FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

Ein Netzwerk-basiertes Business Model Framework

für das Internets der Dinge

DIPLOMARBEIT

zur Erlangung des akademischen Grades

Diplom-Ingenieur

im Rahmen des Studiums

Wirtschaftsinformatik

eingereicht von

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Wien, 17. Jänner 2017

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FAKULTÄT FÜR !NFORMATIK
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A Network-based Business Model Framework

for the Internet of Things

DIPLOMA THESIS

submitted in partial fulfillment of the requirements for the degree of

Diplom-Ingenieur

in

Business Informatics

by

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to the Faculty of Informatics

at the TU Wien

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Erklärung zur Verfassung der Arbeit

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Thomas Biasion

Danksagung

Zu Beginn möchte ich mich bei Dr.-Ing. Stefan Schulte und Christoph Hochreiner für die hervorragende Betreuung dieser Diplomarbeit bedanken. Ihre fachliche Hilfe aber auch ihr Beitrag zur wissenschaftlichen Arbeitsweise haben mich in vielerlei Hinsicht geprägt. Ich möchte mich außerdem bei allen Kollegen und Experten im Gebiet für das Feedback bedanken, das den wissenschaftlichen Gehalt der Arbeit steigerte und die Benutzerfreundlichkeit der Software verbesserte.

Zuallerletzt möchte ich einen außerordentlichen Dank an meine Eltern Gerhard und Brigitte aussprechen, die mich in all meinen Lebensphase begleitet und unterstützt haben.

Kurzfassung

Geschäftsmodelle sind ein Forschungsgebiet der Managementwissenschaften. In der Praxis werden Geschäftsmodelle häufig untersucht um ein allgemeines Verständnis über die Funktionsweise eines Unternehmens zu schaffen und um nachzuvollziehen wie Gewinne erwirtschaftet werden. Meist werden Geschäftsmodelle aus der Sicht eines Unternehmens konzipiert. Aufgrund dieser einseitigen Betrachtungsweise werden in komplexen Netzwerk-basierten Branchen, Kooperationen mit Partnern und Konsumenten bei der Erstellung von Geschäftsmodellen vernachlässigt. Dies hat zur Folge, dass das Innovationspotenzial von Geschäftsmodellen nicht voll ausgeschöpft wird. Das Internet der Dinge (IdD) dient als Paradebeispiel für ein Business-Netzwerk, in dem das Fehlen von Netzwerk-basierten Geschäftsmodelle verhindert, dass bahnbrechende Produkte und Dienstleistungen marktreif werden. Das Ziel dieser Diplomarbeit ist die Entwicklung eines Frameworks zur Modellierung von Netzwerk-basierten Geschäftsmodellen um deren Innovation im IdD zu fördern. Das hier vorgestellte, wissenschaftlich fundierte Framework trägt den Namen NBMF (engl. networked business model framework). Dessen Anwendung ist benutzerfreundlich, weil das Framework als webbasierte Software mit graphischer Oberfläche umgesetzt wurde. Die Evaluierung des Frameworks erfolgt hauptsächlich über die Durchführung einer IdD-Fallstudie. Zu Beginn werden Geschäftsmodelle von Produkt- und Serviceanbietern im IdD analysiert, indem für jeden Anbieter ein Business Model Canvas erstellt wird. Dadurch werden die Einschränkungen des Business Model Canvas für die Darstellung von netzwerk-basierten Geschäftsmodellen ersichtlich. Diese Einschränkungen werden im NBMF dadurch aufgehoben, dass der Austausch von Nutzen und die monetären Zahlungsströme zwischen Unternehmen dargestellt werden können. Außerdem können Relationen zwischen den Blöcken des Business Model Canvas dargestellt werden. Das Business Model Canvas dient als Grundlage für das NBMF und wird mit Konzepten der e3-value Ontologie und des IoT Business Model Builders bereichert. Das Resultat ist ein kohärentes Framework, das von Kundenbedürfnissen ausgeht, daraus den Nutzen und Zahlungsströme aus der Sicht des Netzwerks konzipiert, dann die Komponenten des Geschäftsmodells für jedes Unternehmen beschreibt und letztendlich automatisierte Rentabilitätsberechnungen für den Unternehmenserfolg generiert. In einer Fallstudie zur Hausautomatisierung wird die Vorgangsweise mit dem Framework und der darauf aufbauenden Software vorgestellt. Außerdem enthüllt die Fallstudie wichtige wirtschaftliche Dynamiken und Merkmale von IdD-Geschäftsmodellen.

Abstract

Business models are studied in management science and are investigated in practice to create a common understanding of how companies create and capture value. Mostly, business models are examined from a company perspective to reveal the role and capabilities of the company in a market. In complex network-based industries this perspective neglects the importance of relationships to partners and customers. The Internet of Things (IoT) serves as the paragon for a business network that is missing out network-based business models to propagate groundbreaking products and services. The main goal of this master thesis is to foster innovative business models for the IoT by providing a network-based business model framework. The framework, called NBMF, is first defined in theory, then implemented as a web-based design tool and finally evaluated by conducting an IoT case study. To gain concrete insights into challenges and opportunities in the IoT, business models of the most common types of companies in the IoT are analysed in the graphical form of the Business Model Canvas. The limitations of the Business Model Canvas for modelling the companies and their relationships in the business network are resolved by extending the Business Model Canvas. The NBMF introduces intra-company relations between its building blocks and inter-company relations expressing the exchange of value propositions and financial transactions. Furthermore, the NBMF integrates amongst others concepts the e3-value ontology and the IoT Business Model Builder. The resulting coherent framework for business models includes a customer viewpoint, a network viewpoint, a company viewpoint and a statement for an automated profitability calculation. A case study about a Home Automation Ecosystem shows the functionality of the web-based design tool and its underlying theoretical framework. Additionally, the case study reveals opportunities for business model innovation in the IoT.

Contents

CHAPTER 1

Introduction

1.1 Motivation

Kevin Ashton coined the term Internet of Things (IOT) in 1998. Since then, technological developments opened the doors for applications in different areas of business and life science. Communication in the Web 1.0 and Web 2.0 was characterised by human interfaces (human to human, human to machine). The Web 3.0, also known as Semantic Web, will be shaped by machine to machine interactions. Content of the Web 3.0 will allow machines to act more intelligently [WAD14]. Radio Frequency Identification (RFID) is used to identify items wirelessly. It is besides other identifications techniques one of the fundamental technologies for the next generation of the web [Tan10]. Objects equipped with sensors and networking interfaces monitor their environments and transmit the resulting measurements over a Wireless Sensor Network (WSN) to the Cloud [WLR14]. Wireless communication capabilities are constantly improved and allow the exchange of information between long distances in differing environmental circumstances. Devices are getting smaller and so are perfectly embedded in the environment. Because of the smaller size and the improved communication capabilities, devices can now be installed in surroundings that were previously inappropriate. The enormous number of sensors and computing power generates a huge amount of data. With all this information, the vision of the IOT is getting real and enables new potentials for different kinds of services. Data is stored in the Cloud which makes the whole system very robust and flexible [GBMP13]. It enables companies to build products and services together by following service-oriented architectures. By technical standardisations (e.g. RFID, Bluetooth, 6LoWPAN) many improvements have beed achieved and it is technically already possible to build complex products that combine different functionalities and technologies. The service thinking and standardisation would potentially also unleash new potentials in the business domain. Building applications around “things” is a very difficult managerial task because typically many actors are involved [WLR14].

The IOT industry is growing rapidly. Gartner estimates that 6.4 billion devices will be connected to the internet in 2016 and this number will in increase to 20.8 billion in 2020 [Inc14b]. As shown in Figure 1.1 today most money is spent in the vertical-specific business sector. According to Gartner's forecast the rate of expenses for the cross-industry business market and the consumer market will increase essentially. The new circumstances will change the way of doing business. Manufacturing companies are the first who are affected in current days. Many manufacturers copy the models and lessons learned from software companies to increase their chance of success [PH14]:

- Shorter development cycles: Products are released in smaller incremental cycles in order to shorten the go-to-market time and adjust to customer needs. The agile product development forces collaboration between departments and monitoring of customer satisfaction.
- Product-as-a-Service: Reoccurring revenue is promoted by introducing subscriptions. Instead of relying on one time purchases, users pay a fixed amount in regular time frames (monthly, yearly) as long as they use the product or service.
- Focus on customer success: With the Software as a Service (SAAS) model customers can switch between vendors easily. This forces companies to target customer value generation as their primary goal, which again leads to better services.
- Products as part of bigger systems: Modular thinking enables integration into other systems. It may animate developer communities to extend features of the product.
- Analytics as a competitive advantage: Data analytics increase advertising revenues and data mining helps to identify the most critical bugs. With increasing technical capabilities for analysis, additional applications will be feasible in the future.

Business Models (BMs) in these markets will look differently and companies with innovative, sustainable, Network-based Business Models (NBBMs) are likely to be more successful than their competitors. As a result of the shift from industry-specific to multi-industry applications BMs or rather BM constellations are required [LTB10].

Modelling techniques exist to model the different aspects and driving forces within a company. Some of the techniques like Porters Competitive Five Forces [Por08] or e3-value [GA01a] investigate the company in a market or in a network context. Nevertheless most of the tools used today just focus on internal processes and workflows in a company. These tools are very helpful to build internal structures and align processes to a long term goal [Por85, Ost04]. However these techniques are not suited to model the dynamics of BMs within a chain or network of companies. Software tools visualising the value streams between the different actors of such networks could create a better understanding of markets [MSA05].

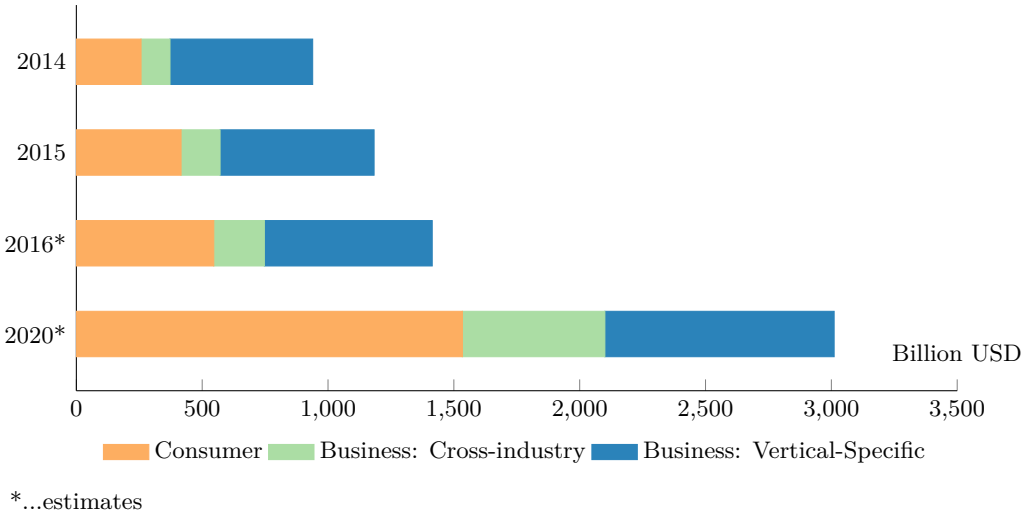


Figure 1.1: IOT expenses 2014-2020 (adapted from [Inc14b])

1.2 Problem Statement

The IOT industry is still facing many issues. Technical standardisation, security and privacy are some examples of problems that have been addressed, but that are not fully resolved yet. Still a lot of work has to be done before IOT systems are adopted globally [Tan10]. Besides the technological challenges, the progress of the IOT depends on the acceptability for users and the BMs [LWRS12]. SAAS revolutionised the software industry and the same will happen in the IOT industry [FWW15]. The change of BMs is going to disrupt various industries, destabilise companies and rewrite many organisational charts that have been used successfully for decades. New companies will appear, following lean management approaches and innovative BMs. These startups as well as big corporates have to experiment to find sustainable BMs [PH14].

Existing BM frameworks and tools are useful to explore potentials and impacts within a single company [WN13]. Therefore state of the art BM patterns make sense from a company's perspective. They can be sustainable and are often well tested. But they often completely fail to work on a network level [SS15]. Some frameworks [Gor02, Ost04] already model relationships to other actors in the market and do not solely focus on internal processes of a company. The IOT requires technical solutions and the industry already made big steps forward by introducing technical standards. Efforts have now to be taken at a company level by innovating BMs and collaborations with partners and customers [WF15]. Growth and success of the IOT strongly depend on the evolution of new BM constellations that are suited to work on a network basis. A broader viewpoint will help companies to understand the dynamics and drivers of the industry. These perceptions could then lead to better services and thus to faster adoption of IOT technologies.

Therefore, a framework for NBBMs is needed to discover driving forces of markets and test the effects on the network when changing the BM of a single company. The framework has to promote network-based solutions that are provided by collaborating companies. Concepts of existing BM frameworks have to be integrated to lower the entry barrier for using the framework in practice. By providing a software implementation of the framework the design of BMs can be simplified and support BM-Designers in practice.

1.3 Research Questions & Expected Results

In this master thesis three main Research Questions (RQ) will be answered. The questions are presented and described in the following, together with a description of the expected results.

RQ1: How does the IOT industry look like today in terms of the most common business models and constellations of stakeholders?
To answer this question, recent literature is consulted and elaborated. Scientific papers and books about the IOT are screened for examples about business scenarios in this domain. A business scenario contains sets of companies aiming to produce a product or service for consumers. Relationships among the companies will be investigated. The business scenarios will serve as a use case along the whole thesis. For every single company of the scenario the typical BM is described in prose and modelled by applying the Business Model Canvas (BMC) [OP10]. Relationships amongst companies as well as to end customers will play an important role in the framework designed in the context of RQ2. Hence relationships will be investigated in detail. Parameters determining network effects (e.g. amount of customers) and institutional regulations (e.g. data protection laws), which influence the market are stated.

RQ2: How can a network-based business model be modelled and simulated to foster business model innovation and to increase total value creation?
Based on the insights on problems and challenges of the current situation in the IOT industry, a new framework for NBBMs in designed. The framework will feature all the qualitative aspects of the BMC, which originates from Osterwalders' Business Model Ontology (BMO) [Ost04]. Quantitative aspects based on the e3-value ontology by Gordij will allow the generation of the revenue, the costs and the profitability sheet [GA01a]. If the IOT industry is also affected by other influences than the single companies and customers, these parameters will be included in the model. The model will be described in prose and represented in a graphical manner. A web-based tool is implemented, so that the model can also be used meaningfully in practice.

The following features will be implemented as part of this master thesis:

- Feature 1: Applying the BMC template for companies and users in the market.
- Feature 2: Categorisation of the BMC of every company to predefined BMC types.
- Feature 3: Referencing of an entry in the BMC of one company to an entry in the BMC of an other company. The references will be shown graphically to express the dependencies between the BMCs. Potentials and challenges of the network can so be detected more easily.
- Feature 4: Calculation of costs, revenues and profitability.
- Feature 5: Extensive use of colours to enhance the expressiveness of the model.
- Feature 6: Persistent storage of the models in a database to create a knowledge repository.

The tool will comply to the analytical model of the thesis and it will be functionally complete already in this first release. It will be a software prototype, but people in the domain of business modelling should be able to use the tool without major difficulties. As full functionality is the goal of this first prototype, usability of the tool has to be improved in further versions.

