

Peculiarities of IoT-Based Business Model Transformations in SMEs

(Full Paper)

Viktorija Varaniūtė, Kaunas University of Technology, Lithuania, viktorija.varaniute@ktu.lt

Elena Vitkauskaitė*, Kaunas University of Technology, Lithuania, elena.vitkauskaite@ktu.lt

Asta Tarutė, Kaunas University of Technology, Lithuania, asta.tarute@ktu.lt

ABSTRACT

Internet of Things (IoT) is gaining much attention from practitioners and academia and serves as a business mean to increase efficiency and improve business processes. Since small and medium-sized enterprises (SMEs) play an important role in the market's value creation, it is particularly important to understand key aspects of IoT-based business model transformations in SMEs. However, the existing literature on IoT-based business models mainly focused on transformations in large companies. Therefore, this paper aims to identify the preconditions of adopting IoT in SMEs and possible resulting business model transformations. A systematic literature review was chosen as the main research method for this paper. Results of the analysis were summarized as the preconditions for IoT-based business model transformations using Osterwalder & Pigneur's Business Model Canvas concept as a basis.

Keywords: Business model; business model canvas; Internet of Things; IoT; SME.

*Corresponding author

INTRODUCTION

According to European Commission (2015) "we stand on the brink of a new industrial revolution, driven by new-generation information technologies such as the Internet of Things (IoT), cloud computing, big data and data analytics, robotics and 3D printing". Even though technological innovations have a significant impact on both: society and businesses, IoT is considered to be the primary tool of Industry 4.0 which may bring significant economic benefits (Manyika et al., 2015) and provide speed, flexibility, and individualization. Nonetheless, nowadays we witness a struggle of introducing such innovations into business models.

The context of large companies usually dominates recent discussions of the IoT. However, SMEs play an essential role in the market's value creation. Therefore, it is imperative to consider how SMEs manifest such new trends, like IoT. Warriani and Southin (2017) and Nylander, Wallberg, and Hansson (2017) presented studies, which are related to the challenges faced by SMEs engaging in IoT solutions. The main results of their studies have shown that the most important challenge is the implementation and integration of new IoT based systems and solutions influenced by the resource scarcity, unstructured processes, competencies of the employees working with IoT, need for partnership, the need for support related to the government funding, business and innovation systems. The IoT presents a number of challenges for SMEs. However, to gain the opportunities and benefits that IoT can provide, the peculiarities of IoT use in SMEs need to be identified. Therefore, this paper aims to identify the peculiarities of IoT-based business model transformations in SMEs.

The main contribution of the research is the identified preconditions for IoT-based business model transformations using Osterwalder and Pigneur's (2010) Business Model Canvas concept as a basis.

The paper is organized as follows. Next section provides an overview of existing IoT and business model literature, followed by discussions on necessary preconditions to get ready for implementation of IoT-based business transformations. Based on the results of the literature review, the further section provides the research methodology, followed by the section in which peculiarities for IoT-based business model transformation in SMEs are presented. The paper is concluded with the conclusions, theoretical and practical contributions, limitations and suggestions for future research.

THEORETICAL BACKGROUND

The IoT has primarily been researched from a technical perspective, while research from the management point of view is only now gaining momentum. The IoT is used on a wide spectrum of activities, i.e., in the daily lives of individuals, operations of businesses, in processes of the public sector. Such a broad coverage of the IoT indicates that this technology can be applied to different business sectors, and will affect all kinds of industries.

According to Dijkman et al. (2015), the IoT refers to the interconnection of physical objects, by equipping them with sensors, actuators and a means to connect to the Internet. Atzori, Iera, and Morabito (2010) describe IoT as capable of using sensor and

actuator technology to gather data as well as to communicate with each other and the online world. Arnold (2017) explained that “IoT refers to the progressing digitization and smart connection of industrial manufacturing including all company functions, across all products and services, by integrating the entire value chain, resulting in novel business models, and by means of new digital technologies.” IoT implementation leads to different kinds of benefit, such as identified by Kiel et al. (2017, p. 5): “resource efficiency in terms of material usage, energy consumption, increased flexibility, optimized decision making, customization, highly profitable business models, demography-sensitive job design, and improved work-life balance.” To be able to keep up with the changes in technologies and get the predicted benefit, companies have to review their business model and take into account the impact of technological advances.

