revolution (Jeon and Suh 2017)	This paper provided an analysis used data mining as modelling method and it is expected that this paper will be helpful for the researcher and policy maker of the fourth industrial revolution
IoT, data analysis, business models	Sharing economy and "industry 4.0" as the business environment of millennial generation—a marketing perspective (Brkljač and Sudarević 2018)	This paper provided comprehension of the relationship between the sharing economy and the "Industry 4.0"

Research domains	Selected papers related to the domains	Brief description
Manufacturing execution system, data analysis, big data, CPS	Comparative study of crossing the chasm in applying smart factory system for SMEs (Choi and Choi 2019)	This article is focused on the practical methodology encouraging manufacturing SMEs in adopting smart factory system utilizing rapidly changing innovative technology
ICT, data analysis, business model	Change through digitization—Value creation in the age of Industry 4.0 (Kagermann 2015)	This paper discusses the impact, challenges and opportunities of digitization
IoT, big data, cyber security, industrial augmented reality, CPS, cloud computing, blockchain	A review on the application of blockchain to the next generation of cybersecure Industry 4.0 smart factories (Fernández-Caramés and Fraga-Lamas 2019)	This paper analysed the benefits and challenges that arise when using blockchain and smart contracts to develop Industry 4.0 applications. Paper describes the most relevant blockchain-based applications for Industry 4.0 technologies
Cloud computing, big data, IoT, CPS, ICT	Italy's Industry 4.0 plan: An analysis from a labour law perspective (Seghezzi and Tiraboschi 2018)	Article identified actions and perspectives to manage current changes, focusing on workers rather than on technologies. Paper describes new functions of labour law in the Industry 4.0 era

Table 9.2 Sharing economy types in three marketplaces

Sharing business model types		Web platform based	Marketplace type		
			C2C	B2C/C2B	B2B
Traditional sharing practice		-	Yes	-	-
Sharing economy	On-demand-based sharing business models	Yes	Yes	Yes	Yes
	Second-hand-based sharing business models	Yes	Yes	-	Yes
	Product-service sharing business models	Yes	Yes	Yes	Yes

depending on specific business conditions. Another interesting finding is that SE penetrated into wide research disciplines. This is quite promising, since it can lead to multidisciplinary exchanges of experiences and bring new stimulus for further development of these phenomena.

9.3.2 A Qualitative Analysis of Platform-Based Business Models

In this subsection it is intended to provide better understanding of the platform-based business models. The term "sharing" has become very popular in recent times, but as known this term is not new. One could see this positive concept in the past where, for instance, overconsumption in households lead to sharing practice to use their resources more efficiently. In this case, we are talking about traditional sharing. But commonly people act in their self-interest solely no matter what consequences arise from this, since Earth's resources are diminishing. On the other hand, when sharing becomes a group effort, then such practice brings positive results for everyone.

SE can be defined, e.g., as "a marketplace that consists of entities that innovatively and sustainably shape how marketing exchanges of valuable products and resources are produced and consumed through sharing, which can occur when entities take part in the actual or life-cycle use of a product or resource and communicate some form of information,

and which can be scaled using technology" (Lim 2020). SE phenomena relates to global economic and sustainability problems and from this reason it is getting increasing attention in our daily lives. Moreover, sharing economy practice becomes important driver of local economies, what can be documented, e.g., by the fact that only in Europe SE platform generated revenues of nearly four billion euros and transactions of over 28 billion euros (Agarwal and Steinmetz 2019).