RQ3: What are the most influential constellations of business models in network-based markets?
Some considerations about more successful BM networks will be taken from the literature review. These indications will be used to test new constellations of BMs in the IOT market. Relations between the companies will be modelled and profitability statements will be generated with the implemented software prototype. Business networks have different purposes. The network could for example be suited to increase the market adoption of a product or technology. On the other hand, companies would mainly be interested to drive up profit or build a sustainable BM that fits their strategy [HH10]. Therefore, scenarios with different goal settings are used to explain the purposes of the NBBMs. In this context limitations of the model and of the prototype will be expounded and suggestions for further improvements will be given.

1.4 Methodological Approach

In order to answer the research questions of Section 1.3 knowledge is derived from different sources and methods (case study, modelling, prototype, simulation). In line with scientific practices this thesis is initiated with a literature review on BMs. The IOT industry is analysed and a case study is defined. Then the framework is designed analytically and practically implemented. The software prototype is then used to analyse the business environment and dependencies of a case study. At the end the framework will be evaluated and potentials as well as limitations will be declared. In detail the methodological approach consists of the following four main parts:

Literature Review
The Literature Review will serve as the basis for this master thesis in order to expose preceding research on BMs. Established frameworks and tools are explained and their limitations are addressed.

Analysis of Business Models in the Internet of Things Industry
In this chapter the current constellation of the IOT market is analysed. The most important players are outlined and their Single-Company BMs are explained textually and graphically. By applying Osterwalder's BMC [OP10] the intrinsic behaviour of the actors will be shown explicitly. Every BM is classified to a pre-defined type. Furthermore, a motivational scenario (use case) is defined, based on the analysis of common constellations of business partners. Most relevant parameters such as market prices and demand functions will also be quantified.

Framework for Network-based Business Models
Most quantitative modelling tools for business purposes focus on business process modelling. Therefore, a framework for network-based business models is designed and implemented in order to test the effect on the market if a individual company changes its BM. The high value of this framework results from its combined qualitative and quantitative nature. Most BMs, defined by Osterwalder [OP10], can be assigned to each single actor of the market. The nine boxes of each BMC [OP10] can be filled out and quantitative parameters determining the actors market behaviour (market prices, demand) can be set.

Use of the framework to evaluate alternative Network-based Business Models for the IOT market
By applying the BMC [OP10] to all single companies and referencing dependencies between the actors, relationships and dynamics are discovered. The previously defined motivational scenario is now analysed to increase the overall outcome of the value chain. Due to the different viewpoint (from company view to network view), NBBMs will outline the potentials and benefits for the involved actors. The scenario will first be described textually and then tested with the implemented framework. Finally, the framework will be evaluated and limitations will be revealed in the case of the IOT industry as well as for other fields of application.

1.5 Structure

The thesis is structured to fit the methodological approach as it is described in Section 1.4. After the current introducing Chapter 1, the literature review follows in Chapter 2. In this chapter current theory about BMs and value networks is discussed. Established BMs of the different companies and other insights on the IOT industry are investigated in Chapter 3. Based on the gathered knowledge of the previous chapters, the framework for NBBMs is designed and described in Chapter 4. The framework is then used in Chapter 5 to conduct a case study. The findings of the thesis are discussed in Chapter 6 and finally concluded with an outlook on future research in Chapter 7.

CHAPTER 2

Business Models - The State of the Art

2.1 Definition

Although the term BM has been known for many decades, economic theory and business studies lack a clear definition [Tee10]. The term was first mentioned in 1957 in an academic article as a representation of the real world in a model in the context of business games for training purposes [BCM+57]. As investigated by Zott et al. [ZAM11] just very little research was done and few papers were published containing the term BM before 1995. Since the mid-1990s, the rise of the Internet and the *dot com era*, the term gained popularity. Traditionally companies were valued on past performance. BMs now seemed to explain the innovative and disruptive power of technology-based companies. Investors in the *dot com bubble* often invested on the chance of high returns on investment by Business Model Innovation (BMI) [DT14]. Because of its high practical relevance, most research was published in nonacademic journals and academic literature was lagging behind practice for many years [ZAM11].

The term BM can be perceived differently. It can be seen as a statement, a description, a representation, an architecture, a conceptual tool or model, a structural template, a method, a framework, a pattern or as a set. In most cases it is defined as a concept that explains how a company conducts its business. It consists of a set of elements that influence each other, e.g. value proposition, revenue model, network of relationships. Even if concepts of BMs are defined in a similar way, the focus and goal of scientific studies vary substantially. BM researchers tend to not only explore *what* companies do to be successful in the market, i.e. what kind of products and services they produce. In most cases they also describe *how* companies do it, i.e. how to reach the market and serve the customer. This is rarely possible without the collaboration and partnerships with third parties. Many representations aim to model a company as a system of activities. The

system is mostly company-centric and contains as well relations to other entities in the context of a business environment. The aim and objective of such activity systems are to create value. Value can be a tangible product, an intangible service or also an experience. In earlier times BMs emphasised on capturing value. The shift from the value capture to the value creation principle, however still taking value capture in consideration, adjusted the focus of BMs. The customer value proposition is according to many definitions the driving force of a company. How the value is created, is mostly case-specific [ZAM11].

It is relevant for what timespan a BM is designed and from which perspective it is observed. To bring more clarity into the definition, Morris et al. [MSA05] defined three different levels at which BMs can be discussed: economic level, operational level and strategic level. The economic level is the most elementary one because it deals with the profit generation within one company. At the second level, the model focuses on internal processes and the overall infrastructure that allows the company to create value. At the strategic level also external influences of the companies' environment become relevant. Sustainability and competitive advantage are the driving topics of the strategic level. Hence, growth opportunities, market positioning and interactions with other participants in the market are crucial. Differentiation, vision and especially value creation guides the decision making. Some authors [PT11] base their research accordingly on these three categories, but others build on totally different classifications. Due to its interdisciplinary nature, BM research is related to different concepts of strategic management, value chains and systems, strategic positioning and cooperative strategies.

To summarise, no clear definition is found in the literature. Over the last decades, many authors published in the area of business modelling. Research is lacking a common language, is missing conceptual consolidation and was not able yet to develop a theoretical concept [AMIN13]. The problem was recognised and now researchers try to tackle the issue with different approaches [MSA05, GOP05, PT11, ZAM11, PR13, WPUG15].

2.2 Business Model Ontologies

Ontology is a term originating from philosophy. A modern explanation by Borst defines an ontology as a *formal specification of shared conceptualization* [Bor97]. In other words, an ontology is an accumulation of terms, concepts, components and relationships among them. In the context of BMs, an ontology is an abstraction of value propositions including the roles of the stakeholders around the creation of value [Gor02].

This master thesis is based on the Business Model Ontology (BMO) [Ost04] and the e3-value ontology [GA01b]. Both perceive BMs as a concept, but they go a step further to provide a higher scientific value with ontologies. A third well-known business modelling ontology is the Resource Event Agent (REA) ontology [ABE+06]. It originated from an accounting data model and was extended into a business domain ontology [GP07]. The three ontologies [GA01b, Ost04, ABE+06] were initially developed for different purposes, but all of them were extended to expand their applicability [ABE+06]. The two BM ontologies by Osterwalder and Gordijn are explained in Section 2.2.1 and Section 2.2.2.

2.2.1 Business Model Canvas

The foundation stone of the BMC was laid in the PhD thesis of Alexander Osterwalder about the BMO [Ost04]. Based on the BMO, Alexander Osterwalder authored the book *Business Model Generation* together with Yves Pigneur and 470 practitioners from 45 countries [OP10]. The main goal of the book was to explain the BMC to people from the business domain. The book is an evolution of the academic work of the BMO to better suit the needs of practitioners by following the design thinking practice [FP15]. Design thinking was first described in the context of the business domain by Tim Brown, CEO of the design and consulting company IDEO [Bro08]. In contrast to the analytical scientific method, the formal method in form of solution based thinking. The technique starts with a goal definition and aims to find practical and creative solutions to reach that goal. The different methods, e.g. brainstorming, mind mapping, are often performed in teams and no strict order of processes exists [DAE+05].

As explained in Section 2.1, science is missing a clear definition of BMs. Osterwalder also perceives this problem and distinguishes between different taxonomies, components, representation tools, ontological modelling, change methodologies and evaluation measures. The main emphasis of Osterwalder's thesis is on the contribution to BM ontologies. BMO and the e3-value ontology by Gordijn, explained in Section 2.2.2, are the most established BM ontologies in science and practice [FP15]. Unless otherwise stated, the description in this section is solely referencing Osterwalder's book *Business Model Generation* [OP10].

With the BMC, a shared intuitive language is created that can be understood all stakeholders and shareholders of a company. At the same time it expresses the complexity of a BM. By applying the BMC, the assumptions about a BM are evaluated systematically. The canvas itself is divided into nine building blocks that explain how a company wants to make money. The building blocks are called: Customer Segments, Value Proposition, Channels, Customer Relationships, Key Resources, Key Activities, Key Partners, Revenue Streams and Cost Structure. Figure 2.1 shows the full BMC. In the following paragraphs the blocks are explained in detail because a deep understanding of the concept is necessary for the subsequent chapters of this master thesis. Just few pros and cons of the different aspects in the building blocks can be given because the single elements of building blocks mostly depend on the specific case of a BM.

Customer Segments
The customer segments block represents classes of private or organisational customers. The company wants to sell its services and products to these groups. The customers and their value propositions are the most important aspects of any BM. Without customers, the company can not exist in the long run. The view through the eyes of the customers helps to discover new opportunities and to fulfil the customers needs. In most cases it makes sense to segment customers according to similar needs and behaviour. Customer segments can generally be categorised into different types: mass market, e.g. consumer electronics, niche market, e.g. automobile components, segmented, e.g. drink producers with a broad variety of products, diversified, e.g. company selling books and renting cars,

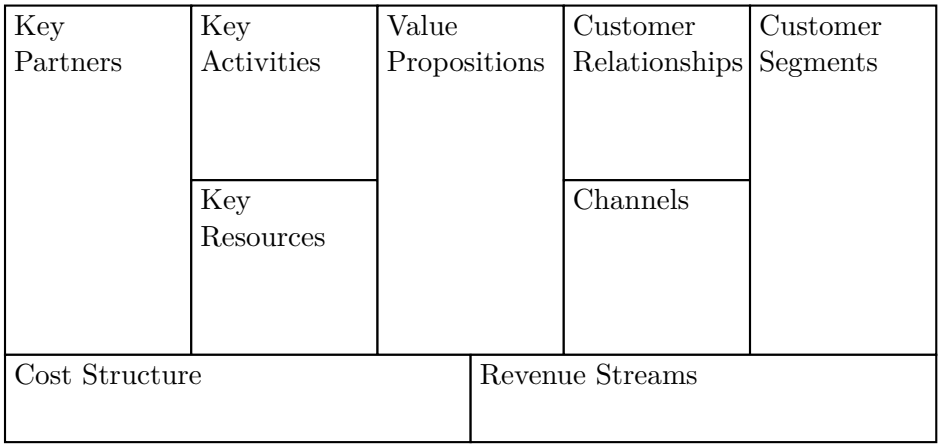


Figure 2.1: Business Model Canvas (adapted from [OP10])

multi-sided platforms, e.g. free newspaper attracts readers and provides advertisement. If a BM targets the mass market, just one large customer group is served that is characterised by very similar needs. When serving niche markets, the company has to design its value propositions, distribution channels and customer relations for every single segment separately. Segmented markets are identified by quite similar needs and problems, but other building blocks of the canvas are slightly affected. Customer segments are denoted as diversified if they are not related to each other. Therefore the value propositions are mostly different for each segment. Multi-sided platforms offer their products and services to several interdependent customer groups with no common value propositions, distribution channels and customer relationships.

Value Propositions
The value proposition block describes the value a company creates by providing products and services. It is understood as a bundle of offers and describes the competitive advantage from the view of the customer. Value propositions can be innovative or represent a unique offer on the market. Sometimes similar propositions already exist in the market and characteristics are just added or improved. Customer values can be qualitative or quantitative and can are grouped by different aspects: newness, performance, customisation, "getting the job done", design, brand/status, price, cost reduction, risk reduction, accessibility, convenience/usability. Novelty is often, but not necessarily, technology related and fulfils previously unprecedented customer needs, e.g. cell phones. Value creation due to performance enhancements is very common in the technological industry, e.g. PCs, and has a long tradition (see Moore's law). However, this kind of value creation is not innovative. Products and services tailored to customer needs often gain a significant amount of value. Customisation gained popularity in industries serving the mass market and can often be achieved without relinquishing economies of scale effects. E.g. optional extras in a car provide value for the customer but does only slightly affect the production process.

Supporting the customer to "get one's job done" is often achieved by bundling or increasing a company's offer, e.g. manufacturing and maintenance. By contrast, the value created by design is often not obvious. It is sometimes just related to the "look and feel" and is hard to measure, e.g. design of consumer electronics. Similar value can be provided by a brand or a high status of a company, e.g. luxury brands. On the other hand, low prices can attract especially price sensitive users, e.g. air travel. Free offers are increasingly affecting more and more industries. Cost and risk reductions are usually related to B2B offers. Cost reductions by CRM systems or risk reductions by service guarantees, for example, usually tackle big problems of customers. New technologies, BM innovation or both combined can make products and services more accessible to people, e.g. fractional ownership of tools. Convenient services or products with high usability can be a company's single value proposition, e.g. first mile logistics.

Channels
The channels block describes how a company delivers products and services to its customer segments. It includes communication, distribution and sales channels. Channels are classified as direct and indirect ones and are again distinguished between owned and partner channels as it can be seen in Table 2.1. Each of the channels can be divided into five successive processes. First of all, the company has to create awareness so that people get to know about the offer. Then the user has to be supported to evaluate the value proposition of the company. Most important for the company is then to enable as many customers as possible to buy the service or product. In the following, the company also has to organise delivery (physically or immaterially). Finally, the company can provide ways to generate post-purchases from existing customers.

Table 2.1: Channel Types of the BMC (adapted from [OP10])

Own		Partner		
Direct		Indirect		
Sales force	Web sales	Own stores	Partner stores	Wholesaler

Customer Relationships
The customer relationships block describes what relationships the company is going to have with the single customer segments. Relationships have various characteristics, but often the most important scale is the degree of automation. Basically, the relationships are motivated by the following reasons with the ultimate goal to increase sales: customer acquisition, customer retention or up-selling. Many times the motivations for the customer relationship correlate with the market saturation. For certain BMs, the customer relationships might be crucial and might strongly influence the overall success of the company. Companies decide between different types of customer relationships. The type of customer relationship it is mainly determined by the market that the company is serving.

Customer relationships can be classified into different types: personal assistance, dedicated personal assistance, self-service, automated services, communities and co-creation.

