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# DISCOVERING THE ROLE OF SCENARIO PLANNING AS AN EVALUATION METHODOLOGY FOR BUSINESS MODELS IN THE ERA OF THE INTERNET OF THINGS (IOT)

Jan F. Tesch

University of Göttingen, [jtesch@uni-goettingen.de](mailto:jtesch@uni-goettingen.de)

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# **DISCOVERING THE ROLE OF SCENARIO PLANNING AS AN EVALUATION METHODOLOGY FOR BUSINESS MODELS IN THE ERA OF THE INTERNET OF THINGS (IOT)**

*Research*

Tesch, Jan F., University of Göttingen, Germany, jtesch@uni-goettingen.de

## **Abstract**

*Within both scientific literature and practice, there is limited understanding about the evaluation aspect of business model innovation (BMI), especially in the context of digitalization and the Internet of Things (IoT). The aim of our research project is to contribute by validating whether methodologies from strategy, such as scenario planning, are appropriate means for evaluating business models in this explicit context. Following a Design Science Research (DSR) approach, we develop an approach to implement scenario planning into a BMI process respective of the features. In cooperation with business innovation employees of a well-known corporation in the technology sector, we apply the methodology to real-world innovation projects, empirically validate its viability, and determine how and to what extent it can be used. As a further result, we aim to scientifically expound its effects on creating competitive strategic advantages in the context of digitalization and the IoT.*

*Keywords: Business Model Innovation, Internet of Things (IoT), Digitalization, Scenario Planning, Smart Homes, Design Science Research (DSR).*

# 1 Introduction

Over the past 15 years, both researchers and decision makers in corporations have become increasingly aware that the development of business models concomitant to product innovation is key for market success (Chesbrough, 2010). The so-called Internet of Things (IoT) – in which machines, all kinds of end-user devices, and further primarily physical products get sensors attached and some kind of intelligence allowing them to communicate with each other – will further accelerate changes in economic paradigms through ambiguous opportunities upon the collection and utilization of data and information (Atzori *et al.*, 2010). In an attempt to develop business models, both theory and practice has shown that, until now, prevailing tools and methodologies in Business Models have struggled with several peculiarities in the context of digitalization and the IoT (El Sawy and Pereira, 2013; Westerlund *et al.*, 2014). It is especially complex for business models with multi-sided platforms (MSP) (Hagiu and Wright, 2011), as money, goods, and information flow multilaterally among suppliers, customers, and partners (Hagiu, 2009). Thereby, several researchers have emphasized the importance of evaluation in an business model development context (Veit *et al.*, 2014).

In practice, evaluating business models means making assumptions for revenue and cost calculations, for which prediction reliability in an IoT context is extremely vague. Incumbents thereby have difficulties assessing technological developments and responding to increasingly faster product innovation cycles (Hylving *et al.*, 2012). For instance, on the revenue side, income from data monetization is difficult to forecast, especially in the B2B aspects of a MSP (Rai and Tang, 2014). One way of dealing with uncertain situations in classical strategic management and product development is the use of forecasting methodologies. As an example, scenario planning is a prominent tool in corporate strategy that is often used to systematically depict possible outcomes of strategic decisions and thus to provide measures for reducing risks (Amer *et al.*, 2013). It has been proven that scenario planning led to outperforming market performance (Schoemaker 1995) and can be key for creating strategic competitive advantage.

The goal of the research project is to contribute to theory on business model research in IS by validating how and to what extent scenario planning can be used as a valid strategic tool for designing business models. In particular, we aim to determine whether the systematic use of scenario-planning methodologies in attempts to innovate business models has an impact on decision quality and thereby leads to competitive advantages. As a contribution to practice, we focus on developing a strategic framework that allows for enhanced risk management in attempting to innovate business models. The resulting method should thus provide transparency for decision makers to evaluate the viability of investments in business model development.

Our methodology builds upon an evaluation artifact by following a design science research (DSR) approach applying guidelines by Hevner *et al.* (2004), Peffers *et al.* (2007) and Gregor and Hevner (2013). The artifact was applied in several IoT innovation projects in cooperation with a pilot case company. To secure the reader's understanding, the artifact is demonstrated with a Smart Home example.

# 2 Theoretical Background and Objectives

Analyzing the various aspects of business model innovation from a practitioners' perspective (Osterwalder *et al.*, 2010; Bilgeri *et al.*, 2015) and reviewing theoretical literature concerning the innovation process outlined (Teece, 2010; Zott and Amit, 2010; Burkhart *et al.*, 2011; Veit *et al.*, 2014) reveals that research has to date mostly focused on the descriptive analysis of existing business models (identification) or the rather qualitative ideation of new ones. However, there is little insight on how to systematically elaborate business models design ideas. Moreover, it is widely agreed that a rather iterative evolution of business models is the most appropriate means of securing the viability of the business model design process (Sosna *et al.*, 2010; Veit *et al.*, 2014; Frankenberger *et al.*, 2013). A practical approach to this is outlined by (Ries, 2011), who argues that rapid prototyping and being able to learn from the customer by offering and testing a minimum viable product (MVP) already in an early stage is the most appropriate. Effectual evaluation in the form of field tests, showcases, and research collaborations is a

means of counteracting the lack of information about future market conditions (Sosna *et al.*, 2010). However, particularly in business model innovations that radically change the way an organization does business, this requires the confidence of an investor or management on the general viability of the innovation. Hence, the required means for effectual evaluation can only be released if management receives some kind of transparency about the general suitability and/or quantitative assessment of the business model innovation project in terms of risk and return. However, in both the theory and practice of innovation processes, the evaluation of business models before releasing the necessary budget for the iterative evolvement is often based on little-scrutinized assumptions, particularly in the context of the complexity that comes along with digitalization and the Internet of Things (Wirtz *et al.*, 2010).