Kinderis and Jucevičius (2013) has identified three main dimensions of business model innovations. First, *digital dimension* - represented by innovative business models successfully integrating recent opportunities provided by information and communication technologies. Second, *strategic dimension* - business model innovation considered to be a part of the competitive strategy (e.g., innovative business models as a result of smart and successful business result related not only to technological but also to organizational and/or marketing innovations). Third, *technological dimension* - commercialization of business models and innovative technologies (business models are considered to support innovative technological-engineering solutions). Overall, business model innovations - the business model's improvement by implementing or adapting innovative solutions. Business model innovation can result in a competitive advantage, improvement of business process management, reduce costs and lead to better value offer to current or potential customers. Therefore, to innovate a business model, it is crucial to understand what a business model is and how it can be used in order to achieve a competitive advantage in the rapidly changing market environment.

Zott and Amit (2010) define a business model as a system where activities link together through the focal company and the surrounding network. “It is a description of the value a company offers to one or several segments of customers and of the architecture of the firm and its network of partners for creating, marketing, and delivering this value and relationship capital, to generate profitable and sustainable revenue streams” according to Osterwalder, Pigneur, and Tucci (2005, p. 10). Westerlund, Rajala, and Leminen (2011) note that the business model of a company depicts how it operates in the market and how it creates value. The company's activities can be explained the details by using the Business Model Canvas (Osterwalder & Pigneur, 2010). Ju, Kim, and Ahn (2016) state that building blocks of Business Model Canvas framework could be grouped into four main categories: infrastructure, value proposition, customer and finances related building blocks. The infrastructure of the business model represents key partners, key activities and key resources. The category of consumer includes components of the customer relationship, channels, and identification of customer segments. Finance category is related to the cost and revenue structure of a business model. Schneider & Spieth (2013) highlighted the necessity “to examine the complete set of business model components since they are closely interrelated and constitute a business model exclusively in their entirety.” However, in the light of technological transformations (such as IoT-based), it should be noted that the analysis of the business model must also change by taking into account the aspects of such changes.

Bohn et al. (2005) noticed that new business opportunities could be opened with the implementation of IoT. Oriwoh, Sant, and Epiphaniou (2013) highlighted that IoT provides excellent opportunities in terms of more efficient production, new data-driven services, and increased automation. Ju, Kim, and Ahn (2016, p. 889) agreed to this by arguing that “IoT allows companies to collect and exchange data and to accomplish tasks that were previously impossible, thus requiring new business models for a highly connected world.” As Turber et al. (2014, p. 18) emphasized, “IoT is expected to have a major influence on the nature of products and services, and in consequence on overarching business models (Yoo et al., 2010; El Sawy & Pereira, 2013), i.e., the overarching logic of how businesses work (Magretta, 2002)”. Therefore, IoT results not only in the extensive organizational opportunities but also in the challenges by changing and enabling novel business models, which leads to the new form of value creation. It worth noting that a number of studies investigating the new challenges in the topic of IoT in conjunction with business models are growing. The relations between IoT and business model are analyzed in various perspectives (for example, Cavalcante, 2014; Turber et al., 2014; Westerlund, Leminen, & Rajahonka, 2014; Weinberger, Bilgeri, & Fleisch, 2016; Tesch, Brillinger, & Bilgeri, 2017). Recent discussions on IoT are usually dominated by the context of large and high-level industrial organizations due to their ability to implement such type of technologies easier. Therefore, it can be assumed, that IoT can have a dramatic impact on manufacturing processes and business models of traditionally low-value industries or in SMEs. Nylander, Wallberg, and Hansson (2017, p. 1) highlighted that “for SMEs in business domains with little or no IT in their products or production processes, the threshold can be high to enter the world of IoT where products are transformed into services and all processes become data driven.” The results of research performed by Müller, Buliga, and Voigt (2018, p. 8) show that SMEs understand the potential benefits of adopting and implementing new technological solutions in business models but “are frequently aversive towards the costs incurred from <.> requiring new machinery purchase and/or the retrofitting of existing machinery as well as the integration of sensors and software”. Therefore, manufacturing SMEs often lack accurate and consistent information necessary to evaluate and adjust manufacturing performance (Müller, Buliga, & Voigt, 2018). Since SMEs play an essential role in the market's value creation, it is particularly important to understand critical aspects of IoT-based business model transformations in SMEs.