Personal assistance is happening by any mean of personal communication (conversation, email, phone, chat) solely by human interactions. Dedicated personal assistance is the most individual way of customer relationship and has to evolve over a long period of time. Every client has a dedicated representative that handles the incoming inquiries. It is common for businesses with large volume deals like banking or B2B contracts. In contrast, a self-service relationship does not require any direct communication with the client. Automated services are aiming to imitate personal relationships by automating the processes of direct communication. An automated service is able to recognise people including their personal characteristics and to recommend tailored offerings. Communities are often supported by companies so that community members share knowledge or solve problems of each other. The company maintaining a community also gets insights into customers preferences and behaviour. Nowadays community live takes place to a large extend in the Internet. Including customers in product development or other traditionally company-internal processes is called co-creation. With these customer relationships, the customer creates value for the company, but the company has to give the customer also additional value in return, e.g. acknowledgement, vouchers.

Revenue Streams

The revenue streams block explains how the company generates revenues from each customer segment. Each customer segment can create several sources of revenues or may also generate negative revenue. The streams of revenues are categorised into fixed and dynamic pricing. Prices are fixed if every customer pays the same amount for the product or service. These prices do not fluctuate. Dynamic prices are adapted according to the preferences of the customer or market demands and are often fluctuant. Traditionally commonly used pricing mechanisms such as fixed pricing, bargaining or auctioning practices are widely replaced by market- or volume dependent mechanisms or yield management. Yield management adapts prices to maximise profits or revenue from a limited resource, e.g. hotel rooms or flight seats, based on the behaviour of the customers. Customers may generate revenue with one-time purchases or revenues may also reoccur, e.g. monthly payments. While the ownership rights are transferred in an asset sale, customers can also be charged a usage fee that depends on time or distance metrics, e.g. kilometres driven with a car. Similar characteristics to usage fees are lending, renting and leasing. With these pricing mechanisms users get exclusive access to a certain right. For the company it generates a reoccurring revenue stream with just little additional costs. A subscription fee is reoccurring revenue that is charged in regular time frames. Giving customers the right to use intellectual property in exchange for licensing fees is very common in the media industry or in patent-driven industries.

Brokerage fees result if a company acts as an intermediator between two parties. For every concluded transaction, a percentage of the generated sales is taken by the intermediator (e.g. credit card provider). Very common in the media industry, but nowadays also in the software industry, is the advertising model. Revenue streams can also result from any kind of advertising of a brand, product or service.

Key Resources
The key resources block describes the most crucial assets needed to run the company in the context of a specific BM, e.g. manpower, money. No BM can function without resources because they enable the company to deliver a value proposition, take care of relationships with customers, attain markets and generate revenues. Key resources are controlled by the company or they may be also acquired from key partners. They can be divided into different types: physical, human, intellectual and financial. Physical resources are mostly capital intensive and include assets such as buildings or manufacturing plants, vehicles and machines, systems and networks. Human resources are needed for any BM but certainly for some they play a more important role than for others. In creative and knowledge-dominant industries human resources are key. Intellectual resources like brands, proprietary know-how, patents or copyrights, partnerships and customer data are gaining significance. These resources can be of considerable value. One reason for this is that it takes a high effort to develop them. Financial resources can be cash, credit, or maybe also a stock option pool for hiring key personnel.

Key Activities
The key activities block describes the most important tasks a company has to fulfil. They depend on the type of BM and, similarly to key resources, they are needed to realise the other building blocks. Key activities are divided into three categories: production, problem solving and platform/network.
Production activities are used to design, build and deliver a product. Problem solving activities are used to tackle customers' problems and resolve them in an innovative way, e.g. consultancies or hospitals. Such activities often require training of employees and knowledge management. Platform and network activities are crucial for networks, match making platforms or software. The aim of platform and network activities is to bring different parties together and to further promote the company, e.g. credit card providers bring merchants, customers and banks together.

Key Partnerships
The key partnerships block outlines the partners and suppliers the company needs for the respective BM. Some partnerships may be essential for a company and are often one of the pillars of a BM, e.g. operating system for PC manufacturer. Companies form alliances to reduce risks, acquire resources or for optimisation reasons. Different types of partnerships exist, depending on the respective reason of the partnership: strategic alliances (between non-competitors), coopetition (between competitors), joint ventures (grow a new business) or buyer-supplier relationships. The most trivial form is a buyer-supplier that aims to optimise resource allocation. Reduction of costs, e.g. by outsourcing, is characteristic for economies of scale partnerships. Reduction of risks and uncertainty is necessary to endure in competitive markets. Therefore, it is quite common to form strategic alliances in one market while competing in other areas. Acquisition of particular resources and activities allows a company to focus on its core competences. Knowledge acquisition, licences and access to customers are common use cases for acquisition partnerships, e.g. a smartphone manufacturer licences an operating system.

Cost Structure
The cost structure block describes the most important costs occurring in a BM. Value creation, customer relations and channels cause costs that have to be covered. After defining the other eight building blocks, the estimation or calculation of costs is relatively simple. Costs can be distinguished between fixed costs and variable costs. Fixed costs are independent of the volume of offers while variable costs increase proportionally to the amount produced. The advantage of decreasing costs with increasing volume is called economies of scale. Larger companies also profit from a larger scope of operations, the so called economies of scope. This derives from the fact that marketing actions and distribution channels can be used for various products at the same time. In some BMs, costs may not play an important role, while other BMs are build around minimising costs. Cost-driven BMs drive down costs as low as possible by low price value propositions, automation and outsourcing. Value-driven BMs, on the other hand, are mostly concerned about value creation. Offers are often personalised and costs are not in the main focus.

In this section the BMC with its nine building blocks was introduced. The canvas can be used to find new BMs or to optimise already existing BMs. By filling out the nine blocks, the designer of the BM is forced to think about many aspects of a BM. The BMC will be used in the following chapters. In Chapter 3 it is used to describe the BMs of the IOT industry. The framework presented in Chapter 4 is based on the BMC. In the next Section 2.2.2 another, value network oriented, ontology is presented.

2.2.2 e3-value

The e3-value ontology was developed in the Ph.D. thesis by Jaap Gordijn in 2002 [Gor02] after a preceding evaluation of a research project [GA01b, GA01a]. The goal of the thesis is to develop a framework that is capable of presenting an innovative e-commerce idea including the profitability evaluation to stakeholders like business consultants, CEOs, COOs and CTOs [GA01b]. The framework focuses on e-business models, short form for BMs that are suited for companies selling their products and services online. The ontology is very lightweight and follows a graphical modelling approach. Gordijn clearly distinguishes value modelling from process modelling. Value modelling, in contrast to process modelling, does not discuss how activities should be done. It describes who exchanges which values with whom and what value that party expects in return. The author aims to explain value networks by modelling the values exchanged between the actors.

The ontological concepts and their relationships are shown in Figure 2.2 as an UML class diagram. Rectangles represent concepts and the associations (lines) show the relationship among them. The concepts are in the following described in detail because Chapter 4 will be based on the e3-value ontology.

Actor
An actor represents an economically, often also legally, independent entity like an company or a consumer. In the case of an company, its goal is to be profitable after a certain time. In the case of a consumer, the goal is to create or increase value for oneself. In a viable e-business model every actor should be able to make profit. Actors may be part of several market segments and exchange value over one or more value interfaces.

Value Object
Value objects are exchanged between actors. A value object can be a service, a product or a consumer experience, which represents some form of value for at least one of the actors involved. The perception of the exchanged value may be different for the involved actors because value is by its nature subjective. Value is no inherent property of a good or service, but it is determined by the importance for the receiving actor [Hol99].

Value Port
Value ports connect actors with each other and thus enable exchange of value between them. Value objects flowing out or into an actor represent a transfer of ownership or a change in rights. The concept of a port is abstract and hides any process behind the value exchange. A value port shows that other components can be plugged in to connect other actors.

Value Interface
Actors have at least one value interface. It presents the value object an actor wants to exchange in return for other value objects. The exchange is transferred via the contained value ports. It is specified in the value interface under which conditions the value exchange is enabled. If a value interface contains several value ports, either all value objects or none of them are exchanged.

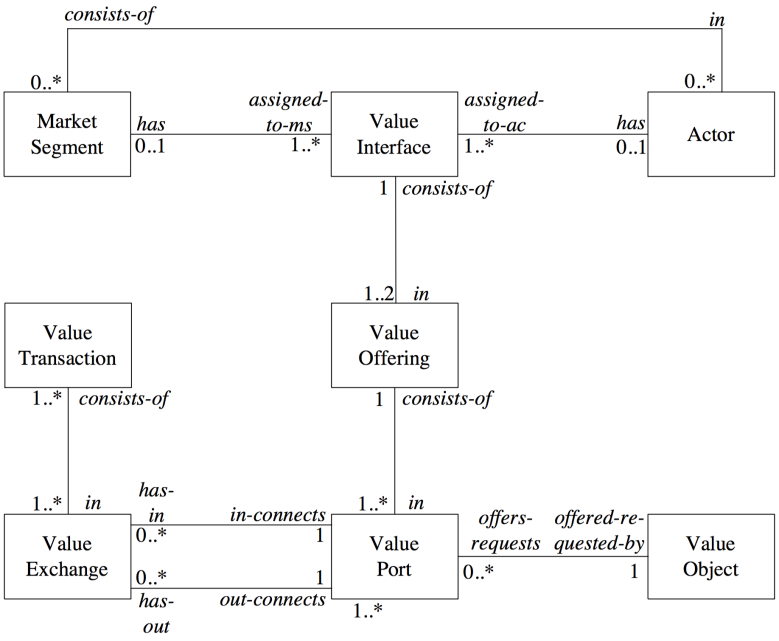


Figure 2.2: e3-value ontology as UML (from [Gor02])

Value Exchange
Value exchanges connect two value ports of different actors with each other. As shown in the example in Figure 2.3 they are visually denoted as blue lines [GA03].

Value Transaction
A value transaction consists of one or more value exchanges. Such an aggregation of value exchanges is needed to detect, if all or none value object should be exchanged. Two ore more actors are included in a transaction. If more than two actors are involved, it is called a multi-party transaction. The concept of value transactions is rather notional. Therefore, it is not included as an element in the software implementation of e3-value as it can be seen in Figure 2.3 [Gor02].

Value Offering
A value offering shows to the environment what an actor offers or requests. It is a set of equally directed value ports and is closely related to the concept of the value interface. Some value objects may only generate value for an actor if they are delivered in combination. Therefore, this concept is necessary to check if values are exchanged on all ports or none at all.

Market Segment
A market segment consists of a large number of actors that share common characteristics. However, actors that are part of a market segment are still individuals or independent organisations. A market segment has zero or more value interfaces. If an actor is part of a market segment but has additional value interfaces, this is modelled explicitly [GA03].

The e3-value ontology is based on a scenario technique called Use Case Map (UCM) [Buh98]. UCMs explain which values should be exchanged out of a consumer need or as a consequence of other value exchanges. In the following the four main constructs of UCMs are shortly explained.

Scenario path and segment
Segments related by connection elements, start and stop stimuli and responsibility points form a scenario path. The scenario path shows via which value interfaces the different value objects are exchanged.

Stimulus
A scenario path starts with a start stimulus (usually a consumer need) and ends with a stop stimulus.

Connection element
Connection elements can split paths into sub-paths or join sub-paths into a single path. The four possible connections elements are: AND fork (split paths into sub-paths), AND join (collapses sub-paths into one path), OR fork (directs a scenario path to the best option of a set of alternatives), OR join (merges paths).

Responsibility element
The responsibility element indicates when value objects enter (or leave) an actor, a market segment or a value activity [GA03].

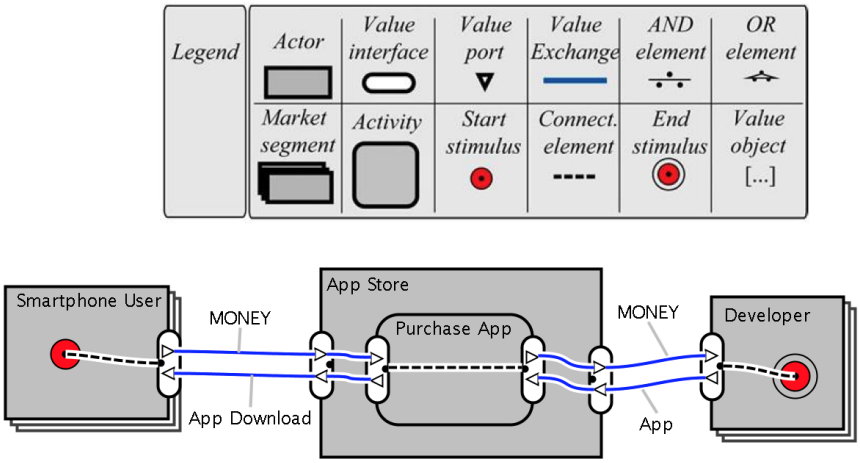


Figure 2.3: Example e3-value model (own example, legend from [PGW06])

Figure 2.3 shows an example of an e3-value model. The model is drawn with the official tool for e3-value, implemented by Gordijn [Gor06]. The tool is used to model the value viewpoint graphically and features the generation of a profitability sheet.

2.3 Business Model Innovation

Today it is not enough for companies to focus on product innovation by investing in technology, research and development. Also, BMs need to be innovated to guarantee long-term success [Che07]. In the IBM 2006 Global CEO Study 765 leaders of corporate and public institutions were asked about their view on innovation. The financial analysis of the study revealed that outperforming companies were putting twice as much effort on BM innovation as underperformers [IBM06]. Business Model Innovation (BMI) got more attention in academic research in recent years. According to Wirtz et al. [WPUG15] it is the most active research topic in the area of BMs. BMI is often recognised as an independent concept in literature. The distribution of the type of research is balanced between conceptual articles and case studies.

As a consequence of the fuzzy definition of BMs in general, as explained in Section 2.1, literature is lacking grounding for BMI research. In addition to BM research, which mostly focuses on value creation and capture on a company level, BMI research includes novelty in customer value proposition [SSR14]. Structural changes of configurations within and among companies are often necessary to deliver the innovative value proposition. Activities are reorganised to solve a customer problem in a way, that is superior to any existing (own or competitive) solution [Sou15]. BMI can lead to sustainable competitive advantage if the BM is sufficiently differentiated and hard to imitate by competitors [Tee10].

A definition and categorisation of BMI are given by Giesen et al. [GBBB07] in the form of a framework. The authors distinguish between three types of BMI: industry models, revenue models and enterprise models. *Industry models* are characterised by innovation in the industry value chain. In the most extreme case, this is achieved by developing new industries that did not exist before, moving horizontally to other existing industries or by redefining existing industries. E.g. Apple entered the music market by delivering music over iTunes. *Revenue model* innovation reconfigures offerings of products, services or the value mix. E.g. Gillette sells underpriced razors but the blades are expensive. In digitised markets, which were enabled by the Internet infrastructure, new pricing models can easily be introduced and tested. Digital prices can be adapted quickly and digital services can be reconfigured regularly. By introducing new features, customers are segmented into different groups with diverse value offerings and different prices. *Enterprise model* innovation is about changing the structure of the enterprise or its role in new or existing value chains. By redefining organisational boundaries, companies can, on the one hand, integrate parts of the supply chain. On the other hand, companies can specialise and focus on their core competencies or activities with high margins. E.g. the Indian telecommunications company Bharti Airtel outsourced its IT and networking activities to focus on marketing, sales and distribution.

