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Evaluating SMEs Readiness to Transform to IoT-Based Business Models

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EVALUATING SMES READINESS TO TRANSFORM TO IOT-BASED BUSINESS MODELS

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ABSTRACT

The connection of devices, as enabled by the Internet of Things (IoT), has a significant impact on business activities, processes, and performance. IoT is, therefore, gaining attention from practitioners and academia. The deployment of technological innovations is inseparable from changes in business activities, and therefore also affects business models (BMs) of both large corporations as well as small and medium-sized enterprises (SMEs). Both face challenges on transformations to their business models due to the use of IoT solutions, although these changes might be different for both. Extant literature on IoT-based business models mainly focuses on transformations in large companies. Since SMEs play an important role in the market's value creation, it is particularly important to understand SMEs business model transformations, caused by IoT. Research on this topic is limited and faces many theoretical and methodological challenges. Therefore, this paper proposes a mixed method approach to study SMEs readiness to transform business models as a result of implementing IoT solutions. Based on a systematic literature review, and a pilot study (by using a case of one SME in Lithuania), we developed a mixed method research design in which input-output relation between case studies for theory formulation as well as theory testing are proposed.

KEYWORDS

Internet of Things; Business Model; IoT; SME; mixed-method research.

1. INTRODUCTION

New-generation information technologies and technological innovations, such as the Internet of Things (IoT), and related technologies like cloud computing, big data and data analytics, robotics and 3D printing, have a great impact on society and businesses. IoT is considered to be the main driver and enabler of this new-generation of smart technologies. Application of IoT in production processes is labelled as Industry 4.0 or as Smart Industry. IoT is defined as the global wireless integrated smart device and gadget, called “things”, making use of a wide range of networked sensors and actuators with as a result that objects communicate with each other and with people using standard protocols (Atzori et al. 2010; IEEE, 2012). The use of IoT can bring significant economic benefits (McKinsey & Company, 2015), which is why companies have an interest in deploying IoT solutions. The deployment of technological innovation is inseparable from changes in business activities, processes and business models (BMs). These changes affect business efficiency, improve business processes by providing speed, flexibility and individualisation, as well as contribute to economic performance.

Chesbrough (2010) noted that the deployment of IoT solutions could not be based solely on technological innovation. The potential of new technologies can only be exploited through innovative BMs (Chesbrough, 2010). Moreover, the development of IoT solutions constantly provides new opportunities for business model innovation. As Hui (2014) points out, the application of routine solutions and BMs may not be enough. In order to exploit new technologies and their potential, companies must fundamentally reconsider their orthodox value creation mechanisms. Therefore, companies need to understand how to change their BMs if they want to take advantage of the opportunities offered by IoT solutions.

The literature on IoT-based BMs mainly focused on transformations in large companies. Many large companies offer a variety of IoT-based solutions and develop use-cases in various industries. IoT solutions for SMEs as well as SMEs developing IoT-cases are still limited. However, dominant players in their ecosystem push a number of IoT solutions to SMEs. Either IoT implementation is the result of a technology push, or is seen as an enabler for current activities and processes, in both cases a deep understanding of the technology and how the business logic of a company in creating and capturing value is affected, specifically in the case of SMEs is an underexplored research domain. Although attention for BM for SMEs is increasing (Heikkila et al., 2018), the role of IT is underexplored (Bouwman et al., 2018). Some studies are related to social media, big data and digital transformation in general. Obviously, research on IoT-based BMs focused on transformations in SMEs is a vast area to explore. The need for these studies is also strengthened by the fact, that SMEs play an important role in the EU market’s value creation, as is also recognised by the OECD (2017).