RESEARCH METHODOLOGY

This paper aims at identifying the peculiarities of IoT-based business model transformations of SMEs. The achievement of this aim is possible by reviewing relevant, existing, and academic literature. Due to this, authors saw a systematic literature review as an appropriate methodological approach. Systematic literature review contributed to the identification of preconditions for IoT-based business model transformations in SMEs using the Business Model Canvas concept as a basis.

Authors found some research related to the research topic of this paper (IoT-based business model transformations) was done by carrying out a systematic literature review. Some studies in this area are already completed by using different databases: Business Source Complete (EBSCO), Science Direct, and Google Scholar (Kiel et al., 2016); Business Source Complete (EBSCO), Science Direct, ABI/Inform, and Google Scholar (Arnold, 2017); ACM, IEEE and SpringerLink (Kinitzki & Hertweck, 2017). Authors collected data from two different databases: Science Direct and Google Scholar. Due to the degree of novelty of the research topic, it was decided not to restrict the systematic literature review by the selection of the time horizon for the sources and by the selection of journals.

After defined aspects (related to the database selection, time horizon, and journal selection) for the research, selection of the articles was specified (Fig.1). In the first step, relevant keywords were identified addressing the research aim of the paper derived from existing literature. The following keyword sample was revealed: “Industry 4.0”, “internet of things,” “IoT,” “business model,” “SMEs.” To link them, the combinations of keywords were used (allintitle: SME OR SMEs OR “small and medium enterprises”, “internet of things” OR IoT; allintitle: SME OR SMEs OR “small and medium enterprises”, “industry 4.0”; allintitle: SME OR SMEs OR “small and medium enterprises”, “industrial revolution”). The search was limited to the keyword reflection in titles of the articles. The database research and scan of the results’ titles initially identified 37 articles, which contained at least one of the keyword combinations in the title, and were relevant for this study.



Source: this study.

Figure 1. The selection process of articles

After removing duplicates from the sample, the search resulted in 31 articles. The articles that were written in different than the English language were also excluded to avoid misleading interpretation on terms and their meaning (Reis et al., 2018). 25 articles were left for analysis. In the following step, each of the authors read abstracts of the articles in order to assess their relevance to our research question. Furthermore, although analysis of the abstracts results showed that 15 articles could be relevant for the systematic literature review, due to the lack of the full-text access of the articles, three more articles were removed from the list. Thus, the sample was narrowed down to remaining 12 articles, which were read in their entirety by all authors. Additionally, the articles’ bibliographies were scanned to avoid leaving out potential relevant articles not registered in the searched databases. However, the later step did not result in the addition of any new articles. The primary requirement, the articles had to fulfill, was a strong relationship between the IoT, business models and SMEs. Five more articles were excluded from the analysis, as their focus did not match the research question of this study. A final sample of 7 articles was received. These articles were analyzed and insights categorized by all authors in relation to the concept of the Business Model Canvas. In the final step, all authors of the paper critically reflected and discussed the categorized insights. The results of a systematic research review can provide significant scientific benefits in the field of management by identifying the peculiarities of adopting IoT in SMEs for business model transformations.