Structured literature reviews from an IS point of view (Burkhart *et al.*, 2011; Veit *et al.*, 2014) indicate that only some publications deal explicitly with evaluating business models as a part of an innovation process. Major research gaps in this field have been identified, as there are “limited insights on criteria and metrics for an appropriate evaluation of business models, which is mainly caused by the small quantity of [large-scale] empirical studies.” Furthermore, no “software-based tool for the management of business model can be found so far, neither for visualization, evaluation or simulation purposes nor as a holistic approach” (Burkhart *et al.*, 2011, p. 16-17). In a nutshell, “understanding, explaining, predicting, and designing IT-based business models holds immense contributions to both research and the business community” (Veit *et al.*, 2014, p. 50). Nevertheless, there is insufficient testimony about the validity of evaluation methods in general (Demil and Lecocq, 2010; D’Urso *et al.*, 2006).

As an attempt to address this issue, Tennent and Friend (2005) suggest implementing scenario planning for the evaluation of business models. However, their approach is applied only to the revenue calculation, thus missing crucial aspects on different business model patterns (Gassmann *et al.*, 2014), value propositioning (Osterwalder *et al.*, 2014) and dependencies on partnerships with suppliers and customers (Westerlund *et al.*, 2014). Kijl and Boersma (2010) demonstrate that scenario planning is a reasonable extension to a holistic business model engineering process. In a later study, El Sawy and Pereira (2013) implement scenario planning into their proposed “VISOR framework” for business model innovation and revealed several extreme “yanks” for their example instance.

However, further insight into its validity for business models in the specific context of digitalization the IoT is still necessary from a theory point of view. To investigate this in greater detail, we identified significant research streams from which we derived the objectives of an artifact to be created. Following a DSR approach (Chapter 3), we identified three relevant research streams for an artifact, from which we derived objectives for it. As outlined in the introduction, we define the following overarching output as the first objective for the artifact:

*Objective 1: The artifact output increases transparency on the overall future viability of the business model and thus aims to enhance the management decision base in business model innovation processes.*

## 2.1 Business model innovation (BMI)

Business models began to experience significant scientific consideration after the dot-com crisis in 2001 (Demil and Lecocq, 2010). At first, the major focus of such investigations lay on defining business models in general (Amit and Zott, 2001; Gordijn and Akkermans, 2001), discussions on the definition and delimitation of strategy and business models (Timmers, 1998; Magretta, 2002; Casadesus-Masanell and Ricart, 2010), taxonomies (Pateli and Giaglis, 2004; Rappa, 2004;), and ontologies (Osterwalder, 2004). This was later advanced through the perspective of the innovation (Amit and Zott, 2001; Baden-Fuller and Morgan, 2010; Chesbrough, 2010; Teece, 2010; Zott and Amit, 2010; Heikkilä and Heikkilä, 2013). Taking these sources into account, one can observe four prevailing phases for designing business models: identification, ideation, integration and implementation (Frankenberger *et al.*, 2013). A rather practical approach from Bilgeri *et al.* (2015) reveals that the majority of tools used and insights gathered are to be seen in the earlier stages of the innovation process, such as ideation. With regard to the integration and thus evaluation, there is little knowledge about relevant success factors and an a priori estimate of the long-term establishment of new business models (Veit *et al.*, 2014). A further yet largely

unnoticed aspect is the implementation strategy for business model innovation, such as business model roadmapping (de Reuver *et al.*, 2013). Thus, the evaluation of assumptions plays a continuous role within the process of business model innovation throughout all phases outlined.

Bouwman *et al.* (2012) propose using scenario planning as a stress-testing approach for evaluating business models. The information needed as an input for scenario planning must be collected continuously throughout the prior innovation phases (Bilgeri *et al.*, 2015). Alongside the aspect of contributing to business model decision support systems (BM-DSS) (Daas *et al.*, 2013), scenario planning offers insights on how to proceed with implementation and may be complementary to roadmapping approaches.

*Objective 2: The artifact should be easy to implement in corporate business model innovation processes concerning different phases.*

## 2.2 Novel requirements for BMI from digitalization and the paradigms of the Internet of Things (IoT)

Westerlund *et al.* (2014) investigate several challenges in innovating business models in the emerging context of the Internet of Things (IoT), claiming for a major shift in business model research. A good approach in identification and ideation is analyzing several “business model patterns” that are prototypical in the context of the IoT (Fleisch *et al.*, 2014). Based on previous work of Gassmann *et al.* (2014), the authors claim that previously purely physical products, such as a light bulb, get sensors, actuators and some data processing and communication units attached. Next to the already existing physical function of the product, lighting in this case, the bulb offers possibilities for additional services.

In addition, multi-sided platforms (MSP) or n-sided markets are the most prevailing business model patterns in the paradigm of a digitalized future of the Internet of Things and Services (Hagiu, 2014; Tuunainen and Tuunainen, 2011). There are several partners (B2B) required for collaboration with the MSP operator. However, each player in such a networked ecosystem tries to engineer its own compelling business model that maximizes its own value share (Solaimani, 2014). A further aspect is the rally of incumbents to secure touch points with the end customer (B2C), such as in the domains of mobility or smart living (Solaimani *et al.*, 2013). Practice in business model innovation in IoT contexts has shown that this particular aspect is often not heeded when designing business models for the operation of such a multi-sided platform. Gawer and Cusumano (2008, 2015) further outline the urge to achieve a sufficient number of active (end-) customers of one segment in order to secure attractiveness for other (B2B) customer segments.

*Objective 3: The artifact should have a specific focus on business models with typical digital patterns, such as multi-sided platforms or n-sided markets.*

## 2.3 Business model evaluation and tooling

Business models, particularly their revenue calculation sections, deal with future value streams and are subject to uncertainty due to the issues described above. This makes it important to highlight the degree of uncertainty within the business model to increase transparency for decision makers. However, traditional strategy tools (e.g., Porter’s generic competitive strategies, five forces, experience curves, portfolio analysis, or the Ansoff Matrix) are becoming increasingly unreliable due to today’s high volatility, shortened product lifecycles, and increased complexity of organizational networks (Westerlund *et al.*, 2014). We have identified some general methodologies for assessing the viability of digital business models and making risks more tangible for a management decision board: Descriptive methods, such as metrics (Heikkilä *et al.*, 2015), analyze business models from a performance measurement point of view. Prediction methods, e.g., causal network models, agent-based modeling, business wargaming or system dynamics, aim to estimate future multidimensional value, revenue and data streams as described in the previous section (Schoemaker *et al.*, 2013). While these models are a proven way of predicting impacts and carving out probabilities of possible scenarios, they often turn out to be too complex for IoT projects. Furthermore, as already Tennent and Friend (2005) outline, such predictive models often do not make

sense if not carried out with a great amount of effort. Within BMI projects in context of the IoT, practitioners face a significantly greater number of uncertainties and higher volatility of driving factors. Hence, we argue that implementing scenario planning into the process of IoT-related BMI is of greater value than in ordinary BMI projects.

