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A design science research approach

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TOOLING FOR INTERNET-OF-THINGS BUSINESS MODEL EXPLORATION: A DESIGN SCIENCE RESEARCH APPROACH

Research in Progress

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Abstract

Attention to business models (BM) is increasing as digital technologies are transforming enterprises in many industries. Technological disruptions such as the Internet of Things (IoT) force enterprises to rethink their BM to create and capture value. Even though the need for business model innovation (BMI) may be clear, how to change a BM is not always obvious, and often requires extensive BM exploration. Existing BM tools are mainly focused on formalizing one specific BM design rather than facilitating systematic exploration of alternative BMs. In this paper, we provide the preliminary results of a design science research project in which software supported tooling is created to support BM exploration.

Keywords: Business models, Internet of Things, Design Science Research, Business model tooling.

1 Introduction

Digital technologies are fundamentally reshaping businesses (Bharadwaj, El Sawy, Pavlou, and Venkatraman, 2013). One prominent example is the Internet of Things (IoT), which is expected to affect enterprises in any industry sector (Kyriazis and Varvarigou, 2013). As the environment is changing, companies need to reconsider and reinvent their existing Business Models (BMs) to stay competitive (De Reuver, Bouwman, and Maclnnes, 2009; Sosna, Trevinyo-Rodríguez, and Velamuri, 2010). BM exploration can provide new insights on business and context to discover new BM opportunities (De Reuver et al. 2016). Systematic approaches to BM exploration and experimentation enable companies to come up with new BM ideas (McGrath, 2010; Baden-Fuller and Morgan, 2010), which may result in sustained competitive advantage (Eppler, Hoffmann and Bresciani, 2011; Sosna et al. 2010).

BMs is an emerging topic in information systems (IS) research (Cosenz and Noto, 2017; Roelens and Poels, 2015; Bouwman, De Vos, and Haaker, 2008; Fritscher and Pigneur, 2014; Kyriazis and Varvarigou, 2013; El Sawy and Pereira, 2013). While there is focus on BM tooling (De Reuver et al. 2016), the potential benefits of tooling are still overlooked (Eppler Hoffmann and Bresciani, 2011). Existing tooling is mainly concerned with formalizing single BM designs (e.g. Business Model Canvas), and far less on supporting the exploration of alternative BMs in a structured way. Existing tooling is often generic without considering a specific digital technology innovation, which is a problem because critical information may be missed and viable solutions may be overlooked.

BM exploration is important when new opportunities require rethinking of the BM. It involves creating BM alternatives and changes, (Cavalcante, Kesting and Ulhoi, 2011), conceptualizing them (et al. 2010) and assessing what could happen under a range of different decision choices (Sterman, 2000; Bisbe and Malagueño, 2012). For this study, we focus on the BM exploration triggered by a technology disruption. While in many publications the process towards a BM is presented linearly, in practice business managers face the uncertainty of the evolving markets (Berends et al. 2016). During BM exploration managers are in an iterative process where they test BMs until they reach a revised, and successful BM (Sosna et al. 2010). Hence, the research question for this research in progress paper is: *How to design and develop software supported tooling to facilitate BM exploration for established businesses that face disruptive technology innovation?*

We focus on Internet of Things (IoT) since this is a major technology innovation that has the potential to fundamentally change BMs. We are interested in the IoT as it is an area that the impact of the BM exploration might be the biggest, and thus it makes it interesting for us to investigate. Considering the changes IoT brings to the BMs, it is no surprise to observe an increasing focus among scholars for IoT BM designs (e.g. Chan, 2015; Westerlund, 2014, Dijkman et al. 2015).

In this research, we create an artifact for BM exploration as a potential solution. As McKay et al (2012) point out the utilization and evolution of an IS artifact over time for specific socio-technical context is of research interest. Thus, our ultimate research goal is to contribute to the literature by showing how BM tooling contributes to BM exploration processes driven by digitalization. The primary user group for our artifact are entrepreneurs that are aware that they might have to reconsider their BM due to IoT but are not yet sure on how to do so. Our target users do not need to have experience in doing BMI or be aware of theoretical concepts (e.g. what are BM components). This research will allow us to provide design guidelines for the development of artifacts for BM exploration. Additionally, the study will contribute to science by providing more insight regarding BMs within the IoT environment. Furthermore, we aim at a practical contribution to the development of an easy to use tool with minimum complexity, and high automation that supports enterprises with their BM exploration and innovation process. However, in this research in progress paper, we present the design requirements that, in future steps of our research, will be tested for their potential contribution to the field. In this publication, we communicate the methodology towards the first evaluation iteration of the developed artifact. See figure 1 for an overview of the current and future steps of our research.