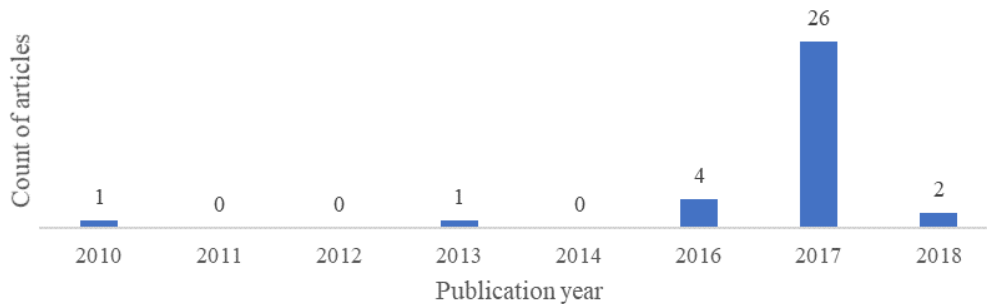
MAIN FINDINGS

Tendencies of the IoT impact of Business Models of SMEs Research Field

A systematic literature review analysis has been done by analyzing scientific sources that mention the keywords “SMEs” or “Small and Medium-sized Enterprises” in combination with “Internet of Things” or “IoT.” A literature analysis has shown that the IoT is often associated and even identified with the fourth industrial revolution, and in order not to miss significant publications related to the study, the keywords “industrial revolution” and “industry 4.0” were also included. The database research and scan of the results’ titles initially identified 37 articles, which contained at least one of the keyword combinations in the title, and were relevant for the research aim.

First of all, the systematic literature review made it possible to identify the tendencies of the research field of the IoT solutions and business models conjunction in the context of manufacturing SMEs (Fig.2). The results show that the first article in the analyzed topic appeared in 2010 with the next article in 2013. In accordance to search criteria, it was determined that the breaking point of

articles was reached in 2017. It is worth noting that in 2017 it was almost seven times higher than in the previous year. Its current status causes the lower number of articles in 2018.



Source: this study.

Figure 2. The number of articles in the research field of IoT and BM conjunction in manufacturing SMEs

According to selected search criteria, it was determined that articles were published in journals (19 articles), conference proceedings (8 articles) and other materials (10 articles). Two articles were published in Global Journal of Management and Business Research, and two more in les Nouvelles - Journal of the Licensing Executives Society, but other tendencies are not evident (due to the small numbers of articles).

The process of articles selection by applying exclusion steps (keywords, no duplicates, English language, relevance, quality), resulted in a final sample of 7 articles in the research field of IoT and business model conjunction in manufacturing SMEs.

IoT impact of Business Models of manufacturing SMEs

The systematic literature review in conjunction with the concept of the Business Model Canvas (Osterwalder & Pigneur, 2010) has made it possible to determine that the implementation of IoT solutions in the production processes of the manufacturing SMEs leads to significant changes in the business models of these companies. The most prominent changes of the business models of manufacturing SMEs caused by IoT noted in the research to date are related to the value creation process. Namely, these decisions change such building blocks of business models as value propositions (4), key resources (7), key partners (4), and cost structure (3). In the other building blocks of the business model changes are also occurring, although their evidence in the scientific literature is less frequently noted.

Table 1: Evaluation of manufacturing SME specific aspects of IoT-based changes to Business Models in selected articles

	Customer segments	Value propositions	Channels	Customer relationships	Revenue streams	Key resources	Key activities	Key partners	Cost structure
	1	4	2	2	2	7	2	4	3
Dassisti et al. (2017)		X				X			X
Kleindienst and Ramsauer (2016)	*	*		*		X	*	X	*
Nylander, Wallberg, and Hansson (2017)						X			
Moeuf et al. (2017)		X	X			X	X	X	
Müller et al. (2017)	X	X	X			X		X	X
Müller, Buliga, and Voigt (2018)				X	X	X	X	X	
Sommer (2015)		X		X	X	X			X

* More generally IT adoption related manufacturing SME specific aspects of Business Models covered.

Source: this study.

Figure 3 provides an overview of the changes of business model building blocks in SMEs due to the implementation of the IoT.

Key partners Strengthening the partnerships by increasing the trust	Key activities Better management of the information flows (thereby improving	Value propositions Product's quality improvement Ability to offer highly	Customer relationships Better information flow with customers	Customer segments Possibilities to address new B2B customer groups
---	--	---	---	--

between partners Productivity of the entire production network of partners improvement Collaboration between SMEs in distributed production networks	management and control)	customized products		
	Key resources Reorganization of production lines Workers' qualifications improvement and staff replacement due to the changing need for skills and knowledge set		Channels Delivery time reduction throughout the value chain	
Cost structure Cost Reduction due to increased efficiency of the production and reduced errors		Revenues streams Expected sales increase Possible changes to payment methods and processes		

Source: this study.