According to a case study by Giesen et al. [GBBB07], enterprise model innovation focusing on network and collaboration was the most common type of BMI. Especially established companies make use of this type of BMI to change course via partnerships and acquisitions. Although 76% of leaders of the IBM study mentioned at the beginning of

this section emphasised the importance of collaborative innovation of enterprise models, just half of the interviewees were doing it actively [IBM06]. With the progress of globalisation, problems related to culture, regulation and technology increase. About half of strategic partnerships and therefore also collaborative innovation of enterprise models fail. Nevertheless, enterprises who are able to manage this kind of innovation have great potentials for success [GBBB07]. The topic about enterprise model innovation is closely related to NBBMs and will be discussed in detail in Section 2.4.

The degree of BMI can be categorised into incremental and radical innovation. Radical innovation changes services and products in a way that existing products and services are cannibalised. Companies often have to build up additional knowledge and competences that were uncommon for their business in order to achieve radical innovation. Incremental innovation can be accomplished by using already existing knowledge in small steps. Incremental changes on products and services, practices and structures are mostly just effective in the short-term. Successful radical innovation leads to long-term competitive advantage and influences the strategic positioning of a company [LTB10].

Innovation does not always have to arise from inside a company. Instead, companies can search outside of their organisational boundaries and cooperate with other companies by sharing information and knowledge. Chesbrough introduced the term 'open innovation' in 2003 and applied it in later research to BMs. The BM can, one the one hand, be a driver for innovation. On the other hand, the BM itself can be subject of innovation, which is called Open Business Model Innovation (OBMI) [ZAM11]. OBMI can be driven by customers, by including the customer in conception, production and delivery processes. The customers is in that case a resource for OBMI. Including customers in the BMI process can completely disrupt the BM because many building blocks of the BM are affected. Technology, internal/external venture handling, license, spin-out, divesting and reaching new markets are mostly in the focus of OBMI. Companies often do not have all competences and resources they need for successful BMI. Therefore, they partner with other companies of the industry and innovate their BM together with those partners [LRP+12]. E.g. Procter & Gamble outsourced the major part of its research and development department to outside partners to increase productivity [OP10]. Section 2.4 describes this process and presents the importance of BMI in company networks.

2.4 Network-based Business Models

Research mostly focused on BMs that are limited to the viewpoint of an individual company. The dot-com era and increasingly complex products are now causing a shift from organisational to network thinking. The trend of network formation can be noticed in nearly any digital industry. The formation takes place at a much higher speed than in traditional supply chains in the chemical and textile industry. Networks do not only evolve in digital industries, but also established traditional supply chains slowly extend to networks, e.g. in the automotive industry [BEPV13].

2.4.1 Origins in the Value Chain

The term NBBM is closely related to value chains. Porter recognised in 1985 that a value chain is composed of a stream of activities that a company carries out. The single activities are grouped in primary activities and support activities. Figure 2.4 shows the value chain including the single activities of a company. Value chains are part of a bigger value system. A value system goes beyond the boundaries of a single company and includes all the value chains from the first supplier to the consumer [LN14].

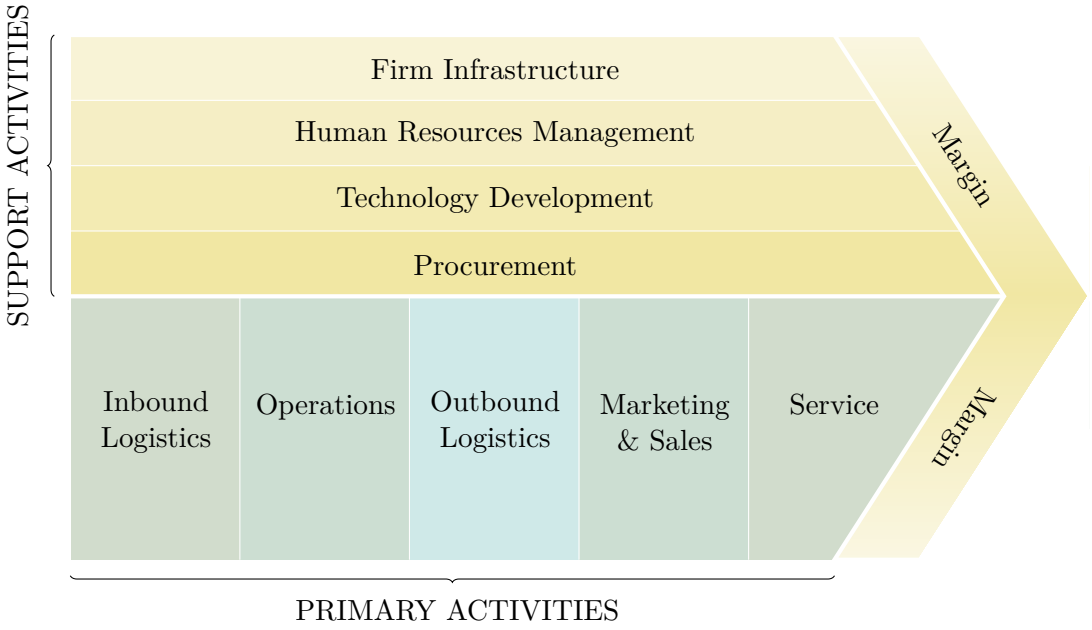


Figure 2.4: Value chain by Porter (adapted from [Por85])

Companies can benefit from forming coalitions with other companies in a value system. Coalitions are long-term agreements in the form of joint ventures, licenses and supply agreements [Por85]. Coalitions among companies and interactions with customers are traditionally not perceived as value creation. Unfortunately, coalitions are often seen by companies as means for value exchange or extraction. Companies try to drive down costs and increase efficiency instead of focusing on value creation for the customer. Managers are often thinking product-specific instead of focusing on the experiences the customer wants to have. Companies are so missing out potential revenues: the companies do not meet the customers' expectations and hence they sell less products or services [PR04].

2.4.2 Network Thinking in the New Economy

With increasing competition because of globalisation and therefore less space for differentiation companies have to change their way of thinking. Reduction of transaction and coordination costs will further promote company networks. It will become more

important for companies to evaluate the options and restrictions for cooperations with partners and networks [TJ01]. As noted in Section 2.3, the IBM 2006 Global CEO Study revealed the importance of innovation of enterprise models [IBM06]. The progress of information systems and standardisation promoted network thinking further. ERP systems and similar software allow companies to move the supply chains to more complex inter-company networks to increase efficiency. Information and communication systems drive down transaction costs and have at the same time a positive effect on economies of scale [TPN+13].

Emerging technologies often bear big financial risks for companies. At the same time they also offer huge potential for economic success. Traditional BMs are often not suited to commercialise pioneering technologies. Knowledge in the technical domain but especially in the social domain and market environment is necessary to develop new BMs. Novel technologies are ahead of their time and therefore value networks still have to emerge [CR02]. However, the entire network has to be considered already when designing BMs to commercialise products and services based on such technologies. Relationships between partnering companies are very dynamic, because they are frequently changing and non-linear. Therefore choosing the best fitting relationship for the chosen BM can be very complicated. Screening of companies in a market is time intensive and agreements usually take long to conclude. This effort is necessary to find the right partners and often crucial for success of the cooperation. Resources of the single companies in a network have to be deployed in a form so they can be shared and utilised within the network. The full capability of the participants in the network can be achieved by linking the inter-organisational network with internal organisational work [FQQ06].

2.4.3 Characteristics of Network-based Business Models

The term NBBM is not an established term in science yet. It appears in scientific papers [NAZ15, LN14, MN13, LTB10, FQQ06], but the term NBBM itself is never defined properly. Problems concerning definitions in the BM domain already discussed in Section 2.1 and Section 2.3 appear also in the advanced topic of NBBMs. Palo [PT13, PT11] uses the term *networked business model*, which can be taken as a synonym for NBBM. Her definition of *networked business model* is used simultaneously to define NBBMs in this master thesis. She defines the term as follows:

'A networked business model describes the way a strategic business net creates value'

Other terms in the literature describe concepts similar to NBBMs. The term *business ecosystem* origins from strategic planning and is commonly used in recent literature in the context of BMs [DWHV15, WLR14, BEPV13, WN13, HK12, ZN12]. Solaimani et al. [SBI15] argue that BMs have been discussed in relation to networks and ecosystems only on a strategic level. With their *VIP framework* they try to align BMs of companies within a network to create value with a joint solution. The VIP framework goes beyond

the strategical level and provides an analysis of the alignment of value and information flows, as well as operational processes. Furthermore, Bouwman et al. [BFH+08] describe BMs in the context of services and service innovation. The foundation of the methodology of their STOF model consists of four main concepts: services, technology, organisational arrangements and financial issues.

Usually, one company has an initial business problem or an idea and therefore needs competences and know-how from other companies [LTB10]. Therefore, the first phase is to form the network and contact partners to clarify their willingness to collaborate. Companies have then to decide what capabilities and resources they can offer and what business units should be involved. Each partner has to speak openly about the strategic goals of the cooperation. It is necessary to build trust and to avoid misconceptions at later stages. When negotiations get more concrete, a leader has to be selected to coordinate and guide the process. The leader of the network usually is the company which provides the critical core competence of the new service and has the greatest motivation for the new BM.

The NBBM analysis is then carried out by all companies of the network together [HHT08]. The analysis includes different processes such as value analysis, network modelling, feasible network restriction analysis and strategy choosing. Network modelling and feasible network restriction analysis are typically the main issues. The whole research and design process of the NBBM is, similar to organisational BMs, infinite and creative. The complexity is, compared to the design of organisational BMs, more extensive because of the relationships to other companies. The goal of the analysis of a NBBM is to determine the position of the participants. Fu et al. [FQQ06] recommend the following steps to design an NBBM:

1. Determine the value object. It can be a service, a product or an experience. It provides some form of value for an entity, usually the consumer.
2. Construct networks that aims to create the value object.
3. Choose a feasible network by analysing internal conditions of the companies and inter-company relationships.
4. Choose a strategy to carry out the BM.

The resulting NBBM and its execution strategy have to be critically analysed. The network partners have to conduct reality checks by jumping back to previous design stages and reevaluating the results. Clear quantitative estimations sync high-level objectives of the NBBM with the operational and strategic objectives of the participating companies [HBH+15]. As soon as the NBBM seems promising, the network can start with sales negotiations with customers and realise the business processes [HHT08].

CHAPTER 3

Business Models in the Internet of Things Industry

3.1 The Internet of Things Industry

The IOT got increasing attention in industry and research. Since the term IOT was coined in the late 1990s, various organisations are working on solutions to get the vision of the IOT closer to reality [PLJC14]. The vision includes statements like "The Internet of Things allows people and things to be connected Anytime, Anyplace, with Anything and Anyone, ideally using Any path/network and Any service" [SGFW10]. Singh et al. [STJ14] distinguish between three future visions of the IOT with a different focus: the things oriented vision, the internet oriented vision and the semantic-oriented vision. The things oriented vision focuses on tracking everything by the use of sensors and tracking technologies like RFID. Sensors mounted on things produce a high volume of data. When the sensors are organised in WSNs, information is gathered in different environments. The resulting information is fine-granular and provides detailed insights about the environment [GBMP13]. The internet oriented vision is built around the IP protocols, which allow the identification and continuous monitoring of sensor based objects over the world wide web. The semantic oriented vision is powered by the massive volume of data which can be processed by the means of semantic technologies [STJ14].

The IOT evolves out of the Web 2.0, i.e. the Internet as we know it today. Interaction of users on social networking sites, blogs etc. is characterising for the Web 2.0. The next generation Web 3.0, also referred to as the Semantic Web, will be dominated by machine-to-machine communication. Whitmore et al. [WAD14] call the transition from the Web 2.0 to the Web 3.0 a paradigm shift. The new paradigm and the intelligent behaviour of machines allow a variety of applications to be build for different purposes. The main application domains are smart infrastructure, healthcare and supply chains/ logistics and social applications.

3.1.1 The Internet of Things Technology Stack

IOT products require a new technology stack to unfold their potential. According to Porter and Heppelman [PH14] smart, connected IOT products are characterised from a functional perspective by three core elements: physical components (mechanical and electrical parts), smart components (sensors, microprocessors, controls, data storage, software, embedded operating systems, digital user interfaces) and connectivity components (ports, antennas, protocols, networks).

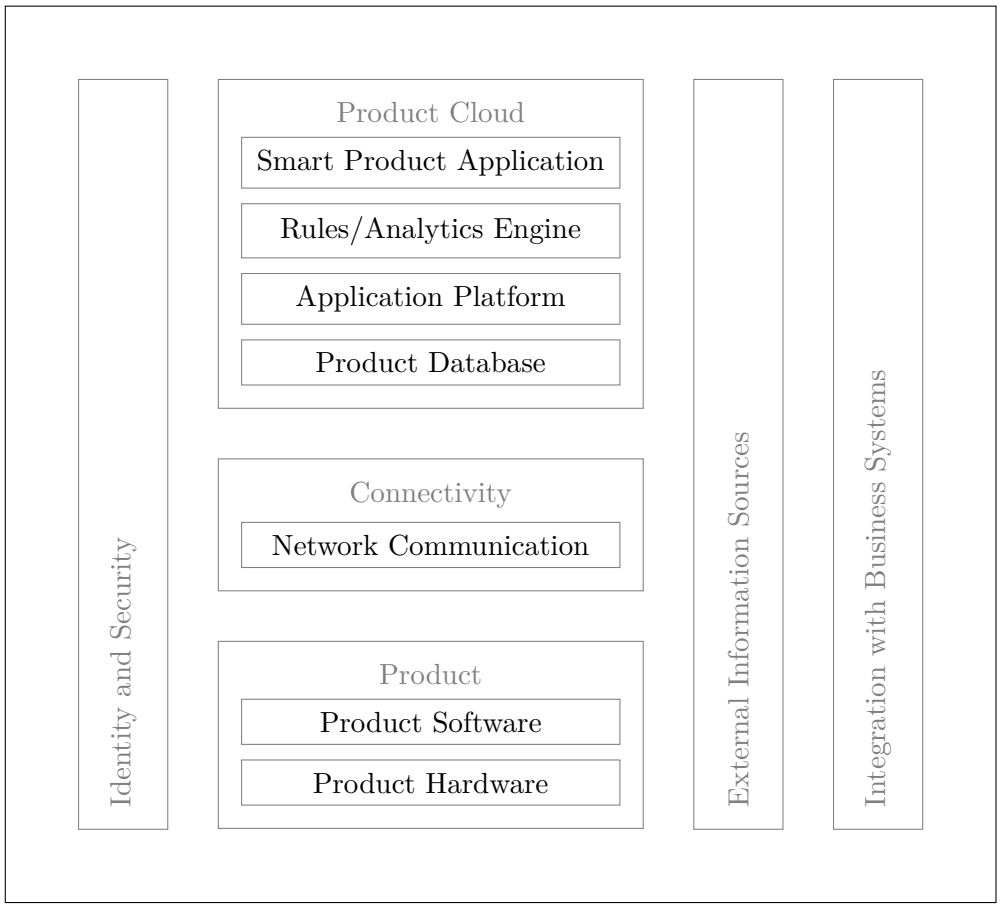


Figure 3.1: The IOT technology stack (adapted from [PH14])

Figure 3.1 shows the multi-layered technology stack according to Porter and Heppelman [PH14] that consists of three main layers: product, connectivity and product cloud. Identity and security, external information sources and integration with Business Systems influence all three layers. The first layer, the physical IOT product, consists of hardware and software. The hardware contains embedded sensors, processors, connectivity ports and antennas. The software is based on an embedded operating system, where onboard software applications, user interfaces and product control components build upon.