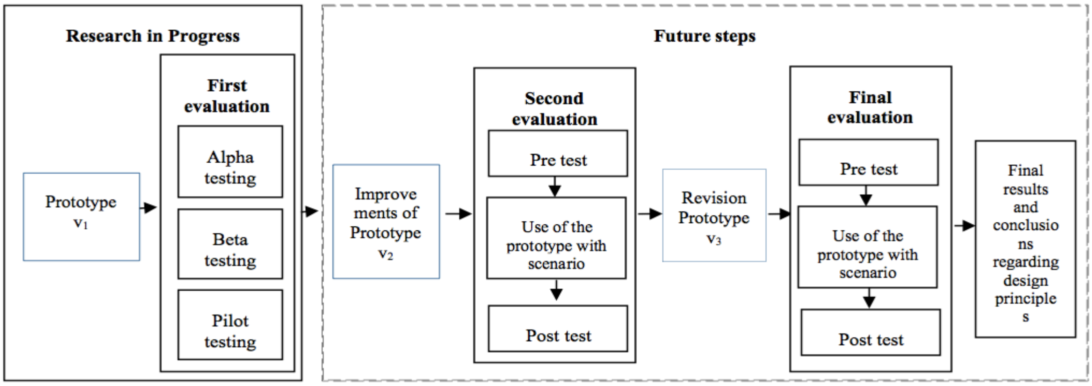

Figure 1. Overview of the current and future steps of this research.

The paper is structured as follows. Section 2 provides a background on BMs, BM innovation (BMI) theory, as well as work related to IoT and BM tooling. Section 3 provides a description of the methodology followed. For this study, we follow a Design Science Research (DSR) approach. The rest of the paper is structured based on the DSR approach. Section 4 discusses the design requirements and gives a short description of the first version of the developed artifact. Section 5 gives a short description of the first evaluation iteration and some preliminary results. In section 6 we conclude with the discussion, limitations and our future steps towards the finalization of this study.

2 Background

Academics define a BM as the core logic of how the enterprise creates value (Kallio, Tinnilä, and Tseng, 2006; Linder and Cantrell, 2000). Another view on the topic is that BMs can be seen as a reflection of the enterprise's strategy aspects (Solaimani and Bouwman, 2012; Casadesus-Masanell and Ricart, 2010; Leem, Suh, and Kim, 2004). We define a BM as '[…] *a conceptual tool containing a set of objects, concepts and their relationships with the objective to express* […] *what value is provided to customers, how this is done and with which financial consequences*' (adopted from Osterwalder Pigneur and Tucci (2005, p. 3). According to Magretta, '*a good business model remains essential to every successful organization, whether it's a new venture or an established player'*'(2002, p. 3). However, BMs often have to be changed over time in response to internal or external drivers (De Reuver et al. 2009) such technology disruptions. Bower and Christensen (1995) characterises a new technology as disruptive when it lacks refinement, has performance problems, disrupts an existing market or creates a new one, and eventually leads to new products.

IoT can be described as a major technology disruption. '*IoT is a network that connects uniquely identifiable things to the Internet. The things have sensing/ actuation and potential programmability capabilities.'* (Minerva, Biru, and Rotondi, 2015, p. 73). A main characteristic of IoT is that it allows physical objects to adopt digital characteristics (Turber et al. 2014). IoT is not about a single novel technology but the combination of many complementary developments such as sensors, connectivity, and analytics. IoT is a major technology disruption because it implies that digital technologies will enter the physical infrastructures and physical product industries. Besides automating existing processes, IoT will enable collecting vast amounts of data and novel ways of actuating, which enable completely new ways of creating value. For instance, IoT enables remote monitoring of vehicle performance. That can enable anything-as-a-service BMs (McKinsey & Company, 2015). IoT has the potential to transform the ways enterprises deliver innovation, improve customer experiences (Brody and Pureswaran, 2015) faster handling and increased cost efficiency, process agility (Uckelman et al. 2011) and more accurate forecasting of stock situations (Geerts and O'Leary, 2014). While the IoT is spreading, the traditional and well-known business model' frameworks might not be in line with the IoT needs. '*To take advantage of new, cloud-based opportunities, today's companies will need to fundamentally rethink their orthodoxies about value creation and value capture'* (Hui, 2014). IoT enables hybrid solutions of physical and digital services and that triggers revising the BMs because physical and digital industries are not clearly separated (Klein, Pacheco and da Rosa Righi, 2017) Disruptive technologies like IoT require a new BM tool. Existing BM tools do not explicitly, support exploration of new value creation through digital technologies entering physical product industries. For instance, research on IoT and BMs is relatively underdeveloped (Ju, Kim and Ahn, 2016).