In practice, the BM Canvas concept (Osterwalder & Pigneur, 2010) has gained broad recognition. However, technology as such is not explicitly discussed as is the case in alternative approaches such as the STOF model (Bouwman et al., 2008) and VISOR (El Sawy & Pereira, 2013). These models focus, for instance, more on the role of technological architecture, platforms, privacy and security, interface designs, and system integration, among other aspects. While extensions of the STOF model discuss the interdependencies of stakeholders in an ecosystem, by focusing on how value creation and capturing takes place, how data is shared, information is provided and knowledge acquired, while at the same time aligning inter-organisational (physical) processes (Solaimani & Bouwman, 2012). Based on the current state of the art BM Innovation (BMI) research, we will focus on how to develop BMI thinking further by focusing on architectural or components based BM changes that are new to the industry of new to the world (Foss & Saebi, 2017). In order to understand the inherent complexity of implementation of IoT and the consequences for SMEs BM, a clear research design is needed.

In this paper, we propose a mixed-method approach, combining case study research based on a literature review and a preliminary case, which served as input for a case study protocol. The case study protocol is used in ongoing case studies. The case studies will serve as input for a large-scale survey on the population of Lithuanian SMEs that have or in the near future will adopt IoT solutions.

Therefore, this paper will contribute to theory formulation with regard to the combination of emerging technologies and BMs, with an emphasis on SMEs. Next, the paper will propose how to test developed propositions. In this way, the paper will propose a mixed method approach that pays attention to the details that need to be mastered in order to understand the impact of the implementation of IoT solutions and how this impact SMEs BMs. These lead to the main contributions of this paper, which is the deeper understanding of how IoT solutions affect the value creation and capturing by SMEs, and how to research this in detail.

The paper is organised as follows. Section two provides an overview of existing literature on the topic of IoT and Business Model in SMEs, in order to uncover the IoT impact of Business Models of manufacturing

SMEs. Section three provides the results of a preliminary case. Based on the literature study and the preliminary case results, the research design and methodology are presented, in combination with methodological guidelines for IoT-based business model transformation research in section four. Section five provides the conclusions, theoretical and practical contributions, limitations and suggestions for future research.

2. THEORETICAL BACKGROUND

The role of IoT on BMI was studied only by a few researchers. For example, Turber et al. (2014) proposed a methodology for developing BMs based on IoT, which touches upon three important aspects: S-D logic, a tiered value-creation dimension, and embedded environments. Fleisch et al. (2015) examined the impact of IoT on service/product development logic and value creation trends. Westerlund et al. (2015) have proposed essential aspects of value creation for Business Models developed in IoT ecosystems. Dijkman et al. (2015) proposed a methodology for developing BMs for IoT-based applications. Ehret and Wirtz (2016) examined the impact of IoT on information-driven service innovations. An overview of research topics on the impact of IoT on BMs confirms the need of the deeper and more detailed analysis of how IoT affects individual components of the BM and how it interacts with component interconnections to create the IoT value.

The concept, characteristics and benefits of the IoT. IoT is one of the fastest growing technology domains, which is a part of a unified global operating system. Depending on the research context, the IoT is defined in various ways. 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. Arnold (2017) explained that IoT refers to the progressing digitisation and smart connection of industrial manufacturing (Ind 4.0) including all company functions, across all products and services, by integrating the entire value chain, resulting in novel BMs. Although there are many alternative definitions (Chase, 2014; Friess & Vermesan, 2014; Guillemin & Friess, 2009 stressing different aspects of IoT, we will follow the ITU (2018) definition. The ITU definition states that “IoT is a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies. Through the exploitation of identification, data capture, processing and communication capabilities, IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled. From a broader perspective, the IoT can be perceived as a vision with technological and societal implications.” (ITU, 2018).

The fundamental characteristics of the IoT are (ITU, 2018) related to: (1) interconnectivity, (2) things-related services within constraints, such as privacy, semantic consistency between physical things and their associated virtual things; (3) heterogeneity as based on different hardware platforms and networks; (4) dynamic changes, number of devices connected, the dynamic or passive state of devices, as well as the context of devices including location and speed; (5) the potential enormous scale; and (6) the ratio of communication triggered by devices. Even more critical will be the management of the data generated and their interpretation for application purposes. This relates to the semantics of data, as well as efficient data handling, big data and big data analytics.