Sharing economy development is adequately supported through scientific and popular literature. It is useful to note that different authors use several synonymous terms describing these phenomena. Some of them can be mentioned here. Botsman and Rogers (2010) describe this as "collaborative consumption"; Lamberton and Rose (2012) as "commercial sharing systems"; Humphreys and Grayson (2008) as "co-production"; Lanier and Schau (2007), Prahalad and Ramaswamy (2004) as "co-creation"; Katz (2015), Lobel (2016) as "platform economy"; Mont (2002) as "product-service systems"; Bardhi and Eckhardt (2012) as "access-based consumption"; Fitzsimmons (1985) as "consumer participation"; Schor (2014), Frenken and Schor (2019) as "stranger sharing"; and Postigo (2003) as "online volunteering". In order to extract specific knowledge from the existing literature, the term sharing economy will be further divided into two main sub-categories: traditional sharing practice (TSP) and sharing economy (SE) (Stanoevska-Slabeva et al. 2017). While in traditional approach products and services are shared based on mutual deal or agreement between both sides of consumers, sharing economy uses payments and feedbacks or complaints through the platforms based on Web 2.0 technologies (Belk 2014a). The concept based on sharing economy opened doors to the rise of numerous for-profit and non-profit businesses. However, there is some confusion or scepticism about this business phenomena among academics and the public due to its novelty and there is no unambiguously view on what exactly the sharing economy will bring for all of us. Belk (2014b) differentiates terms sharing and pseudo-sharing by using epistemological viewpoint. He is explaining that traditional sharing is about helping and building human relations, while pseudo-sharing is a business relationship masquerading as communal sharing. As it was mentioned, traditional sharing is about solving problems related to overconsumption and efficient resources

usage. Other characteristics and differences between TSP and SE are discussed by Demary (2015). According to her, SE companies present an important part of business model portfolio and thanks to them competition in most markets they are active insignificantly increased.

Frenken et al. (2015) identified three types of SE business models, which are on-demand-based sharing economy, product-service-based sharing economy and second-hand-based sharing economy. In line with this categorization the following classification of SE business models can be offered (see Fig. 9.5).

The typical features of sharing business models depicted in Fig. 9.5 are as follows.

On-demand-based sharing business model is using web platforms and apps and present the intersection of tendencies towards peer-to-peer (P2P) or consumer-to-consumer (C2C) exchange and access economy. For example, when ordering the taxi through, e.g., Uber company, BlaBlaCar company.

Second-hand-based sharing business model can be characterized as traditional second-hand business extended through web platform and apps. Typical provider of services based on this business model is Momox GmbH company, which is offering an online buying-and-selling service for second-hand garments across some Western Europe