Sosna et al. argue that most of the prominent BMs are '*gone straight from the drawing board into the implementation* […] *in reality new [BMs] rarely work the first time around, since decision makers face difficulties in both exploratory and implementation stages*' (2010, p. 384). Existing literature on BM tooling is mainly focused on how to design a BM (e.g. Osterwalder and Pigneur, 2010; Bouwman, Haaker and De Vos, 2008; Ballon 2007), or how an enterprise can move from an old to a new BM (De Reuver, Bouwman and Haaker, 2013). In practice, tooling is available in different formats. For example, the BM Canvas (Osterwalder and Pigneur, 2009) is available in many forms such as a book (Osterwalder and Pigneur, 2010), physical cards (Foresight cards, 2012), web-based app (e.g. Leanstack, 2017) and mobile app (e.g. BM Canvas and SWOT). Other tooling formats are printed cards (e.g. Gassmann, Frankenberger and Csik, 2014), board games (e.g. Business Innovation Kit, Starter Kit), printable templates (e.g. Lean canvas; BM Wheel), computer-based (e.g. Haaker, 2017; De Reuver et al. 2009), or web-based (e.g. E3 value). However, these tools are not designed for a specific domain such as the IoT.While BM tools for BM design, testing, and implementation are emerging, supporting tools for systematic BM exploration are lacking, in particular in relation to disruptive technology innovations like IoT. Hui (2004) argues that the implications of IoT for BMI are huge, and IoT requires a BM swift. For instance, regarding value creation, in the traditional BM, the offering was a standalone product, and potentially obsolete, while IoT BM enables products that are constantly updated.

Regarding value capture, Hue argues that in traditional BM the path to profit was via selling products or devices while IoT BM enables recurring revenue (Hui, 2014).

3 Method

For this study, we follow a DSR approach. DSR allows us to produce innovative artifacts as an answer to unsolved problems (Henver et al. 2004; Peffers et al. 2008; Verschuren and Hartog, 2005). For this study, we use the DSR approach by Gregor and Hevner (2013) a common approach used in IS. In this research in progress paper, we present the research approach and some preliminary results for the evaluation. We follow McKay et al. who argue that within the IS field DSR is about '*intervening in contexts to make improvements and ensuring that change works well [within these contexts]*' (2012, p.135) We do so by understanding the context and perceived problem, designing a solution, interpreting it and sharing with potential users to test it.

Table 1 summarises the DSR activities, adapted from Gregor and Hevner (2013), the objectives of this paper and type of research methods, data collection or instruments we used. The remainder of this paper provides a more detailed description of activities 4-7.

Activities	Research in progress objectives	Methods, Data instruments
Introduction (1)	Problem definition, Research Questions Goal (Section 1)	-Literature review.
Background (2)	Understand the theories behind the practical problem. (Section 2)	-Literature review.
Method (3)	Description of the DSR approach followed. (Section 3)	-Literature review on DSR methods.
Artifact description (4)	-Identifiation of the potential solution. -Development of the solution; (Section 4)	-Action research; Microsoft excel program; review of existing tooling.
Evaluation (5)	Description of the evaluation approach for this research in progress. (Section 5)	-Experimental design; interviews.
Discussion (6)	Interpretation of the results. (Section 5)	-Qualitative analysis of the data.
Conclutions(7)	Communication of preliminary results of the first evaluation and improvements before the next iteration. (Section 6)	-Interpretetion of the data; limitations, future research; communication within academia.

Table 1. DSR activities, objectives and methods (adapted from Gregor and Hevner, 2013).

For the second activity (*Background*), we reviewed the literature of BM ontologies and elements, BMI, BM exploration, BM tooling and literature on IoT. The purpose of this activity was to understand the theories behind the problem and what they can provide a solution for the practical problem.

The third activity *(Method)* is about the used method. This section (section 3) focuses on this activity.