However, scenario planning, which aims to project a “what-if” perspective in situations of uncertainty (Bradfield *et al.*, 2005), has been garnering increased attention in corporate strategy. Its most commonly known successful application was by Royal Dutch Shell, who consistently outperformed competitors in oil price prediction (Schoemaker 1995). However, there has been little scientific insight into its concrete application in the paradigm of business models, as orchestrating business processes into an overarching corporate strategy (Magretta, 2002) to create and capture value”. Nevertheless, as, e.g., Tennent and Friend (2005), Osterwalder *et al.* (2010), Kijl and Boersma (2010) and El Sawy and Pereira (2013) scheme, we expect it to be a suitable method for holistically strengthening the robustness of business models. Scientific publications integrating scenario planning and business model innovation as a strategic tool include the work of a business model tooling research group around Bouwman *et al.* (2012), who derived strategic options as a decision base for an IPTV service (Bouwman *et al.*, 2008b) or intermediaries in the insurance sector (Bouwman *et al.*, 2009). Learning from these publications, we can derive the next objective:

*Objective 4: The artifact should include distinct scenarios but still be practically usable within a real-life corporate business model innovation process.*

The business model ecosystem in an IoT future is likely to be subject to political, economic, sociological, technological and ecological changes (PESTE), which from an evaluation or respectively from a scenario planning point of view are sources of external factors that drive business model success (Yüksel, 2012). The wealth of conceivable options for digitalization and the IoT, such as the unclear evolvement of data protection laws in a certain market, causes the above well-described uncertainty in business model innovation processes. As this creates inscrutable complexity, sufficient factors must be considered in order to ensure the information value of the scenario planning as a decision support system (Schoemaker *et al.*, 2013; Daas *et al.*, 2013).

*Objective 5: The artifact should consider a sufficient depth of paradigm changes of the surrounding ecosystems (PESTE analysis).*

### 3 Methodology: Design Science Research (DSR)

As a methodology to build an artifact, we followed the approach outlined by Peffers *et al.* (2007). We also considered the seven principal research guidelines to provide a consistent and viable result by Hevner *et al.*, (2004). The research was undertaken between fall 2014 and winter 2015. Table 1 lays out the methodology in greater detail.

Activity	Description	Results
1. Problem identification and motivation	<ul style="list-style-type: none"> <li>Literature review and case-study research on previous business model innovation (BMI) and tooling</li> <li>Expert interviews and workshops with practitioners and end-users from the pilot case company on previous BMI and tooling</li> </ul>	Research gap clarified and confirmed (see introduction)
2. Definition of objectives	<ul style="list-style-type: none"> <li>Literature review to identify relevant research streams; preliminary model requirements from activity 1 to confirm and extend by theory</li> </ul>	Done (see Chapter 2)
3. Design and development	<ul style="list-style-type: none"> <li>Consideration of existing tools in business model innovation and the use of scenario planning in other contexts</li> <li>Iterative (ADR) approach: Application of the artifact in real-world BMI projects; learning and revising prototypes (alpha, beta, ...) until reaching sufficient saturation in meeting objectives</li> <li>Additional seminars and theses with graduate IS students</li> </ul>	Artifact built after several iterations for improvements

4. Demonstration	<ul style="list-style-type: none"> <li>• Attending interdisciplinary working teams of the pilot case company with the task of elaborating business models for several IoT domains (e.g., smart homes and connected mobility)</li> <li>• Presenting the outcomes of the artifact to decision makers and senior management</li> <li>• Consortia with researchers and business model innovation experts</li> </ul>	Artifact applied in three innovation projects
5. Artifact validation	<ul style="list-style-type: none"> <li>• Critical reviews of the outcomes with end-users and feedback to revise prototypes from practitioners</li> <li>• Application of the artifact to historical case studies of the pilot case companies to reveal whether use of the artifact would have led to better decisions in past business model innovation processes</li> <li>• Workshops and theses with graduate IS students</li> </ul>	Artifact accepted as a valid tool; in application at the pilot case company
6. Communication	<ul style="list-style-type: none"> <li>• Conferences and scientific journal contributions</li> <li>• Contributions to practitioners' outlets</li> <li>• PhD students' consortia</li> <li>• Presentations at innovation summits</li> </ul>	Several publications submitted and published

Table 1. Overview on activities following a Design Science Research approach based on Peffers et al. (2007).

Because design and development (3), demonstration (4), and validation (5) of the artifact requires to be conducted in a rather iterative manner, Sein *et al.*'s (2011) Action Design Research (ADR) was selected as an approach for these activities (Figure 1). Starting by reviewing past BMI projects of the pilot case together with practitioners, an alpha version was designed by considering and combining existing tools from theoretic literature. This alpha version was then applied in the working team (practitioners) of the pilot case company, and its outcomes were assessed by end-users and industry experts. Implementing guidelines from Iivari and Venable (2009) and Wynn and Williams (2012), we systematically structured the subsequent interviews with practitioners and end-users to obtain feedback on the fulfillment of objectives and the validity of the artifact and outcomes. Based on this, the researcher designed the next versions (beta, gamma) and Activities 4–6 were reiterated until the process came to a saturation where redesigns of the artifact would not have led to a better fulfillment of the objectives.