Chase (2014) sees some fundamental challenges, including connectivity, power management, security, complexity and rapid evolution. These challenges can increase the vulnerability and risk of systems. Overcoming the challenges will lead to the benefits that the IoT can provide to the enterprise by speeding up the processes, doing a lot of mechanical work and helping enterprises to be more flexible. Summing up, the IoT would serve the economic and social purposes of the enterprise, but in the same way of the society.

The concept and characteristics of Business Model. BM literature offers a wide range of definitions, typologies, ontologies, BM components, patterns and innovation paths as being used in diverse disciplines as strategic and innovation management, information systems and computer science (Zott, Amit & Massa, 2011; Foss & Saebi, 2017). More and more, there is a common understanding that BMs are related to creating, delivering and capturing value. Developments in the BM and BMI research are branching out to all kinds of disciplines, like entrepreneurship or International strategic management. More and more tools are developed to enable BM design and Innovation (Bouwman et al., 2012; Haaker et al., 2018). We will refrain here from an extensive discussion of BM literature and BM Innovation. We define the latter concept as a change in a company’s business logic of value creation, distribution, and capture that results in observable changes in its

practices towards customers and partners. These changes can be architectural or only related to a single BM component. The changes can be new to the company or new to the industry (Foss & Saebi, 2017).

As mentioned in the introduction, the most broadly used BM ontology is the BM Canvas concept (Osterwalder & Pigneur, 2010). Although we will make use of their ontology, we will add this with more technology-focused components from alternative ontologies like STOF (Bouwman et al., 2008) and VISOR (El Sawy & Pereira, 2013).

The impact of the IoT for the BM in manufacturing SMEs. As Bauer et al. (2014) noted the IoT in manufacturing enterprises (Ind 4.0) is intended for real-time interconnection of employees, objects, production machines, customers, suppliers, innovations into one dynamically managed complex system. By implementing IoT solutions, a company might not only exploit organisational opportunities but also engage in the challenges to change their business model, which result in a new form of value creation. It is noted that the number of studies, which are investigating the new challenges in the topic of IoT in conjunction with business models, are growing. The linkage between IoT and business model are analysed in various perspectives (for example, Turber et al., 2014; Westerlund et al., 2014; Weinberger et al., 2016; Tesch et al., 2017). Large and high-level industrial organisations usually dominate recent discussions of the IoT due to their ability easier to implement such type of technologies. This shows the IoT use in companies' activities can have a dramatic impact on manufacturing processes and business models of traditionally low-value industries or in SMEs. Some features of the manufacturing enterprises that implement the IoT solutions are typically 1) a reduced number of low-skilled workers, as a large number of jobs are carried out by machines (Erol et al., 2016), 2) a need for IT professionals, because system maintenance, upgrades are essential to ensure that the production system operates stably and accurately (Kiel et al., 2016), 3) a need for workers, that are better skilled because they need to work with innovative devices (Kiel et al., 2017), 4) a high average wages due to high qualified work (Kiel et al., 2017), 5) production of customised products, since IoT devices are adapted to rapidly changing processes, and therefore IoT in manufacturing companies can accept a variety of customised orders, and 6) use of Big Data to ensure operational efficiency (Kiel et al., 2017). These features of the manufacturing enterprises that implement IoT lead to the change of business activities, which lead to the change of BM logic.

The impact of the IoT on the BMs relates, for example, to the following BM components:

- Value proposition: a) online interactions greatly individualise a service or product (Kiel et al., 2016; Kleindienst & Ramsauer, 2016; Müller et al., 2018). It obliges the company to understand what the consumer really wants; b) self-production machines and systems not only prepare the service or product but also collect, monitor and analyse information (Kiel et al., 2016).
- Key partnerships: a) increasing the trust between partners and strengthening the partnerships of SMEs (Kleindienst & Ramsauer, 2016; Moeuf et al., 2018; Müller et al., 2018); b) collaboration with customers and suppliers is increasing, which helps to improve product and value chain (Kiel et al., 2016; Moeuf et al., 2018); c) consumers are involved in the manufacturing of product or service design (Kiel et al., 2016;).
- Key Resources, more precisely human resources: a) the need for more skilled workers is increasing (Kiel et al., 2016; Dassisti et al., 2017; Kleindienst & Ramsauer, 2016; Nylander et al., 2017; Moeuf et al., 2018; Müller et al., 2018; Sommer, 2015); b) there is a need for IT professionals who oversee the system, c) reducing unskilled labor (Erol et al., 2016).
- Key activities: to make core activities of value creation more effective, the implementation of IoT solutions enables manufacturing SMEs to manage information flows better, thereby improving management and control (Moeuf et al., 2018; Müller et al., 2018).
- Costs: 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., 2018; Sommer, 2015).