Protocols at the second layer enable the communication between the physical product and the Cloud-based services over a network. The network connecting the first and third layer is in most cases the Internet, based on TCP/IP protocols.

At the third layer, the product cloud, data is processed for the actual purposes of IOT applications. First, the data, produced by the physical IOT product, is preprocessed (aggregated and normalised) and stored in a database. The application platform enables connected business applications by accessing data in the database, visualising it and providing run-time tools. The rules/analytics engine includes rules, business logic and analytical capabilities that reveal new product insights. On top, smart product applications manage monitoring, optimisation and autonomous operation of the functions of the product.

Over all three layers (product, connectivity and product cloud) user authentication and system access provide identity and security. External information sources (e.g. weather, traffic, geographical data, social media) are used at the product layer and the product cloud layer to enrich data. Enriched data increases the functionality and quality of the application. With different tools, data can be integrated into core business systems like CRM systems, ERP systems and PLM systems [PH14].

3.1.2 Operational and Strategical Shift for Companies in the Internet of Things Industry

To produce smart and connected products, companies have to revise their strategies, operations and organisational structures. New capabilities of products transform the value chain, mainly because *data* is the key source of competitive advantage. Nowadays, data is equally critical to success as other core assets like human resources, technology or capital. Compared to other core assets, the value of data increases exponentially when it is increasing or combined with other types of data (e.g. history, location) [BRB+13]. Therefore new business functions are evolving around management, governance, analysis and security of this core asset.

Data originating from smart connected products is often unstructured, e.g. an array of sensor measurements in different data formats. In the past, such data was often standardised and stored in spreadsheets or tables. Because of the high variety of data resulting from IOT devices, data streams are stored in their native formats, so-called "data lakes". Also, external data (e.g. prices, weather, inventory) and company data (e.g. service history, warranty status) are stored in the data lake in raw formats. With different tools, data can then be analysed to get descriptive insights (e.g. product conditions, environment), diagnostic insights (e.g. reasons for failure or decreased product performance), predictive insights (e.g. forecast impending events) and prescriptive insights (e.g. measures to improve outcome or correct appearing problems) [PH14].

Practices in *product development* are fundamentally changing in the IOT industry, because the product is not a closed piece of hardware anymore. It has evolved to become a complex system and it requires interdisciplinary systems engineering to be built. The major part of the software is running in the Cloud and the software on the device, as well as the device itself, sometimes play just a subsidiary role. Functionalities of the product, such as business logic or visualisation of data, are not physically built into the device but implemented as features in the software [VER+15]. The software features simplify localisation for different countries and languages and the product can be configured by a technician or even the customer after it left the factory. Additionally, the devices can be upgraded continually and often also remotely. This allows that new features can be released at an early stage and products can be enhanced over remote software updates. The remote control over the device often eliminates the need for a physical interface to control the device. Omnipresent devices (e.g. smartphones, tablets, computers) can be used to control the device over Bluetooth, RFID, Wireless LAN or similar technologies [PLJC14]. Eliminating physical interfaces lowers the cost and reduces complexity during production and for maintenance of the device. Nevertheless, the amount of built-in sensors and additional software increases complexity again. By monitoring the devices remotely and analysing resulting data, companies are able to identify and address design problems. As a result warranty claims are reduced. Concluding it can be stated that manufacturing for the IOT is an ongoing process and it does not end, once the product is shipped [PH14].

The new ways of product customisation, delivery of products and offering of related services affect the relationship with the customer. Companies have to shift the focus from time-discrete selling to maximising customers' value over time. By monitoring the usage of sold products, companies are able to discover usage patterns or preferred features. Marketers can segment the customers and provide tailored after-sales services with granular pricing strategies. Segmentation is not only applicable on a group level, but also on an individual customer level [BVL16]. After-sales represent high revenues in certain industries, e.g. industrial equipment. Remotely controllable devices shift reactive services, i.e. replacement only after failure of the product, to preventive, proactive and remote services. Technicians can diagnose problems from a remote location and only if local repair is necessary, they have to visit the customer. In many cases, remote repairs are possible by rebooting the device or by applying software updates. This results in decreased downtimes of the product and extended services, e.g. cheap warranties over a long period of time. The absence of local diagnosis of problems at the customers' place reduces the repair service by at least one visit. The decreased effort for customer service does not only save cost and time to companies but it also increases customer satisfaction [WF15].

Security is an important but also a difficult topic in IOT applications. In the past, IT-departments were solely responsible for the security in traditional manufacturing companies. For IOT applications, IT-security becomes part of all functions of a company. Because the applications are distributed, attacks are possible at product level, connectivity

level or product cloud level [Web10]. The products are difficult to protect physically and due to their limited processing power, modern security hardware and software is often not supported [WAD14]. If hackers are taking control of a product, impacts can be fatal (e.g. in case of medical equipment, generators, aircrafts). As a group of unknown hackers showed, IOT devices can be misused to generate DDoS attacks [Inc16b]. The high amount of devices produced very high traffic that caused the biggest DDoS attacks ever seen. This security issue will become even more prevailing when the amount of IOT devices increases. Hence, product makers and manufacturers have to take security risks into account already in the design phase and also the software running on it has to be secured respectively [Inc16a].

Besides security, privacy is also an issue. Customers need to have the control over their data when it is transmitted to the Cloud and when manufacturers can access it. Data policies and regulations require also a high granularity for settings and rules. Best practices for data and network security are evolving (e.g. encrypted storage, privacy by design), but no overall solution exists yet [PLJC14].

The new circumstances mentioned above sometimes force companies to change and innovate rigorously. Additional expertise in software development and other skills along the value chain have to be acquired by companies in the IOT industry. Furthermore the culture of companies is affected, because of faster development cycles and new compensation models, e.g. job flexibility for employees. New functions and roles in companies like chief data officer, development operations groups or customer success management are introduced. The boundaries between existing functions dissolve and collaboration between some functions like R&D and IT increases. Also management structures change, e.g. from the traditional centralised command-and-control model to the distributed model that focuses on continuous improvement [PH14]. A company can offer their products as services, what in turn also affects sales and marketing. Finally, new business models for manufacturers and other actors in this industries will evolve [WLR14]. Almost all building blocks of the current business model are affected. In the following Section 3.2 describes current actors in the IOT industry and their traditional business models.

3.2 Stakeholders and their Business Models

This section describes common BMs in the IOT to answer RQ1 described in Section 1.3. The IOT industry lacks clear structures, stakeholder roles and value creating logics that describe how value for customers is generated [LWRS12]. Due to the high variety of products and services in the IOT, it is not possible to fully generalise the industry for all areas. The stakeholders that form the network of companies in this section are selected to realise an IOT product based on the technology stack in Figure 3.1. In some cases, a concrete example was used to construct and explain the BM of a company. A concrete example was required to demonstrate essential aspects of a BM. As a consequence of using an example, the BM may not be applicable for all possible IOT use cases.

The final outcome of this network of companies is a B2C product, i.e. a product for a private consumer. For a B2B product most probably other stakeholders are of greater interest and business models look differently. In particular Customer Relationships and Channels differ in B2C and B2B use cases [OP10]. In the following, the actors are described in prose and their characteristics are elaborated. The BM of every single actor is drafted in the BMC. Limited general validity is indicated in prose and also denoted in the BMC by using different colours.

3.2.1 Component Manufacturer

Component manufacturers are at the beginning of the supply chain of an electronic B2C product. They design and often also produce components such as sensors, chips or chipsets that are needed by product manufacturers. The business models of this stakeholder vary. Some companies design, produce, sell chips and sensors, e.g. Intel [Inc16c]. Other companies only design chips and license them to third parties, e.g. ARM [LM13].

Component manufacturers that developed integrated circuit devices before the 1980s were called *integrated device manufacturers*. These companies did R&D, product design, manufacturing, sales and support. The high fixed costs of product facilities and increasing specialisation forced this business model in the late 1980s to change.

In 1987 Taiwan Semiconductor Manufacturing Company (TSMC) offered for the first time the possibility to produce, already pre-designed integrated circuits, in dedicated *fabrication facilities*. When the fabrication of chips is outsourced, the chips can be designed independently with electronic design automation software. Sales volumes are in the tens or hundreds of thousands of units and this BM is known as the *fabless semiconductor* BM. Some companies even go a step further. So-called *IP-licensees* outsource the development of the single parts of an integrated design unit. ARM Holdings was the first company designing modular units and licensing them alongside with a software suite to other companies building integrated circuits. Companies create integrated circuits using the licenses in exchange for a fixed initial fee and royalties for each device produced [LM13].

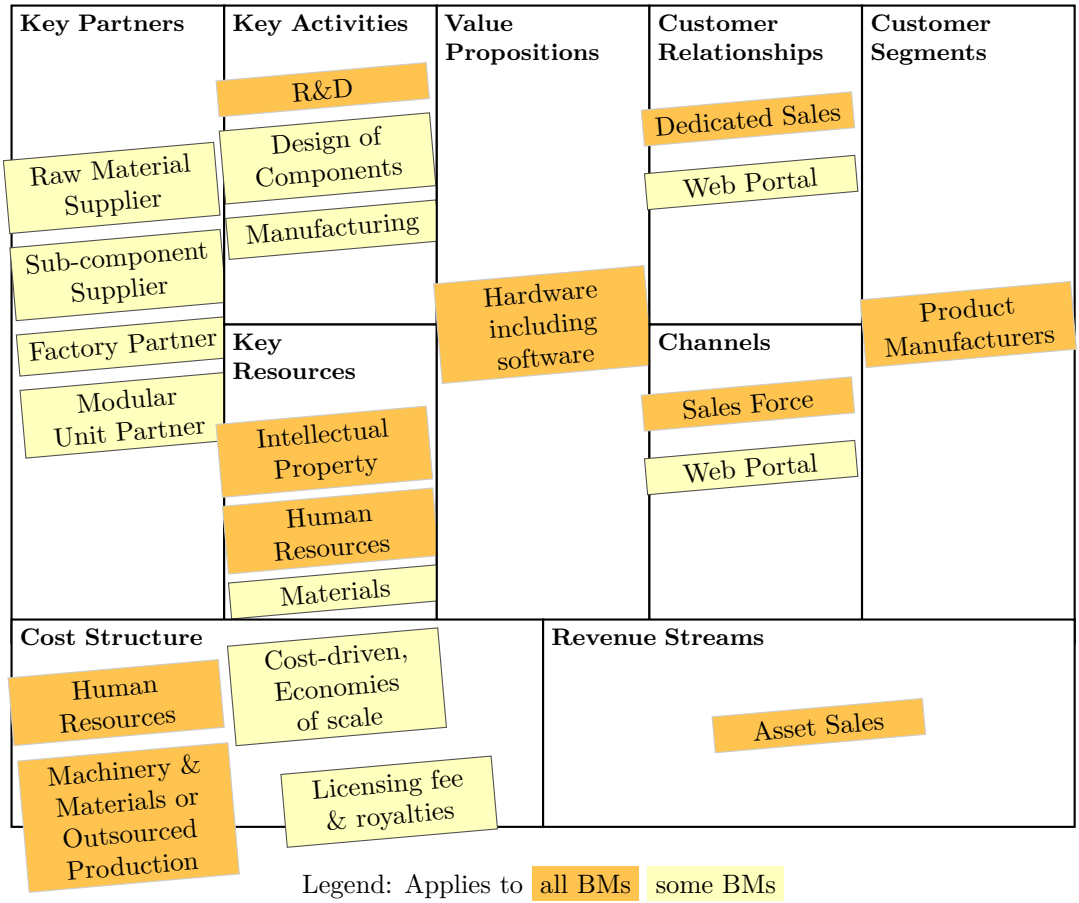


Figure 3.2: BMC of a Component Manufacturer

Figure 3.2 shows the BMC of a component manufacturer. The light colour indicates that it just applies for some cases of the BMs of component manufacturers. The orange colour signals, that the statement is valid for all possible BMs. The value proposition of a component manufacturer is the component that it is offering. A component can be a sensor, a chip or a chipset that product manufacturers use to build a product. Components often include some kind of software that enables the customers to integrate it with other components and integrate it into systems.

Salesforce teams reach the customers in a personalised way and maintain the relationship after the sale. Components are usually sold in huge amounts on a price per unit basis where prices decrease with increasing volumes. In other words, the cost structure is determined by economies of scale. Some manufacturers also sell and maintain relationships over web portals. Important high volume and non-standardised product orders are handled by specialised sales teams. To build the component, a lot of R&D and intellectual property is necessary. Human resources are therefore a major part of the manufacturers cost structure building block [GLF08]. Some component manufacturers still produce components in

their own facilities. In-house production of the components requires high investments in machinery. In that case, suppliers provide raw materials and eventually also sub-components. For fabless productions no investments in production facilities are required but the cost for outsourced production apply. In the case of IP-licensees, the modular unit partner provides software for the design of the components and its intellectual property. In return, the licensee pays licence fees and royalties to the licensor [LM13].

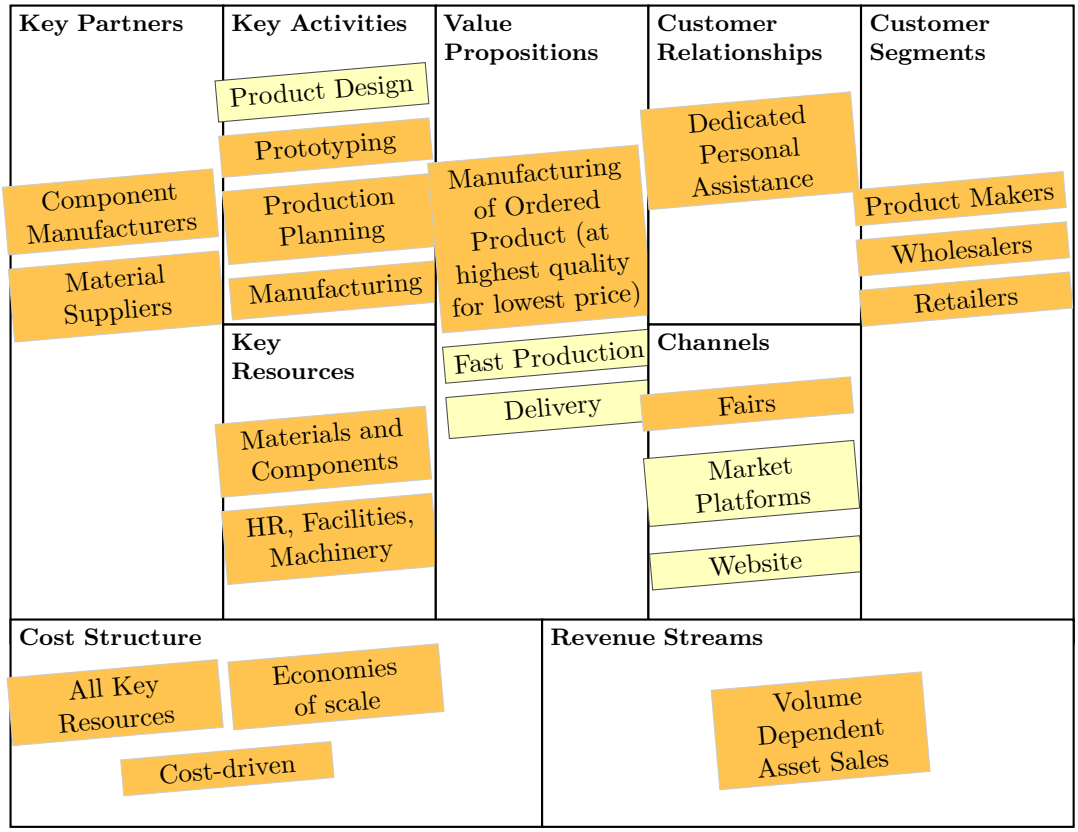
3.2.2 Product Manufacturer

Product manufacturers fabricate the commodities designed by product makers. Figure 3.3 shows the BMC of a product manufacturer. In some cases, wholesalers or retailers may also delegate the product design to the product manufacturer.