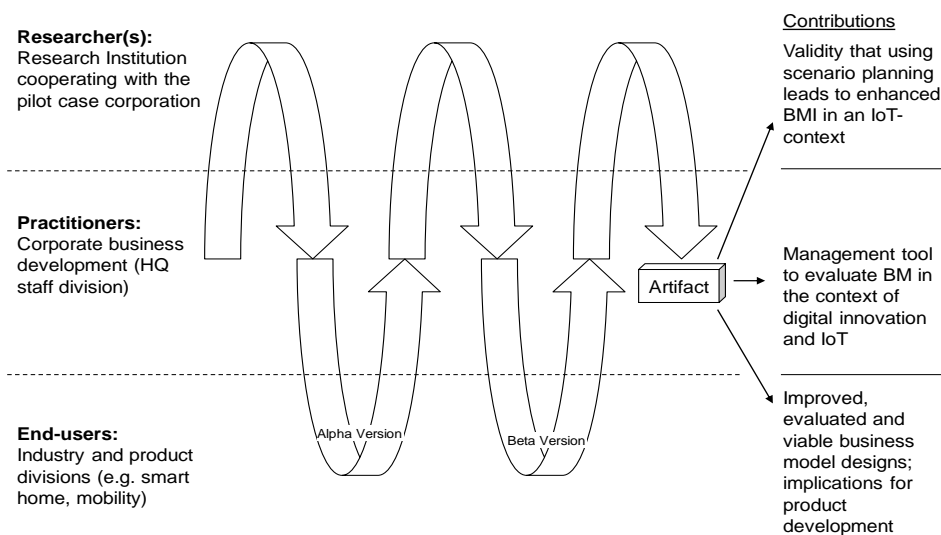


Figure 1. Design, development and evaluation of the artifact: Action Design Research (ADR) (adapted from Sein et al., 2011)

As artifact validation is crucial for ensuring the quality of the theoretical contribution to knowledge, we emphasize our focus on this aspect. Additional guidance by the work of Gregor and Hevner (2013) secures knowledge contribution to the IS community. Moreover, experimental seminars and theses with IS students were conducted to apply the artifact, thus obtaining further insight into the viability of the

resulting implications of the artifact in a theoretical testbed. We also applied further IS- and DSR-related approaches (Dubé and Paré, 2003; Paré, 2004) to analyze historical case studies, helping to clarify whether later outcomes of the artifact would have had a significant impact on the business model viability.

## 4 The Artifact: An Evaluation Framework for Business Model Innovation for the Internet of Things (IoT)

This section describes the artifact, which was developed regarding the research gaps and requirements carved out from reviewing the literature and specifically adapted to meet the objectives outlined in the theoretical background. It is a four-step, heuristic process that results in clear advice for management. Table 2 presents an overview of the artifact. As we experienced business model innovation processes to be rather iterative in practice, we outlined corresponding BMI process phases according to the 4I framework (Frankenberger *et al.*, 2013). Each step is outlined further in the subsequent subchapters.

Step	Initial design	Recapitulation of driving factors	Scenario creation	Impacts and counteraction
<b>Corresponding BMI phases</b>	Identification Ideation	Ideation Integration	Integration	Integration Implementation
<b>Task</b>	Elaborate reference business model design	Investigate ecosystem changes	Build consistent scenarios Reveal key success factors	Find alternative business models that respond to scenarios
<b>Methods</b>	Business Model Canvas	PESTE-analysis Uncertainty grid	Influence diagram Scenario dimensions	Key success factors Stakeholder network diagram
<b>Result</b>	Understanding of interdependencies of the BM with the surrounding ecosystem	List of driving factors of the business model	Set of distinct scenarios	Key differentiation an BM-executing player needs to be successful in each scenario
<b>Meets Obj.</b>	Objective 3	Objective 5	Objectives 4 and 5	Objective 1 and 2

Table 2. Overview of the key steps of the scenario-planning artifact.

### 4.1 Reference business model design

In a first step, a series of workshops with practitioners and end-users of the pilot case company aiming to enter the smart home market is undertaken. Practitioners and end-users comprise associates from business development, product development, engineering, and management. We elaborated a reference business model that serves as a base for the later derivation of uncertainties that are causing risks. As an archetypal pattern on how the business logic works, we chose the multi-sided-platform, as proposed by Giordano and Fulli (2012) for the case of smart homes.

Figure 2 presents a summary of the elaborated business model design using the Business Model Canvas (BMC) of Osterwalder *et al.* (2010), which has been established as the de facto standard typology for mapping and aggregating the various aspects and of business models. Although other frameworks could be conceivable, these primarily focus on four pillars: value proposition (“what”), value delivery (“who”), value creation (“how”), and value capture (“value”) (e.g., Gassmann *et al.*, 2014). We found that the core strength of the BMC lies in the systematic identification and consideration of *key activities* and *key resources*. These two are defined as key success factors (KSF) as they differentiate the focal company from future competitors and “ensure that the business model creates value for the customer and for the business network” (Bouwman *et al.*, 2008a, p.72; Bullen and Rockart, 1981).

The business model has one primary part: the sale of smart home devices, such as thermostats, security cameras, smart lights, or smart door locks (highlighted in grey). The value proposition to customers is that these devices might offer an increase in automation, enhanced security, lower energy consumption,



and new possibilities for healthcare. There are (n) customer segments that can be addressed, e.g., younger people, who might be more interested in automation functionalities, or the elderly, for whom healthcare aspects are most relevant. The key activities of the platform operator are the development of the devices and the building and maintenance of a software backend that allows for the control of several devices; these are then sold to residents. Most of the functionalities are controlled and triggered by software within the backend. Furthermore, the data collected can be used for statistical analysis.