Figure 3: The summary of the IoT based changes to manufacturing SMEs business models

The impact of implementation of IoT solutions for the value creation processes in the manufacturing SMEs is most notable because of the need to re-organize production lines. Moreover, this implementation also requires to improve production workers' qualifications or even change staff due to the changing skills and knowledge set needed for the development of value-added IoT (namely, changing *key resources*; Dassisti et al., 2017; Kleindienst & Ramsauer, 2016; Nylander, Wallberg, and Hansson, 2017; Moeuf et al., 2017; Müller et al., 2017; Müller, Buliga, & Voigt, 2018; Sommer, 2015). Though Dassisti et al. (2017), stress that IoT solutions must rest on (and not replace) existing systems, hardware and software (such as ERP, MES, SCADA) and must require the minimal intervention of the end user at changing the use scenarios. Moreover, IoT solutions must be flexible for the subsequent interventions, i.e., must ensure the possibility to reutilize all the components if SME wants to scale up the overall system, and this indicates the scope of expected changes to these key resources. Authors also emphasize that introduction of IoT in manufacturing SMEs are expected to reduce the operators' learning curve.

Meanwhile, Kleindienst & Ramsauer (2016) note that for manufacturing SMEs implementing IoT solutions, the technical skills, and use of technology solutions interoperable with partner's systems are needed. According to them, the use of simulation tools for production (to produce the product and to overlook the production line) that are tailored to customers (employees) with inappropriate knowledge of simulation and enable them to get good results in a short amount of time should be chosen. Additionally, upgrade of the existing production line equipment is needed to enable (big) data collection, and multimodal assistance systems can help workers with their often diverse tasks.

Also, to make core activities of value creation more effective, the implementation of IoT solutions enables manufacturing SMEs to manage better the information flows, thereby improving management and control (changing *key activities*; Moeuf et al., 2017; Müller, Buliga, & Voigt, 2018). In turn, the better information flows reduce errors at all stages in the value chain and significantly reduce *costs* (Dassisti et al., 2017; Müller et al., 2017; Sommer, 2015).

The more efficient information flow, which is enabled by IoT solutions, also improves the exchange of information with *key partners*, increasing the trust between partners and strengthening the partnerships of SMEs (Kleindienst & Ramsauer, 2016; Moeuf et al., 2017; Müller et al., 2017; Müller, Buliga, & Voigt, 2018). Moeuf et al. (2017) note that IoT solutions implemented by manufacturing SMEs enable better information flow with suppliers and customers, provides the potential to improve the productivity of the entire production network of partners, and IoT (associated with RFID) could enhance collaboration between SMEs in distributed production networks.

The use of IoT offers opportunities to improve product quality, therefore, *value propositions* (Moeuf et al., 2017). On the other hand, implementation of IoT solutions is also perceived as possibly impeding one of the core strengths of SMEs, - the ability to offer highly customized products (Kleindienst & Ramsauer, 2016; Müller et al., 2017). Muller et al. (2017) argue that "SMEs might lose their core strengths such as providing individual and fast solutions, tailored to customer demands." Meanwhile, Moeuf et al. (2017) note that in IoT adopting SMEs utilization of the historical data helps to improve the product quality. They also estimate the potential to reduce the delivery time throughout the value chain (processing and execution time of orders, a collaboration between partners in the network, preserving customer data speeds execution of further orders; indicates changes to *channels*).

DISCUSSION

The analysis revealed that by implementing IoT solutions companies could open new business opportunities. On the other hand, IoT in manufacturing enterprises is intended for real-time interconnection of employees, objects, production machines, customers,

suppliers, innovations into one dynamically managed complex system (Bauer et al., 2014). Therefore companies could face the challenges of changing their business models. The implementation of IoT solutions to the companies' activities also leads to new forms of value creation.

The impact of IoT on business models was analyzed from various perspectives (Turber et al., 2014; Westerlund et al., 2014; Weinberger et al., 2016; Tesch et al., 2017). However, recent discussions are usually concentrated on technological foundations with a tiny touch on the managerial aspects. Moreover, there is a lack of research analyzing an IoT implementation impact on a whole business model. Recent discussions of the IoT related to the business model are usually dominated by focusing on large and high-level industrial organizations due to their ability to implement such type of technologies easier.