Customers expect the product to be manufactured at high quality. The product manufacturer and the customer agree on quality measures contractually before the production starts. Time frames for manufacturing are often very short and the product manufacturer may take care of the delivery to the customer. In the case of the manufacturer-direct model, the product manufacturer sells the product directly to the customer. Selling directly to customers requires a dedicated set of competences which differs from the core competences of a manufacturer, e.g. marketing or end customer service support [Rap04]. The manufacturer-direct business model is not addressed in this section because it is not representative for a product manufacturer and is not relevant in the form of this work. Customers typically get first contact and impressions from the product manufacturers website. A common and very important channel for product manufacturers are also fairs that are specific to a product, topic or industry. In recent years, market platforms like Alibaba[1] also gained interest and popularity. Market platforms are either open, i.e. without registration, or closed, i.e. including registration and identity checks. Relationships with customers are usually one-on-one and characterised by dedicated assistance.

As mentioned above, the product manufacturer may be commissioned to design the product for the customer. Before mass production starts, prototypes are crafted until the customer and the product manufacturer agree on the product characteristics and quality specifications. Production planning is required to ensure quality and resource efficiency of the manufacturing process. The manufacturing process requires big facilities and machinery which is increasingly automated. Human resources are playing a decreasing role in the manufacturing process as robotics and other production technologies take over. Partnerships with component manufacturers and material suppliers are usually long-term and the high volume orders drive down cost. Materials and components, as well as human resources, facilities and machinery are the major cost for manufacturing. The manufacturing business is generally cost-driven due to of global competition and high sales volumes. Revenues are mostly just generated over asset sales. The retail price per unit is decreasing with an increasing volume because the production costs per unit are determined by economies of scale [TZXZ14].

[1] https://www.alibaba.com/



Legend: Applies to all BMs some BMs

Figure 3.3: BMC of a Product Manufacturer

3.2.3 Product Maker

The role of a product manufacturer and a product maker often overlap as already mentioned in the previous Section 3.2.2. However, the design is usually done by a product maker and the production of the product is outsourced to a product manufacturer. A major task of a product maker is to understand and learn about the needs and problems of the customers. The product maker addresses the needs and problems by developing a product that helps the customer to fulfil certain tasks. The BM of this stakeholder depends on many factors, e.g. product category, industry or customers. In this Section, a smart connected B2C product in the area of home automation is assumed, e.g. a smart alarming system. Figure 3.4 shows the BMC of the product maker of such a product.

A product maker is typically confronted with different types of customers. The first customers are often tech-savvy users. These innovators and early adopters like to try out new products and accept problems with immature technologies. Even if the first customers are tech-savvy, the product maker has to make its products very user-friendly.

The big success for companies in the B2C sector usually comes when its products are adopted by the mass market. Therefore, the product maker has to design a simple User Interface (UI) to make the setup, the use and the error handling as intuitive as possible. Methods like the lean product lifecycle [HFF06] focus on understanding the customer. Feedback loops and iterating improvement cycles are common for management practices of the product maker.

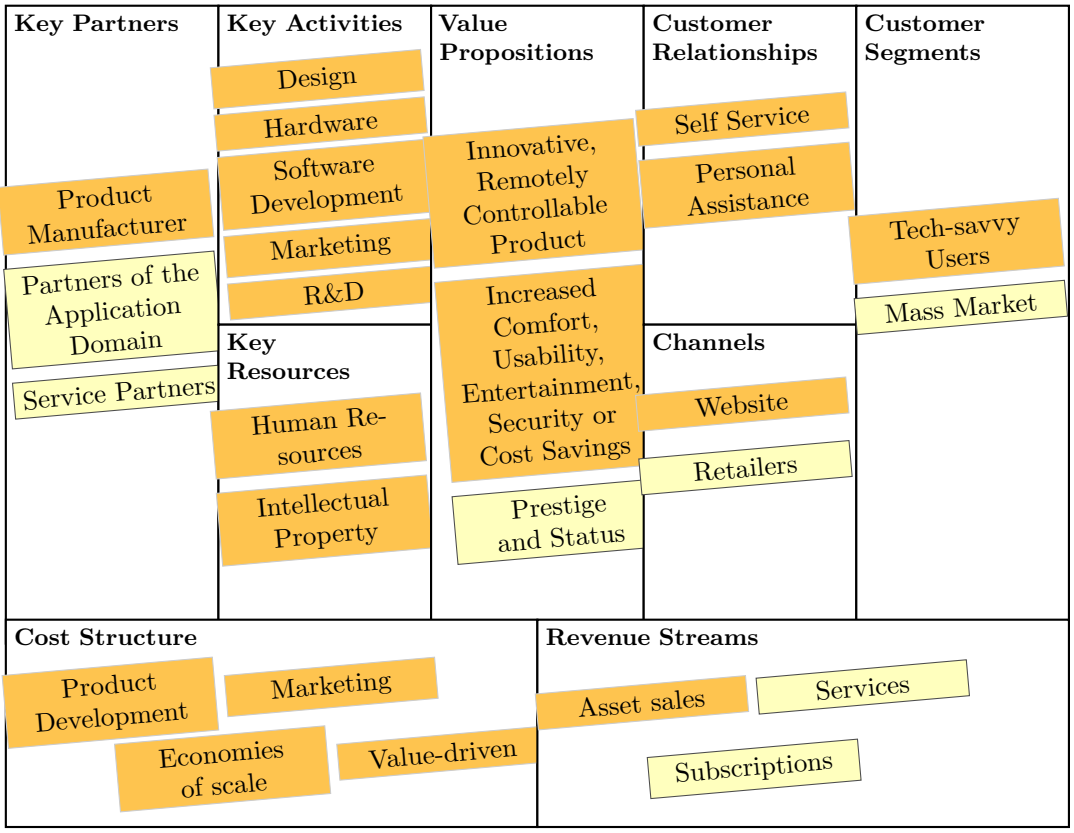


Figure 3.4: BMC of a Product Maker

Not only engaging with but also including the customers in the development process is very promising. The product maker has to listen carefully to ideas for improvement and for new features for different reasons. The suggestions hold a lot of promise because they come from the people who are actually using the product. So the product is improved and provides more value to future customers. When engaged customers, often called power-users, see that their suggestions were heard and implemented, they often become very loyal. Customer loyalty results not only in higher revenues, but customers also speak well about the company and its products in the public. This form of advertising is called word-of-mouth marketing and is known to be really effective.

A product maker sells its products usually over its own website or partners with retailers. To reduce costs for customer relationships, manuals are provided so that customers can help themselves in the case of problems. Anyway, support via call centres, chat or similar channels has to be provided in case the customer runs into problems that can not be solved without third party assistance. Customers often have to go to the company's website to get support. By engaging the customer to come to the website also sales can be increased via cross-selling and up-selling. It is very important, as asset sales are the major part of a product makers' revenue. Also services like installation of the product at the customers' house, or subscriptions for premium features such as monthly payments for burglary or fire alarm notifications, generate additional revenue.

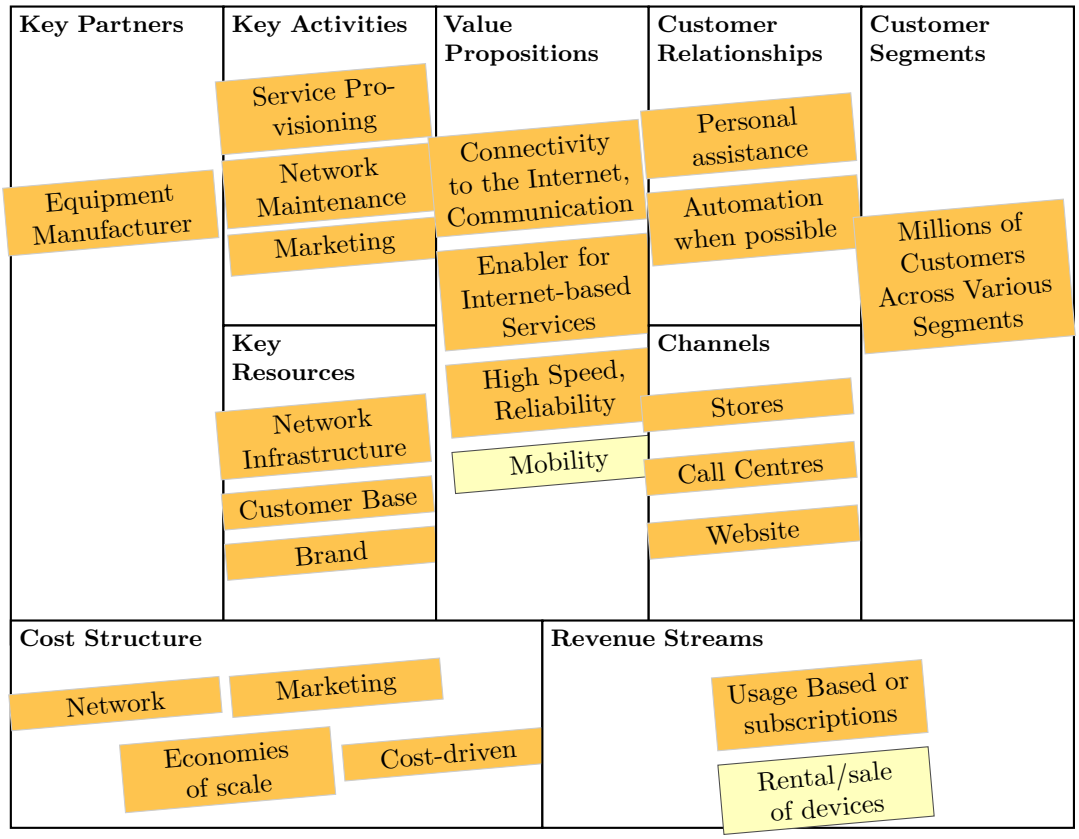
It is essential that the product maker understands the value proposition of the customer, including all problems and needs. Based on these understandings, the company conducts R&D, designs hardware and develops software. Direct marketing is one of the key activities because the company is in direct contact with the customer. Skilled employees and intellectual property are required to accomplish development and marketing tasks. Sometimes external partners, e.g. companies of the same industry, and service partners collaborate with the product makers. Product makers usually do not manufacture the products by themselves. Therefore they also partner with product manufacturers. Manufacturing of the products causes a major part of the costs and is characterised by economies of scale. The BM is, in contrast to cost-driven BMs of component- and product manufacturers, value-driven. Hence, high costs apply for marketing activities to communicate value propositions to customers [OP10].

3.2.4 Network Operator

The term network operator describes stakeholders that supply the infrastructure to connect smart connected products to the Internet. The most common types of network operator are telecommunication providers and internet service providers. Figure 3.5 shows the BMC of a network operator. In recent years, many network operators outsource the expensive network maintenance to equipment manufacturers. This way equipment manufacturers take advantage of economies of scale and network operators can focus on their brand and customer relations. In the BMC in Figure 3.5 and in the following Section, only the current traditional BM including network maintenance is considered.

Generally, everyone consuming Internet-based services is a potential customer of a network operator. The customers of the network operator are very diverse and they are segmented according to their usage behaviour. Network operators offer communication services to their customers. In the past, short messaging services and voice calls were the most important services. Nowadays customers increasingly request connectivity to the Internet at high speed and high reliability. Internet connection is necessary for IOT applications. Mobile internet according to cellular network standards, e.g. LTE, as well as stationary high capacity networks, i.e. tethered internet, are required. The Internet serves as the basic foundation also for many other services. It enables communication in various ways, e.g. call, video, emails, and the exchange of information and knowledge.

Service contracts are offered online on the company's website, in offline stores or over the phone by dedicated call centres. In many cases, e.g. troubleshooting, personal assistance is necessary but network operators try to automate processes wherever possible to minimise costs. Customers are charged for the service either on a monthly basis, i.e. subscriptions, or according to their usage on a unit basis, e.g. megabytes, minutes [GK01].



Legend: Applies to all BMs some BMs

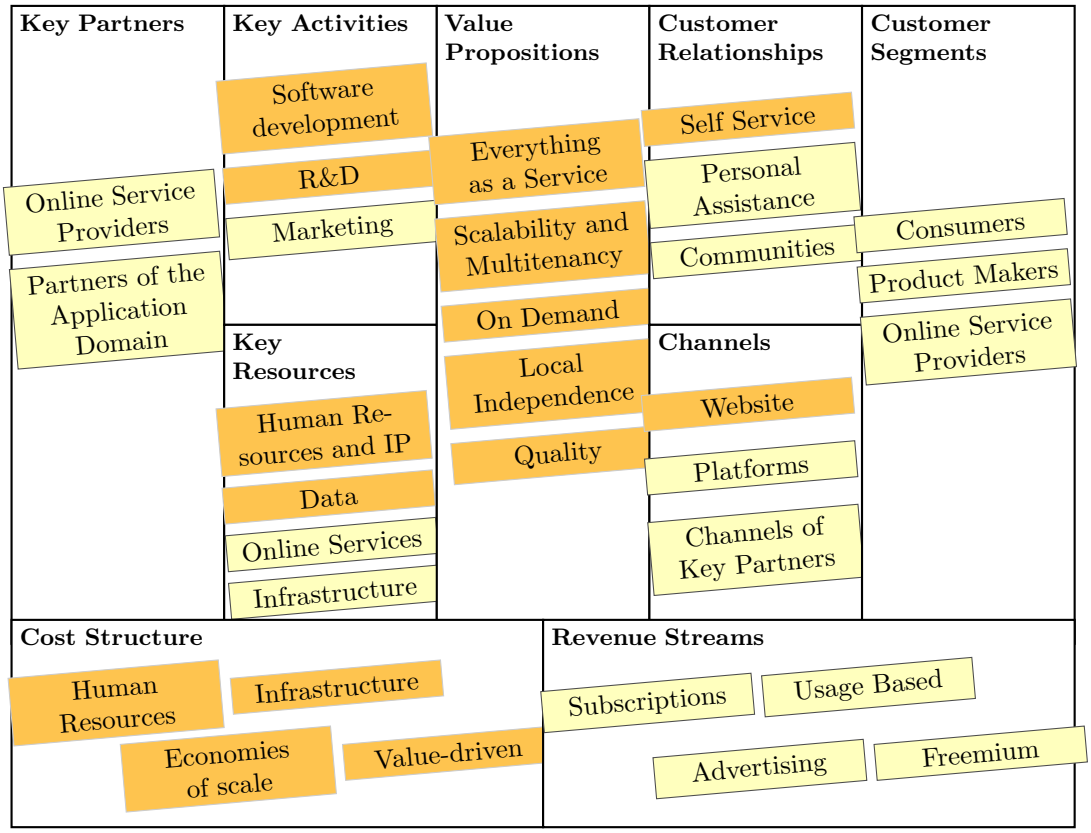
Figure 3.5: BMC of a Network Operator

Service provisioning, i.e. construction of network infrastructure, and maintenance is the main task of the network operator. Building the infrastructure requires a high amount of capital. The business model is cost-driven and denoted by economies of scale. Therefore, marketing is a major activity of network operators to increase the customer base. The fixed costs are very high and marginal costs low. When the break-even point is reached and hence all fixed costs are covered, generated revenues by additional customers imply high-profit margins. Equipment manufacturers such as Nokia Networks[2] or Ericsson[3] are the main partners that supply networking hardware [OP10].