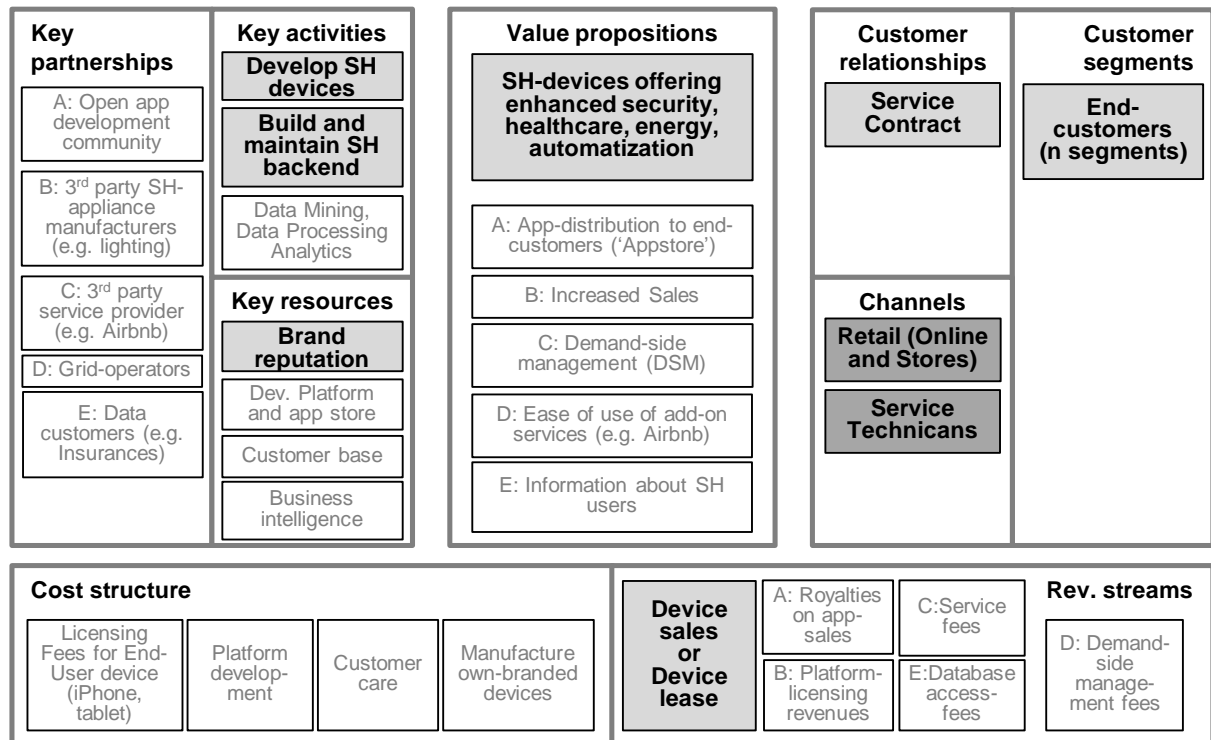


Figure 2. Overview of the business model (adapted from Osterwalder et al., 2010).

In the secondary part of the business model, there are five potential additional revenue sources from partners (white). (A) We reveal technical interfaces of the smart home devices that it is possible to write apps that add new or enhance functionalities and thus offer a better or broader value proposition to the end-customers. Just as with the example of Apple and its iPhone and iTunes, developers are able to distribute their software through an app store of the SH platform operator. In return, the developers must share their revenues and pay royalties to the SH platform operator. (B) It might be possible that one allows other manufacturers of SH devices to be integrated into the SH platform. Such manufacturers profit from not having to develop their own platform and being able to increase sales by offering compatibility. In return, this can be compensated by sharing the revenues from device sales. (C) Additional services concerning automation can be enabled through the SH platform. For example, customers might wish to order groceries online and have them delivered to their refrigerator, even when they are not at home. A smart door lock could grant access for delivery at a predefined date and time. Smart cameras help ensure that the delivery person does nothing other than his assigned tasks in the home. Another example is Airbnb, where the handover of keys often presents an issue. Customer confidence in regard to such service providers might increase, were such a smart home platform to be used. In return, these service providers might be willing to pay a fee. (D) In an environment of dynamic energy supply in a grid, managing energy demand might be of interest. Examples include electric heating/climating, washing machines, or recharging an electric vehicle – all of which could be offered by a SH platform. Customers would profit from a lower energy bill, whereas grid operators would be willing to pay a fee to minimize peaks in energy demand. (E) The SH platform aggregates a wealth of data that can be processed and analyzed. Just like Google or Facebook, this data can be used to enable advertising or even

selling information to B2B partners, such as insurance companies. At this point, the business model outlined represents a “best-guess” scenario of practitioners and end-users involved. Complementary to the business model design described above, a projection of future financial aspects is conducted using several spreadsheets. However, the future viability of the business model outlined relies on several assumptions about future market conditions. These include fixed and variable costs, prices customers are willing to pay, the size of target customer groups, amount and strength of competitors, and the potential monetary value added of data and information to partners.

## 4.2 Recapitulation of driving factors and critical uncertainties

In this step, we critically review the above-described assumptions. As described by Bilgeri *et al.* (2015), assumptions in the context of the IoT should be evaluated throughout the whole business model design process via means such as field tests, surveys (such as conjoint analysis), or effectual evaluation by marketing a minimum viable product (MVP) and early learning from lead customers (Ries, 2011). However, within the practical examples we have undergone, not all factors causing these uncertainties can be deliberated. To make their importance more tangible for management, they can be ranked using two dimensions (Schoemaker and van der Heijden, 1992): the degree of uncertainty and potential impact, as pictured in the impact uncertainty grid (Figure 3).