Kiel et al. (2017) presented an overview of the business model changes, which are influenced by the implementation of the IoT solutions in one of most detailed manner so far. It is noticeable that more or less all business model building blocks are affected. However, these changes are largely noticeable in large companies. All these changes, which are noticeable in large companies, also can be noticeable in SMEs, but the abundance of the changes depends on the SME's ability to implement IoT solutions (or depends on the SME's ability to invest in IoT implementation). Table 3 provides the changes of business model building blocks due to the implementation of the IoT as found by Kiel et al. (2017) along to findings of this study.

Table 3: The comparison of the changes to Business Model building blocks due to the implementation of the IoT

BM building blocks	Summarized description of changes (Kiel et al., 2017)	Summarized description of manufacturing SMEs' BM changes (this study)
Customers segment (Target customers)	New target customers are hardly addressed	Possibilities to address new B2B customer groups
Value proposition	New products, services, and solution packages based on the application of data mining and analytics; Optimization of production systems and processes.	Product's quality improvement; Ability to offer highly customized products (<i>might be impeded by IoT in some cases</i>)
Channels (Distribution channels)	Increasing orientation toward direct sales due to high customer consultation requirements	Delivery time reduction throughout the value chain
Customer relationships (Relationships)	Intensification due to required explanation of highly complex solution packages; Early integration of customers into product and service engineering fosters partner-like collaboration Interdisciplinary teams bear new contact persons originating in IT and R&D	Better information flow with customers
Revenues streams (Revenue model)	Experiences hardly any changes due to customer resistance	Expected sales increase; Possible changes to payment methods and processes
Key activities (Value configuration)	Increasing technology development activities, particularly regarding software development; Consequent service orientation requires extended customer-oriented communication and customer consultation activities	Better management of the information flows (thereby improving management and control)
Key resources (Core competencies)	Need for IoT-appropriate adaption of workforce qualification; Changing role of employees from operators to problem solvers; Increasing relevance of IT systems, cloud technologies, and software	Reorganization of production lines; Workers' qualifications improvement and staff replacement due to the changing skills and knowledge set
Key partners (Partner network)	IT suppliers and development partners, along with customers, serve as collaborative partners; Nevertheless, manufacturers draw on own know-how and key activities rather than on external partners	Strengthening the partnerships by increasing the trust between partners; Productivity of the entire production network of partners improvement; Collaboration between SMEs in distributed production networks
Cost structure	Rising expenses for IT and software; Decreasing production costs	Cost Reduction due to increased efficiency of the production and reduced errors

Source: Kiel et al. (2017) & this study

It is evident that some of the changes expected in manufacturing SMEs are not dependant on the size of the companies and are equally expected to occur in large enterprises as well as small (e.g., decreasing production costs, the need to reorganize the workforce to meet the needs of IoT enabled manufacturing). However, studies with a higher focus on manufacturing SMEs also identified specific changes that might not be perceived as significant in larger enterprises, therefore were might have been dismissed or not covered by studies without the focus on SMEs (e.g., possibilities to address new B2B customer groups, significant changes of partnerships).

CONCLUSIONS

Results of systematic literature analysis emphasize the importance of business model infrastructure and value proposition within the perspective of a business model canvas. The most prominent changes in the business models of manufacturing SMEs caused by the implementation of IoT solutions noted in the research to date are related to the value creation process. Namely, these decisions change such building blocks of business models as value propositions, key resources, key partners, and cost structure. In the other building blocks of the business model changes are also occurring, although their evidence in the scientific literature is less frequently noted.

The main results of the systematic literature review are the identified core expected changes in business models of the manufacturing SMEs.

The analysis within this paper is based on a literature review severely limited to articles with IoT and SMEs mentioned in titles, and some relevant research might have been missed by not expanding the search to abstracts and keywords. However, the findings provide the basis for a conceptual framework of the impact of IoT on business models to be developed and tested by qualitative (case studies) and quantitative (survey of manufacturing SMEs) methods by the authors in following stages of the research.

ACKNOWLEDGMENT

This research was funded by a grant (No. S-MIP-17-4) from the Research Council of Lithuania.