Tesch et al. (2017) emphasised that IoT is expected to have a major influence on the nature of products and services, and in consequence on overarching business models (El Sawy & Pereira, 2013; Yoo, Henfridsson & Lyytinen, 2010), i.e. the overarching logic of how businesses work (Magretta, 2002). Based on the insights as shortly discussed, we used an initial case to define our research focus in more detail.

3. CASE

The case focuses on a Lithuanian manufacturing SME. In 2016, manufacturing enterprises sold for more than €18.7 Bn., of which exports amounted to 64.3%, and it has created more than one-fifth of Lithuanian GDP (Statistics Lithuania, 2016). In order to cooperate with enterprises from economically more advanced countries, Lithuanian enterprises need to use the latest technologies that enable customisation, cost reduction, flexibility and speed. The purpose of the case is to determine how IoT has influenced the BM making use of primary and secondary mainly qualitative data sources. Primary data was based on structured interviews (Müller, Buliga & Voigt, 2018) and a discussion of BM Canvas components. The first part of the interview was intended to collect the view on and experience of the company's manager with IoT. The second part was focused on the filling out of BM Canvas. Secondary data sources are the company's website, articles on, and interviews about the company.

The main criteria for the selection of the company were (1) the company is active in manufacturing in Lithuania with an international and innovation focus; and (2) the company should be in the process of deploying IoT. Twenty enterprises did meet both criteria and were contacted. From the five enterprises that responded on a request to participate in the research, three did not use IoT neither planned to do so in the near future. The final selected enterprise was GRA (the name of the enterprise is not revealed for confidentiality reasons).

The main activity of GRA is the production of non-standard metal equipment, parts, and moulds. Long-term experience with well-known corporations, modern computerised equipment and highly qualified specialists ensure an extremely high quality of these products. GRA's areas of activity are drawing, constructor services, modelling of new constructions, rebuilding existing constructions according to production possibilities, welding, and assembly and supply chain management. The main clients of the enterprise are international engineering groups (98% of the output is exported).

In an interview with the core manager, the importance of the IoT was emphasised, arguing that IoT is an important technology in contemporary life and business. IoT is enabled by a software system that connects all production facilities in the company. The system contains all technical data of the production facilities, collects all data on usage of these devices and the product under production. The system registers progress of production, data on simulations, production time and phases, and other relevant data in order to assess if the production can be more efficient. This system helps to achieve maximum efficiency, process control, breakdown prevention and predictive maintenance, and device load stability.

In order to achieve profitability and market competitiveness, the entire product manufacturing and supply chain must work efficiently and in concert. The IoT technology, connecting all production facilities and use of sensors, helps to achieve this. *“Whether the company uses IoT is relevant to both suppliers and users”* (manager). First of all, in terms of customers, *“Lithuania is not an advanced and highly reliable partner in the manufacturing sector; foreign customers very much appreciate the use of IoT in the production of GRA. This adds credibility. With IoT, it is easier to calculate our production capacity and reduce the deficit, so it is considered that the manufacturing companies that use IoT perform better. Also, customers who use Industry 4.0 technologies have a choice of selecting or be selected by advanced partners to enable systems to interact with each other. However, this does not always work. The biggest problem occurs when systems are different and cannot scan other system information. For example, the drawings of the product must be redrawn by employees of GRA, since the system of customers is usually different.”* The manager has identified this problem as key to full automation.