[2] https://networks.nokia.com
[3] https://www.ericsson.com/ourportfolio/products/ip-network-and-transport

3.2.5 Online Service Provider

Online service providers are companies which offer their services over the Internet. The goods or services are generally intangible and the marginal costs are close to zero. With the rise of the Internet, software companies shifted towards the SAAS BM. Previously, software was delivered on a physical storage medium. One-time purchases and license fees were the main revenue streams. The application architecture with the SAAS BM of online service providers is multitenant and scalable to serve multiple users at the same time and provide reliable services while serving an increasing demand. Consequently, customers do not need to buy and maintain special hardware to run the software, e.g. database servers. The software is available from everywhere and often independent of the operating system because it is accessible from any device with an installed web browser. The access and use of the software are therefore flexible and on demand. Customers do not take the high risk of buying expensive software but can pay for it as long as they need it. This again forces software developers to focus on the quality not only to acquire new customers but especially to keep existing ones.



Legend: Applies to all BMs some BMs

Figure 3.6: BMC of an Online Service Provider

The SAAS BM became popular in the B2C sector, e.g. Dropbox[4], Office365[5], Spotify[6], but also in the B2B sector, e.g. Amazon Web Services[7], Salesforce[8]. The customers of an online service provider in the B2C sector are the consumers. In the B2B sector, the customers can be product makers or business consumers. But online services can be dependent on other, third-party services. Therefore also other online services can be customers of the online service provider. The main channels to reach customers are their own website and platforms like Salesforce or channels of key partners. In most cases, especially in the B2C sector, communication to customers is impersonal. In the B2B sector, personal assistance for important customers is also common. Many companies also build online communities around their services to communicate with their customers and enable value creation by the customers themselves. Dependent, e.g. on the kind of service and on the sector, revenue streams are diverse. Subscription models are the most common revenue streams for online service providers because they imply low risks for customers and reoccurring revenue for providers. Also, usage-based pay-as-you-go models, advertising and freemium models often applied.

The main activity of online service providers is software development. R&D is necessary to develop high-quality services. Companies also have to put efforts in marketing to promote their services and acquire new customers. To accomplish these activities, employees and intellectual property (IP) are the key resources. As described in Section 3.1, data is often a key resource today and will become more important in the future. Many services are data-driven and software is often just an instrument to provide data. Servers and other IT infrastructure is increasingly outsourced to big providers like Amazon or Microsoft who profit from economies of scale. By outsourcing, online service providers do not have to build up their own infrastructure at initial high fixed costs and can scale more easily whenever they are required to do so. Most expensive resources for online service providers are hence employees and the IT infrastructure. The cost, as well as revenue, is characterised by economies of scale and the BM is value-driven. Online services are often composed of different third-party online services and therefore main partners are often other online service providers. Online service providers sometimes require partners of the application domain to develop and provide the service, e.g. Spotify partnering with Sony Music [Tec15].

[4] https://www.dropbox.com
[5] https://www.office.com
[6] https://www.spotify.com
[7] https://aws.amazon.com
[8] https://www.salesforce.com

3.3 Challenges and Opportunities for Network-based Business Models

The vision of a world, where smart connected objects exchange information seamlessly and unnoticeably integrate in the environment is promising for businesses as well as for society. To realise these products and services, different shortcomings have to be resolved and challenges have to be addressed.

Whitmore et al. [WAD14] classified literature related to IOT into seven major categories: technology, applications, challenges, business models, future directions and overview/survey. Figure 3.7 presents the distribution of these categories. Technology is the most common category in IOT research, where topics about hardware, software and IT-architectures are addressed. Applications in the IOT are the second most common topic in this field of research. It is dealing with smart infrastructure, healthcare, supply chains/logistics and social applications. Problems in the challenge category are numerous. They are both technical and social, concerning security, privacy and legal/accountability. The challenges have to be addressed so that IOT is adopted and diffused. Some papers point out future directions of IOT or provide an overview of the topic, sometimes including surveys. Only about 3% of the 127 analysed papers in the conducted research of Whitmore et al. [WAD14] were classified into the BM category. The authors conclude that "The IOT is not well represented in the management literature" and that "The coverage of IOT driven business models is scant". After the study was published in march 2014, research on IOT-BMs became more common and it is now perceived as a major issue of the topic [GSV14, PH14, TBGF14, WLR14, FWW15, GS15, SS15, WF15, PDG+16, ZW16].

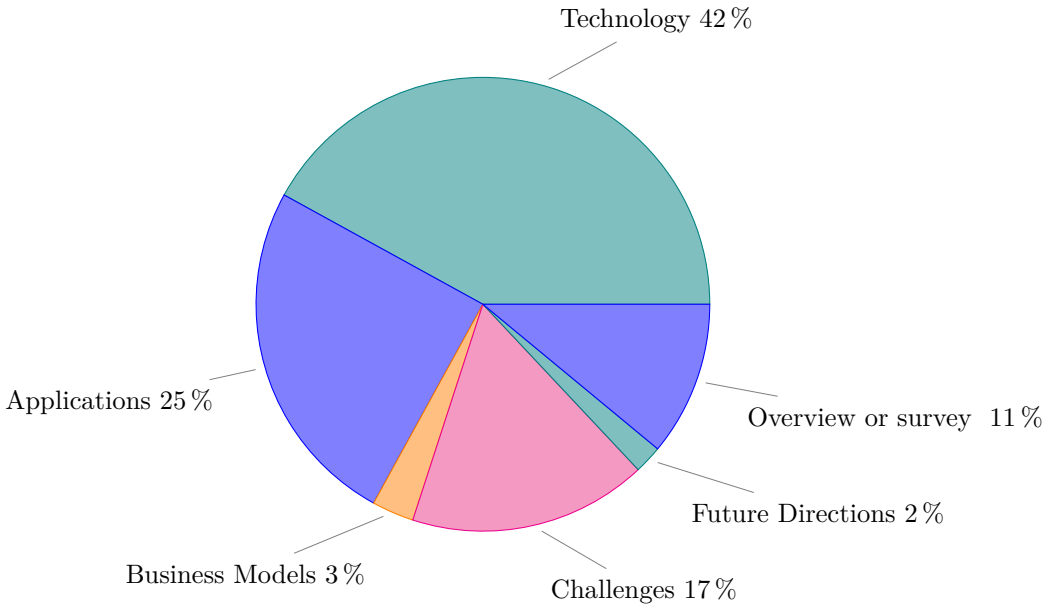


Figure 3.7: Research Topics and Trends in IOT (from [WAD14])

One challenge for the IOT industry, emphasised by Porter and Heppelmann [PH14], is that companies have to focus on *system design instead of production of discrete products*. On the one hand, products become part of the companies' product family. On the other hand, products of a company have to integrate into larger systems that are not controlled by the company itself. E.g. Nest Labs[9] introduced a programming interface that allows interaction with products of other manufacturers. Nest's thermostat also interacts with Kevo's smart lock[10]. So when a person enters the house, the temperature is adjusted automatically.

The value of IOT-systems increases exponentially with an increasing amount of products and hence the ecosystem grows faster. Companies now have to decide what role they want to play in the ecosystem. A company can offer an own system, just single products or both. To offer an own system, a company needs different core competences. It has to implement a platform including interfaces that partners can use to integrate their products. Forming a business network around the own system requires an open company structure. Such a company focuses on gathering intangible assets (e.g. relationships, insights) instead of increasing physical assets. Building up a system is more difficult than just building products but it can lead to much bigger financial rewards [LBW16]. Probably open systems will win in the long run because of the great variety of third party products. Traditionally closed companies have to adapt to the competition of open systems and follow the trend. Not only marketing and sales departments will be affected, but also partnerships including more complex revenue-sharing models will be necessary to successfully place the products on the market [LWRS12].

Smart connected products allow companies to earn revenues according to the *product-as-a-service model*. The model is already tested in different industries, e.g. Xerox'[11] pay-per-copy for copiers, Zipcar's[12] car sharing, Rolls-Royce's[13] Power-by-the-Hour service package for aircraft engines, Philips'[14] pay-per-lux model for selling lighting equipment. Basically, the model can be applied to many IOT products. In some cases, extra sensors may be required to realise the product-as-a-service model which will cause higher product costs. Nevertheless, reoccurring revenues will compensate the initial costs. With a product-as-a-service model, maintenance tasks will move from the consumer to the manufacturer or seller. As a consequence quality and durability of products may increase.

[9] https://nest.com
[10] http://www.kwikset.com/kevo
[11] https://www.xerox.com/printer-supplies/metered-supplies-replenishment
[12] https://www.zipcar.com
[13] http://www.rolls-royce.com/products-and-services/civil-aerospace/services/corporatecare
[14] www.philips.com/a-w/about/sustainability/sustainable-planet/circular-economy/light-as-a-service

Customer value is not necessarily bound to physical goods anymore. Sensors deliver the necessary data but the majority of the value is provided by services. Services use the data, process it and present it to the end user. Physical products may thus only be conceived as the medium to provide a service. So the traditional distinction between goods and services will progressively blur. Services are also composable. By reusing services in different solutions, more advanced and feature rich services can be composed at lower costs. Accordingly a service can also be replaced with a competitive offer if the competitor provides a better or cheaper service. The view of this service dominant logic is network-centric and has the ultimate goal to provide a specific customer service. As a consequence new market dynamics, complex relationships and activities between market partners evolve. Relationships between market partners and customers build a so-called *value creation network*.

A single company is often only able to deliver a part of the value. The value of a service is mostly not self-contained for the end user. Therefore partners are needed to compose the complete service for end customers and to reveal the full value. Resources, such as knowledge, skills and technologies, are not only shared within a company but also between network partners. Therefore, competitive advantage will be to a high extent determined by the collaborative competence of a company and driven by NBBMs. Not only the business partners are part of such value creation networks. Also, the customer is now part of the value creation process, which is also called co-creator and co-producer [TBGF14].

The IOT industry is still at an early stage and its technologies are evolving very slowly. Westerlund et al. [WLR14] point out three major challenges to overcome: the diversity of objects, the immaturity of innovation and the unstructured ecosystems. Because of the high *diversity of objects*, it will be very difficult to standardise the interfaces with which they connect to the Internet. There are different ways to connect things, companies, and consumers and therefore various BMs are possible. The process of connecting things can be complex from a technical perspective. But the complexity has to be hidden from the consumer and the setup has to work as simple as a plug-and-play mechanism. As argued by Turber et al. [TBGF14] company networks have to focus on the system design that includes modular objects of different manufacturers. So far *innovation is immature* and companies do not manage to scale up. They fail to make the important transition from the so called early-adopters customer group to the early-majority customer group. This results from the circumstance, that the early-majority customer group does not tolerate immature technologies anymore and that they already evaluate the product. In order to provide better solutions, companies have to specialise and organise in networks to improve technologies. Nowadays the required networks and *ecosystems are unstructured*. New roles still have to evolve and to be defined. Managers need to establish relationships in new industries and extend existing relationships. In may cases markets do not exist yet and customers are missing, what makes it difficult to convince partners to invest. The primary focus of companies should not be to build networks and follow interests of the stakeholders. Companies should rather focus on generation and capture of value [WLR14] with the ultimate goal to provide solutions for an end-customer.

To conclude, the IOT industry evolves very slowly. It faces technical shortcomings that have to be solved. Products have to be designed to work within broad systems where many partnering companies are involved. Currently, innovation in this area is mostly actor- and industry-specific and innovators lack to work together [SS15]. Connected solutions demand new NBBMs. The importance of NBBM was underestimated for a long time in literature but is now seen as a key factor of success for IOT solutions [WAD14]. A major part of scientific literature nowadays is just describing the problems of BMs in IOT. Just very few approaches for practical solutions are found [LWRS12, Rev14, TBGF14, WLR14]. It is not possible to find one NBBM that fits all company networks because the situations are very diverse and problems are complex. Researchers in the IOT field need to develop a common understanding of the main problems and jointly work on solutions. In the case of NBBMs this is difficult. Frameworks and design tools to model NBBMs do not exist or are to limited. Some frameworks also may have a special purpose [SKP+11] or are abstract [HH13, SS15]. Authors point out that traditional frameworks are mostly not suited to model complex NBBMs. Leminen et al. [LWRS12] present a basic framework which helps to analyse NBBM based on the two design factors: infrastructure and customers. They conclude that the framework is to limited and needs future research to describe the dynamics and structures of the IOT ecosystem. Wortmann and Flüchter [WF15] point out the importance of alignment of the IT and the business strategy. They argue for new models and frameworks to support this alignment in an IOT network. Westerlund et al. [WLR14] elaborate the key pillars of a BM design tool, namely value drivers, value nodes, value exchanges and value extracts. They suggest a shift in BM research from individual company's self-centred objectives to a network approach. The focus has to be on value design within a network of companies, which is closely related to the definition of an NBBM given in Section 2.4.3. The authors demand new NBBM frameworks for the IOT ecosystem that help network partners to choose the best-suited NBBMs.

The following Chapter 4 introduces a framework that helps to address the challenges with the design of NBBMs presented here. The framework will endorse scientists as well as practitioners to discover and evaluate NBBMs in the IOT industry.

CHAPTER 4

NBMF - A Framework for Network-based Business Models

4.1 Introducing the Framework

In this chapter the framework for NBBMs, called NBMF, is elaborated and presented. Finding a methodology for the design of a BM framework is challenging. Research often focuses on building theories and testing theories. The aim of this work is to develop a practical framework including a graphical design tool. The framework is based on solid theories such as the e3-value [Gor02] and the BMC [Ost04] which are combined and extended (see Section 6.1.2). The literature review in Chapter 2 and the draft of the BMs of the stakeholders in the IOT industry in Chapter 3 serve as a basis and motivate the development of the NBMF.

The IOT industry is a paramount example of a network-based industry. Companies in the IOT-industry need to develop a common understanding of the main problems and jointly work on solutions. Frameworks and design tools like the NBMF will support business modelling and promote collaboration. Existing BM tools and frameworks are not suited to model connected network-based business models or their field of application is limited. As discussed in Section 2.4, some frameworks have been proposed in relation to IOT. But they either have a special purpose [SKP+11] or are not practically applicable [HH13, SS15].