REFERENCES

- [1] Arnold, C. (2017). The Industrial Internet of Things from a Management Perspective: A Systematic Review of Current Literature. *Journal of Emerging Trends in Marketing and Management*, 1(1), 8-21.
- [2] Atzori, L., Iera, A. & Morabito, G. (2010). The Internet of Things: A Survey. *Computer Networks*, 54(15), 2787–2805, doi:10.1016/j.comnet.2010.05.010.
- [3] Bauer, W., Schlund, S., Marrenbach, D. & Ganschar, O. (2014). Industrie 4.0 – Volkswirtschaftliches Potenzial für Deutschland. Berlin, Stuttgart: BITKOM, Fraunhofer IAO.
- [4] Bohn, J., Coroama, V., Langheinrich, M., Mattern, F. & Rohs M. (2005). Social, Economic, and Ethical Implications of Ambient Intelligence and Ubiquitous Computing. In: W. Weber, J. Rabaey, E. Aarts (Eds.) *Ambient Intelligence* (pp. 5–29). Springer-Verlag, Heidelberg.
- [5] Cavalcante, S.A. (2014). Designing Business Model Change. *International Journal of Innovation Management*, 18(2), 1–22, doi:10.1142/S1363919614500182.
- [6] Dassisti, M., Panetto, H., Lezoche, M., Merla, P., Semeraro, C., Giovannini, A. & Chimienti, M. (2017). Industry 4.0 paradigm: The viewpoint of the small and medium enterprises. In *7th International Conference on Information Society and Technology, ICIST 2017* (Vol. 1, pp. 50-54).
- [7] Dijkman, R.M., Sprenkels, B., Peeters, T. & Janssen, A. (2015). Business models for the Internet of Things. *International Journal of Information Management*, 35, 672–678, doi: 10.1016/j.ijinfomgt.2015.07.008.
- [8] El Sawy, O.A. & Pereira, F. (2013). *Business Modelling in the Dynamic Digital Space*. Springer, Heidelberg.
- [9] European Commission (2015). Fostering SMEs' growth through digital transformation. *European Commission*. Retrieved from <http://s3platform.jrc.ec.europa.eu/-/fostering-smes-growth-through-digital-transformation> (13 June 2018).
- [10] Ju, J., Kim, M. S. & Ahn, J. H. (2016). Prototyping business models for IoT service. *Procedia Computer Science*, 91, 882-890.
- [11] Kiel, D., Arnold, C., Collisi, M. & Voigt, K. (2016). The impact of the industrial internet of things on the established business models. *International Association for Management of Technology, IAMOT 2016 Conference Proceedings* (pp. 673-695).
- [12] Kiel, D., Arnold, C., Collisi, M. & Voigt, K. (2017). The influence of the Industrial Internet of Things on business models of established manufacturing companies – A business level perspective. *Technovation*, 68, 4-19.
- [13] Kinderis, R. & Jucevičius, G. (2013). Verslo modelio inovacijos: tipologijos ir dimensijos vadybos teorijoje. *Ekonomika ir vadyba: aktualijos ir perspektyvos: mokslo darbai*, (1), 84-95.
- [14] Kinitzki, M. & Hertweck, D. (2017). Comparison of Business Model Development Frameworks with regard to IoT. In Rossmann, A., & Zimmermann, A. (Eds.): *Digital Enterprise Computing* (pp. 25-36).
- [15] Kleindienst, M. & Ramsauer, C. (2016). SMEs and Industry 4.0—Introducing a KPI based Procedure Model to identify Focus Areas in Manufacturing Industry. *Athens Journal of Business and Economics*, 2(2), 109-122.