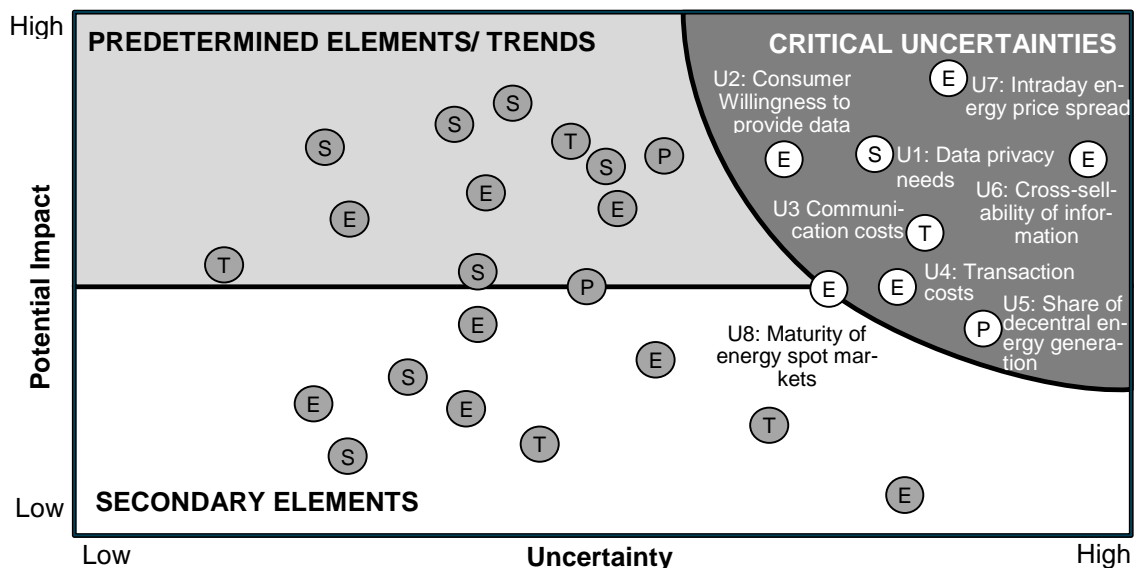


Figure 3. Driving factors from PESTE analysis for the smart home case, illustrated by the impact uncertainty grid (Schoemaker and van der Heijden, 1992).

The assumptions described above are dependent on several external (ecosystem) driving factors stemming from political, economical, sociological, technological, and ecological aspects. The so-called PESTE analysis (Yüksel 2012) describes the identification and consideration of these factors as a tool in the strategic management process. In the smart home case, we held eight structured case interviews with external experts, including technical, market, and industry specialists. Applying the methodology outlined by Yüksel (2012) with a survey scaled from 1 to 9 and a subsequent ranking algorithm, we were able to quantify the surveyed information in order to add the external driving factors to Figure 3. The PESTE analysis identified around 30 driving factors that influence assumptions of the business model and thus can be identified as “critical uncertainties”.

### 4.3 Scenario creation

As we found eight critical uncertainties, even just taking extremely low or high parameter values would result in a scenario space of  $2^8 = 256$  scenarios. Considering extreme parameter values for critical uncertainties provides insight on the worst-case and best-case scenarios that represent a corridor of possible outcomes in the business case (Schoemaker, 1995). Although these possible outcomes are a good indication of what could theoretically happen, they are rather unrealistic. Therefore a consistent set of parameter values for critical uncertainties had to be developed, thereby leading to comprehensive scenarios within the corridor. To do so, we sought to gain further insight into whether and how driving factors stand in causal relationships.

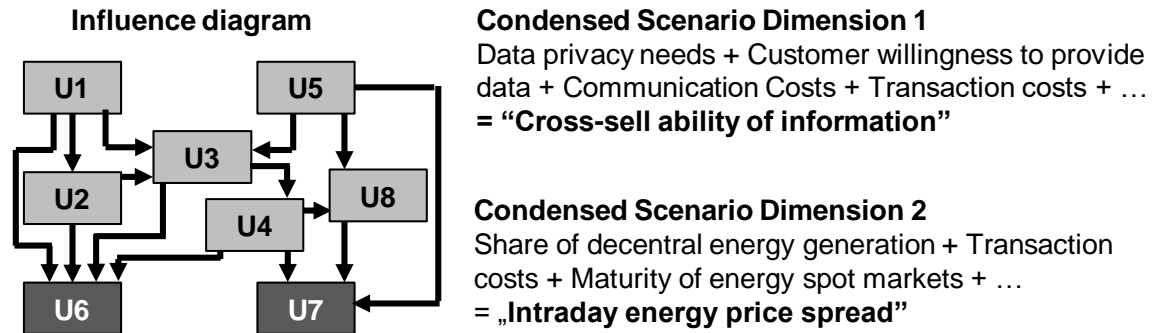


Figure 4. Using correlations between driving factors to identify scenario dimensions (simplified).

Within the previously described interviews, we also asked the external experts to fill out a correlation matrix for the internal and external driving factors they mentioned. Applying Van der Heijden's (2005) influence diagram to reduce complexity but still considering all key uncertainties, we assessed how the most critical uncertainty factors are interrelated based on the findings (Figure 4). As illustrated in this smart home example, it turned out that two of the key uncertainties can be used as preliminary drivers for determining a simplified but still realistic scenario space. In other words, we were able to condense the complexity of possibilities into two key scenario dimensions.

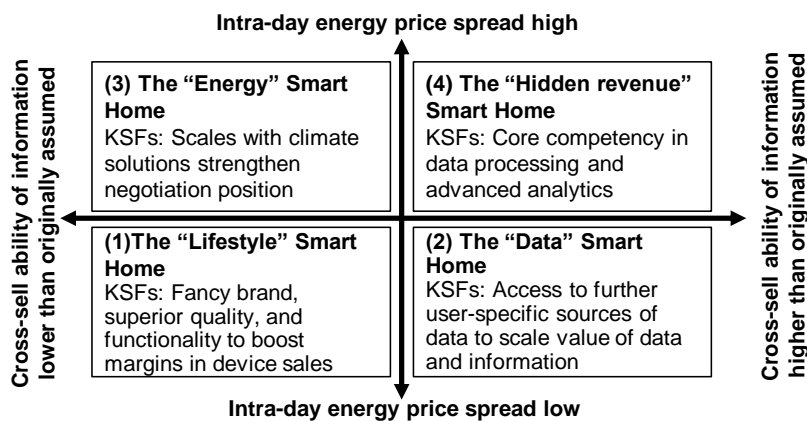


Figure 5. Key scenarios for the smart home platform and identified key success factors (KSF) to differentiate from potential competitors.

To construct comprehensive and distinct scenarios, we considered extremely raising or lowering outlooks for the two dimensions. As depicted in Figure 5, the resulting four quadrants set the foundation

for formulating comprehensive but strictly distinct scenarios (van 't Klooster and van Asselt, 2006). These extremes are the basis for what-if evaluation of the business model in a later step.