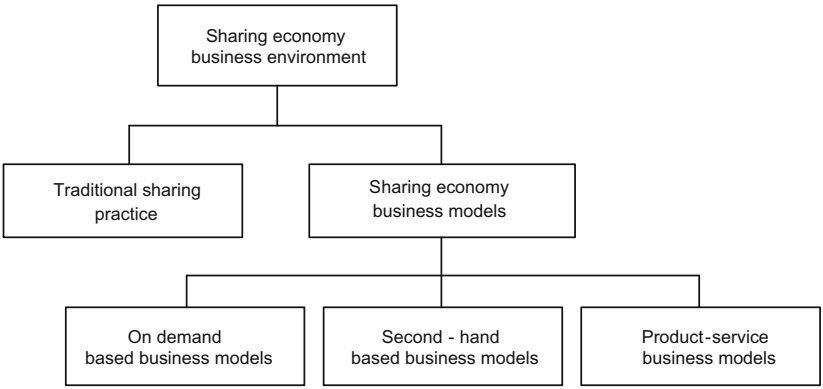

Fig. 9.5 Classification of sharing economy business models

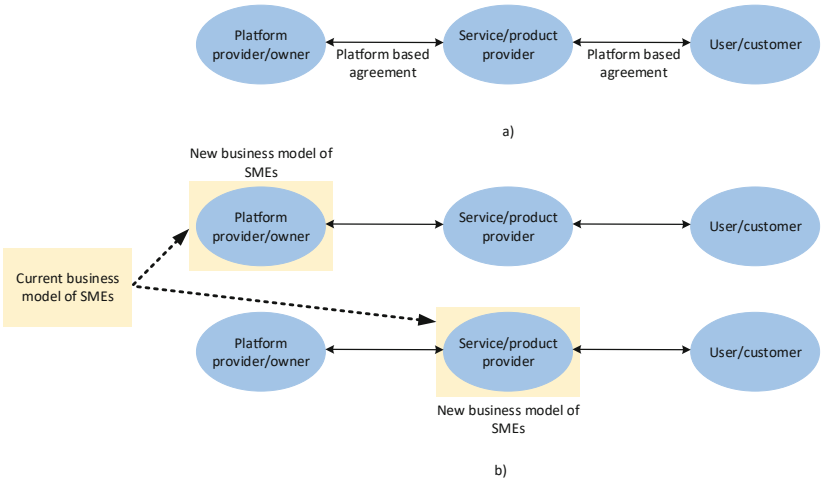

Fig. 9.6 **a** The three actors of platform-based business model, **b** The two possible new strategies for SMEs

countries. Another well-known web-based platforms are for example Ebay or Facebook.

Product-service sharing business models are based on leasing a good from a company on business-to-consumer marketplace (B2C)/consumer-to-business marketplace (C2B) rather than C2C. Consumer utilizing this business model obtains temporary access to a product, while the company retains ownership. An example is car-rental via Hertz or Zipcar.

In order to help SMEs to follow above-described business model it is useful to identify their relations with different online marketplaces. For this purpose, the following comparison of these sharing business models is provided by authors in Table 9.2.

The most relevant sharing business models for transition of SMEs towards sharing businesses are those which operate on B2B and C2C marketplaces. C2C sharing business models are mostly based on virtual networks, through which individual consumers and individual suppliers are connected.

Similarly, for the same reason, transition of SMEs into smart organization is considered to be also suitable in case of B2C/C2B marketplace models. Naturally, it requires the adoption of the E-business solutions allowing many SMEs to respond to these challenging opportunities (Gutowska and Sloane 2009). Nevertheless, the number of B2B sharing marketplace platforms, where one business system sells goods and services to other business systems, is still low when comparing to the B2C and C2C counterparts. The reason why is likely that implementation of the B2B sharing model in SMEs requires combination with complementary innovation-based business models, what is especially challenging for innovation-based SMEs.

In order to formulate practical implications for SMEs, which are acting in B2B and/or B2C markets, it is firstly useful to define main actors of platform-based business model as shown in Fig. 9.6a. Then, in principle, there are the two possible strategies for implementation of platform-based business models (see Fig. 9.6b), which SMEs can choose from.

The first of them is an exploitation at least one of existing online business model platforms and the second one is based on development of own online business model platform.

9.3.3 Typical Features of Platform-Based Business Models

There is no doubt that platform-based business models themselves have a number of inherent advantages over traditional business models. Typical features of platform-based business models can be characterized as follows: they are scalable, networked, intelligent, and with open architecture.

In general, Industry 4.0 prioritizes business models which incorporate the following attributes (Ibarra et al. 2018):

– *A service-oriented approach*. Such business model orientation enables manufacturing companies to provide services through global network to other cyber-physical systems, humans or companies. This approach

emphasizes the long-term need for a change from product sales to service-oriented businesses.
- *A user-driven approach*. This direction means for companies to be more responsive to user-driven demands by learning more about their customers. This approach usually helps to identify new innovation areas and comes up with more individualized products. It can also occur that new innovations are adopted by their suppliers.
- *A network-oriented approach*. Such orientation means that business models are based upon the principles of openness, peering, sharing and acting globally. According to Rauch et al. (2017), especially, distributed manufacturing network models are considered as one of the drivers for the design of the "factory of the future". It means that traditional centralized manufacturing systems will be substituted with more and more decentralized and geographically dispersed manufacturing networks.

9.4 New Work Roles in Industry 4.0 Environment

An introduction of Industry 4.0 into manufacturing significantly affects manufacturing processes in a way which lead to disruptive innovations in work patterns. New work roles and personal tasks of manufacturing staff in Industry 4.0 environment directly result from the necessity of intensive human–machine collaboration requiring new knowledge and working skills. According to Romero et al. (2016) smart factory concepts are placing human operators, named as Operators 4.0, as central actors in manufacturing processes. Such workers will be assisted by automated systems allowing them to utilize and develop their creative, innovative and improvisational skills, without compromising production objectives. In this context, one of significant features of smart factories is *human-centred manufacturing* conception.