For activity 4 (*Artifact description*), we focus on creating a set of design requirements for the artifact. For this study, we develop three main design requirements to link the three main functions that we want to test with the developed tool. For that purpose, we took two specific actions: (a) firstly, we focused on a specific industry, the automotive ecosystem, as we identified it as an industry with major IoT disruptions; (b) subsequently, we conduct a design project for a mobility business with existing state-of-the-art BM tools in order to learn the shortcomings of existing tools and extract more requirements regarding what BM exploration tooling needs to include. Additionally, we created a set of generic functional and non- functional requirements in order to make sure that the tool is valid to be tested in next phases of the research. Finally, we developed the first version of the prototype.

Our fifth activity (*Evaluation*) is to evaluate the artifact to conclude regarding the satisfactory or unsatisfactory functionality of the artifact (Verschuren and Hartog, 2005). This paper only presents the first evaluation iteration. This iteration includes the alpha and beta testing as well as an initial pilot where participants test the tool. This pilot test follows the experimental design developed for the overall study. For this research in progress paper we do not explain the evaluation of design propositions that informed the design of the tool functionality. However, we have a detailed plan to test them. In the evaluation of the prototype, we will use experimental design to evaluate the utility of the design guidelines. Specifically, we will conduct pre- and post-test questionnaire on the extent to which users are able to achieve the goals specified in the design guidelines. We will use the same questionnaire items while testing an alternative tool with similar functions as a control condition.

In the sixth activity (*Discussion*), we discuss and interpret the results. For this research in progress, we discuss the preliminary results regarding the artifact and based on the results how it could be improved in the future research.

For the seventh and last activity (*Conclusion)*, we communicate the results and the contribution to the scientific community (Hevner et al. 2004). In this publication, we communicate the methodology towards the first evaluation iteration of the developed artifact. Feedback from the communication together with feedback from the evaluation activity will be used as inputs for the next iteration and improvements of the study and the artifact.

4 Design and Development

4.1 Identifying the design requirements

The next activity of the study is to create the design requirements we want to test as part of the evaluation process of our research. The design requirements allow us to develop the artifact. Chesbrough argues that '*every company has a business model, whether they articulate it or not. At its heart, a business model performs two important functions: value creation and value capture* (2007, p. 12). Technology disruptions, like the IoT, are '*a business model problem, not a* technology problem' (Christensen, 2006, p. 48). However, even in the cases that enterprises invest in new ideas, they often have little ability to do BMI incorporating these changes (Chesbrough, 2010).

In the case of the dynamic nature of IoT, there are new ways of capturing and delivering value that does not require a completely new BM but a new version with merely few components of the existing one changed. It is argued that the dynamic nature of IoT requires experimentation with the BM, as there is no single answer to what it should be changed (Capgemini, 2014). Demil and Lecocq (2010) argue that the BM adaption is a continuous interaction between the BM elements and the environment. However, the entrepreneurs do not think of their BM as a set of components might have trouble identifying and revising them. We follow the prefilled template approach (the users can select from predefined options). We argue that prefilled templates can influence the understanding of BMs components and subsequently in the users' engagement to the BM innovation process (Eppler, Hoffmann, and Bresciani, 2011). Hence, we define the first requirement as: the artifact should have ***pre-filled BM templates that could facilitate the user's understanding of the components of the existing BM.***

Generating ideas on what components of existing BM should be changed is an important aspect of BM exploration (Achtenhagen et al, 2013; Berends et al 2016). How IoT will affect BM components is still not clear. Enterprises need to identify what changes they need to do in their existing BM such as to identify which capabilities need to be developed within the enterprise, or what business partners are needed for potential IoT opportunities (Klein, Pacheco and da Rosa Righi, 2017). However, what opportunities IoT can bring to the enterprises is not always clear as there is not a comprehensive view of what components of BMs can be affected (Krotov, 2017). Enterprises have no choice but to examine every possible change to every possible component. Thus, idea generation is important in this context. What we argue is that a BM tool with a focus on a specific domain has a positive impact on BM change. Thus, the second design requirement is: The artifact should have ***solution-based BM patterns that might improve idea-generation on how to change different components of the existing BM.*** By solution-based patterns, we mean BMs that take into consideration the IoT.