Moreover, *“after the implementation of IoT, some suppliers of materials had to be replaced. A system that combines production facilities, bookkeeping, etc. requires very precise data on both production and invoicing, etc. Companies that use outdated technologies sometimes send only paper-based information about the goods they receive. Manually entering information leads to errors and requires additional work. Both suppliers and customers must be on a similar level. Industry 4.0 requires better communication between buyers and suppliers. When everything is digitised, fewer errors occur, and this speeds up processes”*.

The manager of GRA stated that IoT caused no difficulties or inconveniences. He argued that the implementation of the IoT had a significant impact on the company's speed, flexibility and product quality. On the other hand, the director said, *“the main thing to become less dependent on human resources is to invest in*

software. More work is done by production facilities, which makes employees, with fewer competencies, less needed.” Due to this, the company pays attention to the improvement of qualification, increased salaries for qualified labourers and a safer and pleasant working environment.

With regard to BMs, “the company is changing those components of the BM that require changes with the implementation of IoT (key activities). Eastern European countries, which are not leaders of innovation and progress, should first seek to approach advanced countries and try to collaborate with them (key partners). For this reason, GRA is trying to reach the standards of advanced companies”. The manager states that they “are not attracted to innovations as such, or simply the desire to be the most up-to-date leads to the technology of Industry 4.0. The key aspect of the company’s investment is the need to stay competitive. The growing number of manufacturing companies in Asia, which are characterised by cheap labour and high production volumes, are pushing for quality and customised products. Customers are demanding more and more unique products. It is very important to produce precisely without using unnecessary resources. Both in logistics and partnership with other companies, everything has to be adjusted and calculated. IoT makes it more manageable and predictable. Due to such changes, after the implementation of IoT, some components of the BM are changing. The company does not resist such changes to increase its productivity in order to maximise the benefits of technology for the company. One of the changes brought about by IoT in the company is the training of staff and the abandonment of many of lower competence employees.” Table 1 summarises how the BM of GRA was affected by IoT.

Table 1. GRA BM before and after the implementation of the IoT solutions

BMC Building Blocks	Before the implementation the IoT	After the implementation of the IoT
Customer Segments	B2B customers requiring unique metal constructions	B2B customers requiring unique metal constructions. <i>The opportunity to work with high technological level enterprises</i>
Value propositions	Non-standard metal equipment, parts and moulds. Production of which is characterised by: <ul style="list-style-type: none"> • Speed • Quality 	Non-standard metal equipment, parts and moulds. IoT helps the SME to amplify their key values: <ul style="list-style-type: none"> • <i>Speed - more effective implementation</i> • <i>Quality - stability of product quality</i> • <i>Credibility due to the fact that IoT is used</i>
Channels	Exhibitions E-mail and telephony	Exhibitions Direct sales by e-mail and telephony
Customer Relationship:	Personal service; Customer acquisition at Exhibitions and Fairs	Personal service Customer acquisition Exhibitions and Fairs
Revenue Streams	Product Sale (unique metal constructions)	Sale of production (unique metal constructions)
Key resources	Materials Staff/employees Equipment	Materials Staff / employees <i>changed qualification and competencies</i> <i>IoT enhanced equipment</i>
Key activities	Producing Timely procurement of materials	Producing <i>faster with higher efficiency and effectiveness</i> <i>System development</i> <i>Qualification improvement of employees - training in the use of IoT</i>
Key partnerships	Suppliers of materials Suppliers of complex products/parts	Suppliers – <i>some replaced to ones with the same level of technology use</i>
Cost Structure	Materials Depreciation of the equipment Salary	Materials – <i>cost savings due to more efficient use</i> Depreciation of the equipment Salary

The table shows that the components *directly affected* due to the implementation of the IoT are *key activities and key resources*. The software system plays a core role in key activities, and IoT contributed to changes in key resources. The system, which is part of the IoT, is implemented in the company’s processes, trying to connect as much equipment as possible. The more pieces of equipment are connected to the system, the better

it can assess the most efficient way of manufacturing, and the quality of products delivered. This system improvement directly affects the *value proposition*.