- [16] Magretta, J. (2002). Why Business Models Matter. *Harvard Business Review*, 80(5), 86–92.
- [17] Manyika, J., Chui, M., Bisson, P., Woetzel, J., Dobbs, R., Bughin, J. & Aharon, D. (2015). Unlocking the Potential of the Internet of Things. *McKinsey Global Institute*.
- [18] Moeuf, A., Pellerin, R., Lamouri, S., Tamayo-Giraldo, S. & Barbaray, R. (2018). The industrial management of SMEs in the era of Industry 4.0. *International Journal of Production Research*, 56(3), 1118-1136, doi:10.1080/00207543.2017.1372647.
- [19] Müller, J. M., Buliga, O. & Voigt, K. I. (2018). Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0. *Technological Forecasting and Social Change*, 132, 2-17, doi:10.1016/j.techfore.2017.12.019.
- [20] Müller, J. M., Maier, L., Veile, J. & Voigt, K. I. (2017). Cooperation strategies among SMEs for implementing industry 4.0. In *Proceedings of the Hamburg International Conference of Logistics (HICL)* (pp. 301-318).
- [21] Nylander, S., Wallberg, A. & Hansson, P. (2017). Challenges for SMEs Entering the IoT World – Success is about so Much More than Technology. In *IoT '17 Proceedings of the Seventh International Conference on the Internet of Things*, October 22–25, Linz, Austria, Association for Computing Machinery. Article No. 16. doi:10.1145/3131542.3131547.
- [22] Oriwoh, E., Sant, P. & Epiphaniou, G. (2013). Guidelines for Internet of Things Deployment Approaches – The Thing Commandments. *Procedia Computer Science*, 21, 122–131, doi:10.1016/j.procs.2013.09.018.
- [23] Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: origins, present, and future of the concept. *Communications of the Association for Information Systems*, Vol. 16, Article 1, [1-25]. doi: 10.17705/1C AIS.01601.
- [24] Osterwalder, A., & Pigneur, Y. (2010). *Business model generation: a handbook for visionaries, game changers, and challengers*. John Wiley & Sons.
- [25] Reis, J., Amorim, M., Melo, N. & Matos, P. (2018). Digital Transformation: A Literature Review and Guidelines for Future Research. *Trends and Advances in Information Systems and Technologies*, 1, 411–421, doi:10.1007/978-3-319-77703-0_41.
- [26] Schneider, S. & Spieth, P. (2013). Business model innovation: towards an integrated future research agenda. *International Journal of Innovation Management*, 17 (1), 1-34, doi:10.1142/S136391961340001X.
- [27] Sommer, L. (2015). Industrial revolution-industry 4.0: Are German manufacturing SMEs the first victims of this revolution? *Journal of Industrial Engineering and Management*, 8(5), 1512-1532, doi:10.3926/jiem.1470.
- [28] Tesch, J., Brillinger, A. & Bilgeri, D. (2017). Internet of Things Business Model Innovation and the Stage Gate Process: An Exploratory Analysis. *International Journal of Innovation Management*, 21(5), [1-16], doi:10.1142/S1363919617400023.
- [29] Turber, S., vom Brocke, J., Gassmann, O. & Fleisch, E. (2014). Designing Business Models in the Era of Internet of Things. Towards a Reference Framework. M.C. Tremblay et al. (Eds.): *DESRIST 2014*, LNCS 8463 (pp. 17–31).
- [30] Yoo, Y., Lyytinen, K., Boland, R., Berente, N., Gaskin, J. & Schutz, D. (2010). The Next Wave of Digital Innovation: Opportunities and Challenges. In: *Research Workshop: Digital Challenges in Innovation Research* (pp. 1–37).
- [31] Warrian, P. & Southin, T. (2017). The Internet of Things and Printed Electronics: Case Studies of Innovation by SME Manufacturers. *Global Journal of Management and Business Research: Interdisciplinary*, 17(3), 34-44.
- [32] Weinberger, M., Bilgeri, D. & Fleisch, E. (2016). IoT business models in an industrial context. *Automatisierungstechnik*, 64(9), 699–706. doi:10.1515/auto-2016-0054.
- [33] Westerlund, M., Leminen, S. & Rajahonka, M. (2014). Designing Business Models for the Internet of Things. *Technology Innovation Management Review*, 4(7), 5-14, doi:10.22215/timreview/807.
- [34] Westerlund, M., Rajala, R. & Leminen, S. (2011), *Insights into the dynamics of business models in the media industry*. Laurea Publications A74 42 p., Vantaa.
- [35] Zott, C. & Amit, R.H. (2010). Business Model Design: An Activity System Perspective. *Long Range Planning*, 43(2-3), 216-226, doi:10.1016/j.lrp.2009.07.004.