The term human-centred manufacturing can be characterized as quasi autonomous manufacturing unit, e.g. cell in which a group of multi-skilled operators works as team (Hancke et al. 1990). The team also includes robots, where both actors collaborating on frequently

changing operational tasks. Presently, human–robot collaboration is a wide research field, which brings high economic benefits. Due to these reasons, transition of SMEs towards smart organizations cannot succeed only by introduction advanced technologies, but need to be also targeted at designing and developing smart workstations based on human centeredness with incorporation of different types of human Operators 4.0 into autonomous manufacturing units.

Romero et al (2016) proposed the following typology of Operators 4.0:

- *Super-Strength Operator*. This category of operators is represented by intelligent wearable human–robotic exoskeletons for manual for manual handling work. Exoskeletons are helping workers across a variety of industry to prevent workplace injuries and illnesses.
- *Tech-Augmented Operator*. This type of operators is strongly supported by augmented reality (AR) technology. As it is assumed that a number of tasks in manufacturing will be increasingly automated, then augmented reality technology is able to provide additional capabilities to the human operators. It's thanks to that, that AR technology is able to interact with the physical objects in a more intuitive manner where the real objects are accompanied by computer-generated perceptual information.
- *Virtual Operator*. In this case, operators of this type are utilizing virtual reality (VR) technology. VR technology is evenly as AR a vital toll supporting shop-floor operators in the smart factories. For example, it can provide a combination of interactive virtual reality and advanced simulations of realistic scenarios for optimized decision-making for the smart operator.
- *Healthy Operator*. As an example of this type of Operator 4.0 is a human operator using wearable trackers, which are devices dedicated to measure exercise activity, stress, heart rate and other health-related metrics.
- *Smarter Operator*. These operators are supported by Intelligent Personal Assistant (IPA) software, which is dedicated to assist people with basic tasks, usually providing information via online sources. This

software, which is based on artificial intelligence, helps a smart operator in interfacing with machines, computers, databases and other information systems (Myers et al. 2007).
– *Collaborative Operator*. His role lies in co-working with industrial collaborative robots, which provides assistance to the human operator.
– *Social Operator*. In this case, operators are used for communication enterprise social networks, which enable faster cooperation between smart operators and smart machines.
– *Analytical Operator*. The specifics of this operator lie in organizing and analysing large sets of data to identify useful information and predict important events. Usually, Analytical Operator is connected to several other applications using advanced data analytics.

These types of operators 4.0 present ambitious nomenclature of work roles in smart manufacturing environment assuming that physical and software components are deeply intertwined in cyber-physical systems and supported by human–machine interaction technologies, such as dialogue systems, multimedia-multimodal displays, adaptive interfaces and others.

9.5 Conclusions

When coming back to the tractate idea about the three crucial factors for successful transition of SMEs towards smart factory which are namely *advanced manufacturing technologies*, *advanced business models* and *human-centred manufacturing* conception, now it is more clear that the main dilemmas that SMEs have to face are: to which technologies they need to invest; and which advanced business model is for them suitable. The both of them need to be solved undependably, and this chapter wants to offer some insight into opportunities for exploitation of sharing economy platform-based models.

In this context, when focusing on the second dilemma concerning a business model selection and application, it can be pointed out here that sharing economy is developing promisingly for the better, since

it is changing the consumer behaviour towards green practices. Hopefully, this fact can positively motivate SMEs in their transition towards smart factory. However, technological development, as precondition of further development of SE, is not always positively perceived among people. It is due to the fact that advanced technology and related industrialization brought many negative impacts on the environment. On the other hand, further technological development is considered as an important impetus to facilitate transition of SMEs towards the Industry 4.0 conception, which is considered as sustainable growth factor. The root of this contradiction lies in classical dilemma what to prefer—technological development or environmental protection, but optimally both. So thinking optimistically, further successful implementation of Industry 4.0 concept can bring promising benefits for everyone.

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