BM elements that have been *indirectly affected* due to the implementation of the IoT are *key partnerships, value propositions, customer segments*. Some suppliers have been replaced to make processes faster and reduce the number of errors. Some suppliers were not sufficiently advanced to implement and use IoT based technology, lacking the necessary technical support. In addition, when an IoT is operating in a manufacturing SME, accuracy is required and digitalised. The technology itself plays a role in the improvement of the quality of both the products to be delivered and to operational processes.

To sum up, it can be argued that GRA implemented the IoT in order to become more efficient and to improve quality and processing speed as part of the company's value proposition. After implementing the IoT, the company had to adapt to it to reap the expected benefits. Looking at the changes in the BM, significant changes were noticed in two components - key activities and key resources. Indirect changes occurred in key partnerships and consumer segments. All of the changes were partially done to make IoT technology work as efficiently as possible, while the IoT technology itself is aimed at making the company more efficient and high-quality implementation of the value proposition.

4. DISCUSSION

Based on this preliminary case, some conclusions for future research can be drawn. First of all, in this case, the implementation and use of IoT affected technology as used by the company as well as the operational processes of the company profoundly. A limitation of the BM Canvas model is that it does not discuss the technology as such. IoT, as is reflected in this case description, remains a black box and as such does not make clear what the real impact is.

Furthermore, the relations with suppliers and customers are mentioned, but a broader view on the eco-system in which the company is acting is missing. From extensive research in the field of BMs vis-à-vis emerging IT-systems, we know that the interaction between technological developments needs to be studied in detail and in concert with changing in the eco-system beyond the tier-1 relations of the focus enterprise.

There is a number of questions that remain open based on the first case, i.e. what was the trigger to change the BM? Was there first a strategic decision and next the BM was changed? Was the first technology renewed as a result of external drivers or internal pressure? Was technology implemented and then the BM adapted, or was it done in parallel? How the BM was managed, and how was communication with internal and external stakeholders managed? Was the change only on a component level or was the BM architecture also affected? Was there a roadmap for BM change made or used? Was the BM changes a process of experimentation or was the introduction of IoT and the change of the BM well thought out up front, or was the processes a question of haggling and responding on the spot? A simple fill out of the canvas does not provide detailed information on BM Innovation as related to IoT. Therefore, we redefined the research design in more detail.

In our research, we propose to make use of a mixed method approach. This first case was instrumental in assessing the limitations of the Canvas model and enforced us to elaborate on the technical side of IoT as well as understanding the related position of the company in an eco-system, Therefore based on an additional set of case studies that are sampled based on two dimensions, i.e. (1) the maturity of IoT, more specifically if (a) implementation of IoT is underway or (b) IoT is already incorporated, and (2) the complexity of the related ecosystem, more specifically based on (a) a subordinated tier-1 position in the supply or (b) as a keystone player or dominator who plays the core role in the ecosystem. this will lead to a 2x2. In the case study we will extend the analysis as based on the BM Canvas with components that discuss the technical architecture and platform dimensions, privacy and security, interface designs, system integration, as all part of the STOF approach, the core internal and external processes related to value creation and capturing and information and knowledge exchange, as well as how (inter-) organisational processes are actually executed. The results of these analyses will inform the questionnaire in more detail. Both the case study protocol and the –draft– questionnaire are available on request.

5. CONCLUSION

Results of systematic literature analysis emphasised the changes of business models of manufacturing SMEs because of the implementation of IoT solutions. IoT did lead to process optimisation, such as speeding up the processes, doing a lot of work in an automated way, offered new business opportunities and helped the enterprise to be more flexible. The analysis of the preliminary case showed that the BM components of the selected company GRA directly affected are key activities and key resources. BM elements that have been indirectly affected due to the implementation of the IoT are key partnerships, value propositions, customer segments. All of the changes in the BM were partially done to make IoT technology work as efficiently as possible, while the IoT technology itself is aimed at making the company more efficient and to offer a value proposition that makes the company move upwards in the value constellation. The results of the preliminary case leads to the conclusion that the implementation and use of IoT affected technology as used by the company as well as the operational processes of the company profoundly. A limitation of the BM Canvas model is that it does not discuss the technology as such. IoT, as is reflected in this case description, remains a black box and as such does not make clear what the real impact is.

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