As shown in Figure 5, key success factors identified for successfully competing in each scenario differ significantly. The transparency revealed on this already enhances the decision base for management and implies strategic adjustments for the business model design and its implementation. In the next section, we take a closer look at two scenarios to explain this in further detail.

#### 4.4 Analysis of impacts and development of strategic implications

Having developed transparency on the interrelations among driving factors, we created scenarios that change the surrounding paradigms of the overall business model landscape. Practice has shown that within the scenarios, key success factors differ and the viability changes depending on the characteristics of the player executing the business model. To counteract this, the business model of the smart home platform must be redesigned to best respond to the characteristics for each scenario. Figure 6 depicts corresponding stakeholder network diagrams (Bilgeri *et al.*, 2015) for Scenarios 1 and 4.

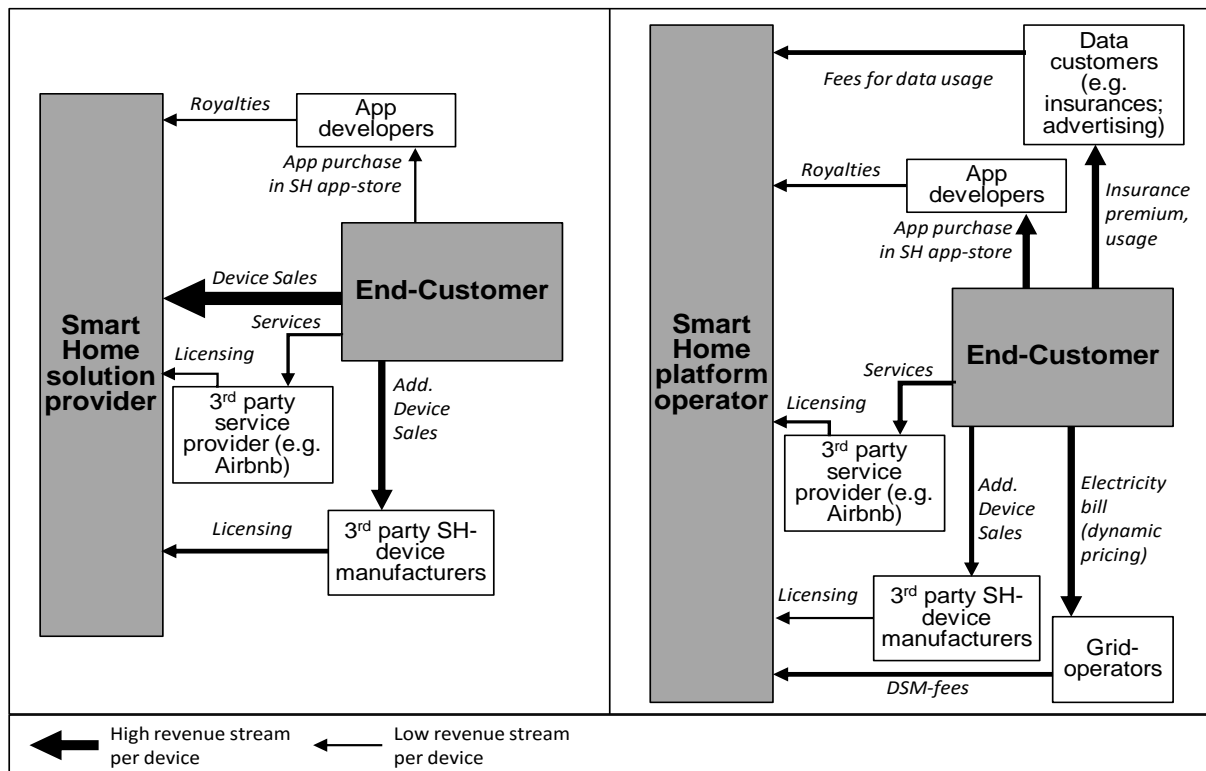


Figure 6. Stakeholder network diagram (Bilgeri *et al.*, 2015) for the “lifestyle” (left) and the “hidden revenue” (right) smart home scenario.

In the “lifestyle” smart home scenario (1), the business model of the smart home platform should emphasize increasing sales from devices, as income from secondary partners presents very little potential. Without a functioning spot market for energy and thus a fixed price for energy throughout the day, there is no benefit for grid operators in the smart home ecosystem. One can assume that the energy-saving functionality of the smart home platform thus plays a minor role. The same is true for the idea of cross-selling data to, e.g., insurance or advertising firms. Thus, in Scenario 1, competitive differentiation to achieve superior margins comes from physical devices. The focal firm should therefore focus on key success factors (KSF) to developing devices that provide the customer with a unique functionality in terms of comfort, such as automation, security, or healthcare. Further emphasis should be placed in offering superior device quality as a KSF, such as reliability and solid look and feel. Furthermore, a

strong brand reputation could serve as a KSF. As the vast opposite, the business model of the “hidden revenue” smart home scenario implies maximizing revenues through secondary partners. This is highly reliant on the quality of data gathered throughout the customers’ use. Sales from devices become less important, whereas securing a large customer base is a key success factor for combining and pursuing data analytics. To achieve this, an extreme consideration could be to give away devices for free. Strategically, the focal firm should emphasize capabilities in software and securing a highly capable backend platform as KSF. Furthermore, the key to superior competitiveness is access to data sources outside the smart home ecosystem that can be combined with user-related data.