After identifying potential chances is an important step towards a revised BM is to make decisions upon which of the previously identified changes should be implemented. The literature suggests that a way to support decision making is by using assessment methods such as critical success factors, or metrics that can assess the feasibility of the changes (Haaker et al. 2017; Heikkila et al. 2016; Bouwman et al. 2008). However practical tools supporting BM change assessment are not available as existing BM mainly focus on designing new BM or revising existing BM and they do not go a step forward to assess the feasibility (Heikkila et al. 2016). A clearly and structured description of the BM is required for assessing the feasibility of potential changes (Haaker et al. 2017). That might not be possible in the case of the reshaping of a BM due to a digital disruption. Assessing potential changes towards an IoT could support decision making towards a revised BM and therefore it could contribute to BM exploration. We articulate the last design requirement as: ***The artifact should have evaluation metrics to improve user's decision making about whether to adapt components in the BM.***

4.2 Development

The description of our artifact is done in three steps. Each of the steps reflects one of the design requirements we previously described in section 4. That allows us to apply and test the design requirements independently from the other. We developed the artifact with the use of Microsoft Excel. The three steps are: (1) Creation/description of the existing BM, (2) Exploration and identification of IoT opportunities and potential changes and (3) Assessment of the changes.

The design requirements format the functional development of the prototype. However, we wanted to create a prototype that is user-friendly too. The design requirements supported our decision on the components that the artifact should include. Future publications will focus on the methodology behind the artifact elements. The artifact contains three steps, each of which reflects one of the design requirements from Section 4. We created an initial version of the artifact to test and receive feedback. Figure 2 presents a screenshot of one of the three main parts of the artifact. Due to page limitations, a clickable prototype of the artifact can be accessed via https://marvelapp.com/6918bi3 (Marvel App, 2018). The prototype illustrates how a user could use the artifact for the case where a car renting company shifts from their traditional BM to the car-sharing BM. The users choose from drop-down lists what they think is relevant to the specific case and fills out the gaps. The drop-down lists are based on the analysis of the existing literature (e.g., for *revenue model* the options of the drop-down list are: Crowdfunding, Onetime fee, Razor & blade, Add-on, Freemium, Revenue sharing, Licensing, Affiliation, Pay-per-use, Advertising). The artifact 'guides' the users by providing drop-down lists and explaining what each step is about. It should be noted that in the current version of the artifact, the outcome of this final step is a list with selected changes that, according to the user, might have a positive, negative or unknown contribution to the critical success factors.

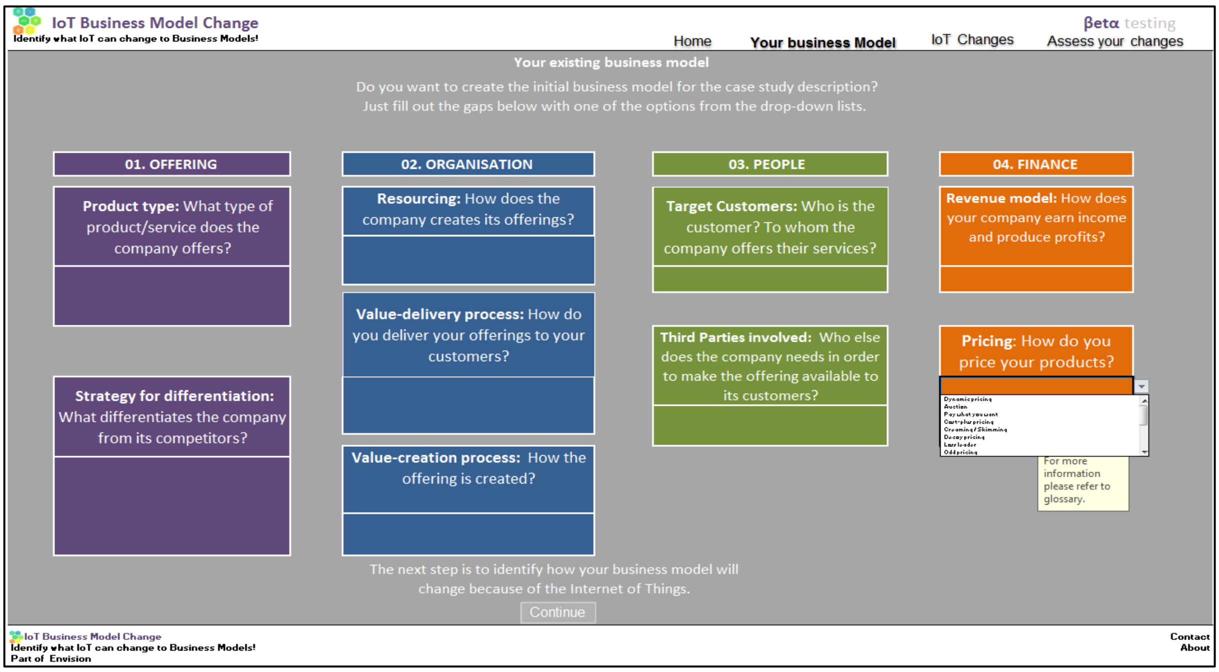

Figure 2. Screenshot of the first step of the developed prototype. A drop-down list is presented at the right side of the figure.

5 Future Evaluation and preliminary results

For the evaluation, we will follow an experimental design approach. Due to page limitations, the description of the evaluation is not discussed but was summarized in Figure 1. Every evaluation step is followed by an analysis of the feedback and/or comments and then improvement of the prototype. For this research in progress, we only focus on the first evaluation. This first evaluation contributes to the improvement of the prototype before the testing of the artifact with users in an experimental setting. Our initial evaluation iteration included an alpha (not reported in this publication as t) and beta testing as well as a pilot testing with potential users.

For the *beta testing*, we asked the opinion of four BM consultants, and 20 Master students with entrepreneurship interest. The beta testers used the prototype and provided their comments. The main focus of the beta testing is to discuss the functional requirements. We collected the feedback through face-to-face conversations, Skype or by answering a small questionnaire with open questions. It should be noted that in this evaluation cycle we collected feedback that will allow us to improve the artifact and receive some comments regarding the three design requirements. However, we do not measure the effectiveness of the design requirements to the BM exploration.

In general, all informants appreciated the functionalities of the artifact. Regarding design requirements the beta testers acknowledged that the artifact would be useful and that the pre-filled options are an interesting feature. As beta tester 2 mentioned *The pre-filled option is interesting as it is not a common feature on the design of existing BM tooling [artiact]',* while beta tester 1 argued that 'Pre-filled is a perfect idea'. However, beta testers mentioned that some info regarding the existing costs should be added. A common feedback we received regarding the design requirement two is that the users have to add manually some information. As one beta user mentioned '*you put the user to think the transformation. This is the job of a consultant Also, I am not sure if they will understand that you give them inspiration and not a specific solution. However, they will get inspired*' (beta tester 1). Another beta tester suggested using examples from existing cases. Regarding design requirement three, beta testers argue that the artifact could help users to make decisions However, different assessment questions for different BM changes are needed. A common comment was that in next iteration of the artifact a prioritisation list should be generated that could help the users to make decisions.

6 Conclusion and Future Research

This paper provided intermediate results of design, development and preliminary evaluation of a software-supported artifact for BM exploration within the IoT ecosystem. This research in progress contributes to the field by providing the first step towards an improved solution, in the form of a software tooling (i.e. the artifact) for the BM exploration process (Gregor and Hevner, 2013).

We used a DSR approach to create the artifact. For the awareness of the problem, we followed an action research. Results from our previous research (Athanasopoulou et al., forthcoming 2018) combined with literature review, defined the design requirements. These design requirements established the design of the artifact. The created artifact serves as an evaluation instrument to evaluate which of these features contribute to the BM exploration process. As part of the DSR logic, we do iterative cycles for evaluation. In this research in progress, we present the first evaluation cycle and some preliminary results. In the near future, the outcome of this evaluation cycle will contribute to the revision of the artifact towards an improved version of it. A limitation of this research in progress paper that future research could investigate is to justifying the options in the drop-down lists through an extensive review of existing literature on BMs in IoT.

A limitation of the present paper is that the evaluation of the design requirements is not complete yet. As next step, we will evaluate the design requirements in an experimental setting (see figure 3). While doing so, we will control for properties of the users, for instance, their experience with BMI and the extent to which they already made decisions on changing their BM because of IoT. Being a research in progress paper, the main limitation is that the evaluation is not yet done.

After the analysis of our final results, we will contribute to science and practice. More specifically, the study will contribute to the BM innovation theory with the three developed design requirements, extracted from the literature and practice, with the overall aim to contribute to the BM exploration process. Additionally, the study will contribute to the science by providing more insights regarding the BM within the IoT environment. Future studies could investigate if the artifact could be used for different technology disruptions, and what changes need to be made for different technologies. In practice, our study will contribute to the development of an easy to use artifact with minimum complexity, and high automation that supports enterprises with their BM exploration and innovation process.

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