The scenarios described above are extreme positions that span the corridor of possible future developments. However, in all scenarios, the role of a smart home platform as an enabler for additional services, such as autonomous delivery of groceries, appears to be a stable source of income in all scenarios. With the scenarios illustrated as extreme positions, we developed transparency on what could theoretically happen. As part of a structured business model design process, investors and management were able to quantitatively evaluate the financial viability of the business model better than without employing the artifact. Furthermore, measurable indicators of the scenarios and checkpoints as a trigger for altering processes of the business model are be sketched on a timeline by combining them with technology roadmaps, such as proposed by de Reuver *et al.* (2013). This resulted in an actionable implementation plan that outlines a pathway from a generic initial business model to a scenario-adapted one, revealing whether one scenario is likely to become reality or even leading to fully mothballing the whole business model innovation if necessary. Hence, we are able to confidently ascertain whether key assumptions of the business case would lie within a certain range in the future. We therefore acted out different future opportunities, weak points, and strong elements to develop a plan for determining how the initial business model must be transferred if corresponding scenarios are likely to become true.

## 5 Discussion

As a means of validation in Design Science Research, the artifact was applied in three real-world IoT business model innovation projects with a pilot case industry partner: a smart home platform as described above, electric vehicle charging infrastructure, and an ebike-sharing platform. We held interviews with end-users (industry experts), practitioners (BMI experts) and senior management, who validated the outcomes of the artifact and provided evidence that the systematic use of the scenario-planning artifact as outlined led to better management decisions in their fields of responsibility. The three innovation projects demonstrated that with the artifact, practitioners are able to systematically reveal shortcomings in business model designs. It emerged as a good input for critically reflecting upon design elements, allowing for risk reduction of a future-proof business model concept (Objective 1). The artifact is explicitly valid in an IoT context and is likely to be the foundation for the future development of key resources of the pilot case company. In addition, we underwent several ex-post case studies of past business model innovation attempts, which indicated that the application of the artifact would have returned appropriate results. Furthermore, all partners involved agreed on the validity and ease of use of the artifact (Objective 2). Referring to Table 2, the artifact has proven to be a valuable tool that helped improve the evaluation of the future viability of the BM in all innovation phases of a corporate BMI process. As Frankenberger *et al.* (2013), e.g., emphasize, the BMI process is typically rather iterative; therefore, the change of PESTE factors requires that the scenarios be revised constantly over the course of the project. Through its easy practical applicability, the artifact can to be iteratively computed to, e.g., trigger crucial steps for business model implementation at the right moment. The artifact was designed to meet requirements from new business logics in the IoT, as outlined in Objective 3. This primarily stemmed from the fact that the BMI projects of the pilot case company had this characteristic; however, we argue that it might be also used for business model innovation in general, as such projects typically deal with less complexity and fewer interdependencies between customers, partners, suppliers, and other stakeholders in the ecosystem. Considering Objectives 4 and 5, the wealth of possibilities that might be caused by a change in external PESTE factors is tremendous. However, our artifact provides a heuristic

approach for dealing with extreme positions and, as with all simplifications and models, cannot perfectly reflect reality as a whole. The outcome of the artifact is based on derived scenarios (four in the smart home case), which can be seen as an abstracted derivation of the set of critical uncertainties (eight in the smart home case), omitting impacts that might stem from other PESTE factors. We nonetheless experienced the artifact to be a valid compromise of consistency, depth of paradigm changes of the surrounding ecosystem, and usability of the artifact in practice. All interview partners from the pilot case company acknowledge the sufficient fulfillment of the requirements stated in Objectives 4 and 5.

The main limitation of this research project is that the elaboration and validation of the artifact followed by an ADR approach only took place in cooperation with a single pilot case company. However, as this technology company is a conglomerate operating in several industries and markets worldwide and thus the IoT projects were diverse. Furthermore, the business model innovations investigated have not yet been fully implemented or rolled out, so there are still no insights into real market success. The artifact presented provides neither information on the probability of scenarios nor evidence on quantitative assumptions.

There are several research opportunities for gaining scientific insights into the role of evaluation and methodology beyond this research project. To increase the consistency of scenario planning (objective 5), we suggest extending the above approach with further prediction methodologies, such as System Dynamics. Mapping quantitative values for key uncertainties against historical and extrapolated data, one could gain better insights into the likelihood of scenarios. While this requires a vast amount of additional effort, we argue that it might be worthwhile in larger-scale projects, where ease of use (Objective 4) is only a minor prerequisite. If additional prediction as described above is undertaken, the probabilities of the scenarios can be subsumed to quantitatively calculate an overall assessment for risk and return as a basis for management to make decisions. Further, ways in which customers' needs and preferences could be met regardless of existing solutions should be investigated in greater detail. Kim and Mauborgne (2005), for instance, present a well-approved and feasible methodology for business model innovation (Osterwalder *et al.*, 2010), but it is yet to be tested in the setting of the new paradigms of digital transformation and IoT (Westerlund *et al.*, 2014). As a vehicle, we suggest investigating whether quantitative surveys such as conjoint analysis could be a means of testing this methodology. Especially in multi-sided platforms, one faces a "chicken-and-egg" problem, meaning that the attractiveness for secondary (B2B) customer segments, rises with the size of the B2C customer base and vice versa (Gawer and Cusumano, 2008). An approach to this would be an extension of roadmapping methods, such as those by de Reuver *et al.* (2013), which may be joined with our scenario-planning approach.

## 6 Conclusion

We have presented an approach that created a valid artifact for evaluating and predicting the viability of future business models in the context of the IoT. With this contribution to ECIS 2016, we intend to further communicate and demonstrate the artifact and this ADR approach. Above all, scenario planning can take over a central role within evaluating assumptions in a business model design process. To conclude the role of scenario planning, we again refer to the 4I framework by Frankenberger *et al.* (2013). Within the *ideation and integration* segment, scenario planning improves the consistency of the business model design. It reveals sources of risk caused by uncertainties – both internal (unrealistic assumptions) and external (PESTE) factors – thus contributes to the continuous assumption evaluation in business model innovation (Bilgeri *et al.*, 2015). Actual management decisions are enhanced by revealing best- and worst-case scenarios, thereby increasing transparency on the risk and return of the innovation project. In *implementation*, the different scenarios serve as input for a subsequent implementation roadmap plan. Thus, using scenario planning iteratively in business model innovation helps to identify and emphasize on the importance of key success factors for the focal firm. Adequate planning of future key activities and strategic management decisions to establishing future key resources are therefore essential for securing a superior market positions in complex ecosystems.

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