In a cooperation by the University of St.Gallen and Bosch, the Bosch IoT Lab, BM experts are working on a modelling approach for the IOT. In a report [Bos15] they present the IOT business model builder. It is a management tool that can be used in workshops to support the complete lifecycle for developing business ideas until the evaluation of the BM. The IOT business model builder considers 10 phases with clearly defined goals and tool recommendations. Some of the tools presented in the IOT business model builder follow similar principles as the NBMF Framework as explained in Section 6.1.3.

Libert et al. [LBW16] propose a management guideline, called PIVOT process, to move from physical assets driven BMs to NBBMs. This management guideline discusses many problems inside a company when changing and innovating business models. Its focus is on a single company and its internal processes, not to form a business network of companies.

The NBMF framework introduced in this work focuses on the network aspects. It is designed to fill the gap in IOT research and diffusion of IOT products in practice. The integration of established concepts allows domain experts to use the framework intuitively in practically oriented scenarios. With the framework, scientists and practitioners can share their thoughts about BM constellations in the IOT as well as for other industries that require extensive collaboration between the different stakeholders.

4.2 Goals and Characteristics of the Framework

The primary goal of the NBMF framework is to find innovative NBBMs that foster the propagation of new products and services that would not be possible with traditional BMs. The resulting products and services provide value for at least one stakeholder, that could be a consumer in a B2C scenario or a business customer in a B2B scenario. Value is often generated along a value chain and a network can be seen as a derivative of a value chain. Therefore, every stakeholder in the network potentially adds value to the final product.

Quantification of value is difficult because value is perceived subjectively [TAP+11]. However, perception of value [AN98] and value based-pricing [Hin04] are essential mechanisms that companies need to understand to drive a successful business. The following scenario shows how the quantification of value may affect a value transaction (see Section 2.2.2): A man purchases a flight ticket for 300 Euro from Airline A to visit his relatives. The flight ticket has immanent value for the man, who really wants to see his relatives. The immanent value of the flight ticket for the man corresponds to at least 300 Euro, otherwise he would not buy it. The real value perceived by the man, can only be estimated by Airline A. For another person, who wants to make holidays but has no preference for a specific destination, the value of the flight ticket would be below 300 Euro and Airline A could not sell it to that person.

As shown in the scenario, the real value can often not be measured objectively with quantitative units. A financial transaction, which is a type of value transaction, is determined by a quantitative unit - the price. In the NBMF framework, we consider a value transaction either as a value proposition (a product, a service or a feeling) or a financial transaction (money). Value transactions represent relationships in the NBMF framework that connect different stakeholders. They form the foundation for BMs and consequently also for NBBMs. To find and maximise the value transactions of a NBBM, it is important to gather as much information as possible about the customer.

When companies design BMs they often start with the goal to increase revenue, decrease cost or risk for the company. This can lead to new BMs or to improving an existing BM, but it generally does not improve value propositions. Hence, it does not provide additional value for customers. A price reduction, e.g. as a consequence of a cost reduction in a company, does not provide added value in the long term. With the NBMF framework, BM-Designers are forced to change their viewpoint to invent new or to innovate already existing value propositions. First, the framework focuses on the design of value propositions for customers. Later, solutions to implement and provide the value propositions are discussed and evaluated.

The design process of a NBBM with the NBMF framework is depicted in Figure 4.1 and described in detail in Section 4.4. The viewpoint changes on a problem and potential solution as well as the network character distinguishes the NBMF framework from other BM tools and frameworks.

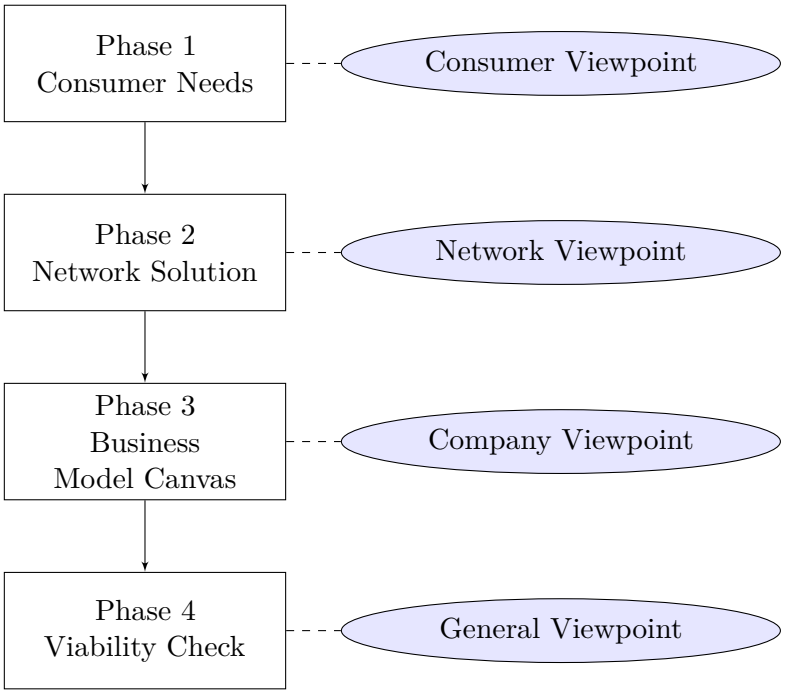


Figure 4.1: Phases and Viewpoints of the NBMF Framework

The design process of the NBMF starts with Phase 1: the determination of the consumer needs. The designer of the NBBM has to take the viewpoint of a customer to truly understand the problems and needs. Once the need of the customer is understood, the designer switches its viewpoint in Phase 2 from a customer to a network perspective. The designer then works on the solution that typically includes different actors. Especially in service-oriented industries, companies often partner up with other companies in the same domain to provide a solution. The solution in the NBMF framework is modelled as a composition of value propositions that are provided by the different stakeholders,

i.e. companies, of the network. In Phase 3, the designer changes its perspective to a company viewpoint. Activities, resources, channels and relations of different companies that are needed to produce and provide the solution are defined in detail. In Phase 4, the cost and revenues to realise the solution are evaluated for every single stakeholder to check for the viability of the solution.

By switching the viewpoint several times, the designer increases the quality and probability of success for the NBBM. In the NBBM is not feasible from only one of the viewpoints, the whole NBBM is doomed to failure. All involved stakeholders are in this way able to design a joint NBBM, what in turn encourages reaching a consensus for the implementation. All stakeholders participating in a network need to speak openly about expectations and assumptions to avoid any misunderstandings at a later stage. Showing and discussing parts of the BM, that are otherwise concealed within companies, promotes open collaboration between the stakeholders [LBW16]. The income statement of a stakeholder gives an estimation of the outcome and can also be compared to other stakeholders of the network. A fair outcome for all stakeholders, i.e. opportunity to make a profit, is necessary to realise a sustainable NBBM [DVH+15].

Digital technologies (e.g. email, video calls, web services) are used to promote collaboration in companies, as well as between companies. They facilitate the exchange of information between stakeholders and reduce cost [SHF08]. Most software tools (e.g. CRM systems, ERP systems, PLM systems) help to overcome operational challenge. Software tools may also support decision makers in strategical questions. E.g. the US-Army used software for the reporting of the Balanced Scorecard [Rev05]. Although, the NBMF framework can be used as a design tool for BMs with pen and paper, the real potential is only revealed with an implementation in form of a software system. Therefore, the framework was implemented as a web application with a Graphical User Interface (GUI). This way the software is user-friendly and can be used by different stakeholders together without previous installation or setup. For details on the software based implementation of NBMF framework see Section 4.5.

4.3 Elements of the Framework

The NBMF framework consists of different elements. Figure 4.2 shows these elements in a UML 2.0 diagram. Only the core associations between the elements are shown to illustrate the power of the framework while keeping it simple and clear. Elements, i.e. classes in the UML diagram, are objects that appear in most of all four phases of the NBMF framework. So to say, they create a transition over the four phases. E.g. a Financial Transaction is added in Phase 2 and is used in Phase 4 to calculate the Income Statement.

In the following Subsections, the characteristics of the elements and their relationships to other elements are explained.

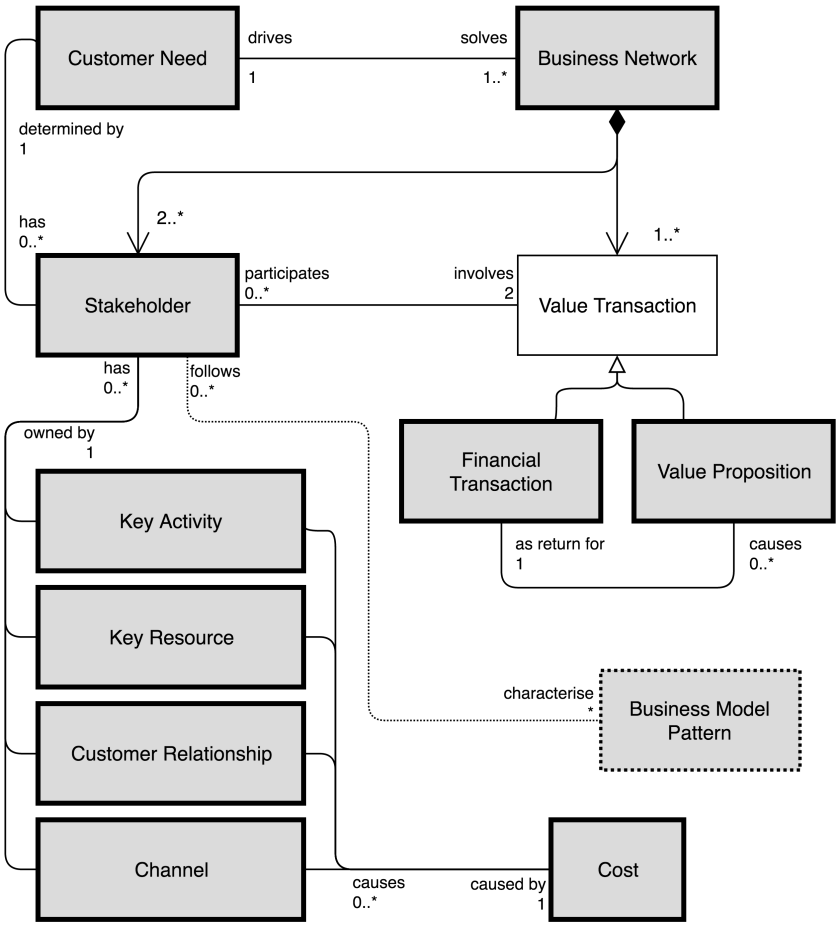


Figure 4.2: UML 2.0 Class Diagram of the NBMF Framework

4.3.1 Business Network

A Business Network is created at the beginning of the modelling process. When starting the modelling process, the designer of the NBBM already has some ideas about the problem-solution scenario one wants to model. The Business Network represents the container that comprises all other elements. It contains different kinds of information, whereas some can be considered as a global configuration of a NBBM. Table 4.1 shows all attributes for a Business Network.

A Business Network has a *Title* to give the modelling project a name, e.g. “Automobile Industry 4.0”. It also has a *Description* that denotes the purpose of modelling, e.g. “Industry 4.0 changes the automobile industry completely and corresponding BMs are required”.

Table 4.1: NBMF Element: Business Network

Business Network
Title
Description
Calculation Periods
Location
Currency
Language

The *Calculation Periods* attribute is composed of a number and a time unit. It describes a timeframe, e.g. 7 years, for which the NBBM is designed and the outcome is calculated. The Calculation Periods are used in Phase 4 to calculate the Income Statement. Calculation Periods determine the NBBM and its success because digital industries are characterised by high fixed costs, e.g. for the development of software, and low marginal cost, e.g. hosting cost. If the Calculation Periods timeframe is set to short, too little revenue can be generated so that the initial cost are payed of. Calculation Periods can and should be altered during the modelling phase to see resulting effects on the NBBM and to outline the operational timeplan.

The *Location* attributes indicates location relevant characteristics of the NBBM. It can describe a geographical location like countries or continents, e.g. Austria or Central Europe. In the case of intangible digital products and services, the sales market may be worldwide and determined by special characteristics, e.g. locations with mobile Internet speed greater than 50Mb/s. The Location may also indicate legal regulations or cultural characteristics.

The *Currency* for a NBBM is set on a Business Network level, i.e. Financial Transactions and Costs are all carried out in the same currency. It allows to focus on the design of the NBBM and abstracts potential challenges with financial details.

The *Language* is set for a NBBM project, which states the language of all text fields within the NBBM.

4.3.2 Stakeholder

The Stakeholder is an actor in a Business Network that is characterised by human decision making. It may be a single individual or a group of actors that behave similarly. Stakeholders are free to make their own decisions, can change their characteristics and behaviour over time and may react to actions of the stakeholders. Actions of the Stakeholders in the NBBM are static to keep it comprehensible for users. Dynamic modelling of Stakeholders would overcomplicate the design process of BMs so that the essence and clearness of a BM would be lost. The attributes of a Stakeholder are shown in Table 4.2

Table 4.2: NBMF Element: Stakeholder

Stakeholder
Stakeholder Type
Title
Description
Real World Example
Segment Size
Segment Size Multiplier

Every Stakeholder is assigned a predefined *Stakeholder Type*. The two available Stakeholder Types are: Consumer or Company. A Company is characterised by the fact that it creates value for other Companies or for a Consumer. Companies are organisations with the goal of making a (not necessarily monetary) profit and they have an own culture, identity and internal structure. A Consumer is an actor at the end of a value chain and usually does not produce goods or services. Therefore, a Consumer is defined similarly as a Company with the exception that it can only produce Value Propositions but cannot attain Resources, Channels, Relationships and Activities. Hence, a Consumer is not strictly just consuming value but it is also providing value. In digital industries, this behaviour is becoming more prevalent. E.g. Consumers may take the role of content creators (crowdsourcing) or finance a Company (crowdfunding) [Ost04] but in most cases, the Consumer just consumes, and provides a financial transaction in return. In such a case the Consumer is called prosumer [DVH+15].

Every Stakeholder has a *Title*, e.g. "computer component supplier", and may also have a *Description*, e.g. "provides high-tech chips for IOT devices". The *Real World Example* allows the designer of the NBBM to specify concrete examples of companies which could take such a role when applying the NBBM. In the case of a computer chip manufacturer, the Real World Example could be e.g. ARM or Intel.

A Stakeholder may not only be one individual or a single Company. A construct, called Segment, is used to model a group of actors. A Segment consists of Consumers or companies that follow similar behaviours and have similar characteristics. The most remarking characteristic of a Segment is that all stakeholders in a segment perceive Value Propositions similarly. As described in Section 4.2, value is perceived subjectively, but the single actors of a Segment are so similar that they can be pooled without affecting the quality of the resulting model. Modelling with Segments results in a cleaner representation of Stakeholders but still allows accurate, realistic calculations.

For calculations in Phase 4 of the NBMF Framework, the amount of actors in a Segment is considered. The attribute of the Stakeholder describing the amount of actors in a Segment is called *Segment Size*. It denotes the number of actors per Calculation Period, which is an attribute of the Business Network element. The Segment Size affects the profitability of a NBBM. Most digital products are characterised by high fixed and low marginal cost. Therefore, in digital industries often a minimum number of customers is

required to make a solution financially profitable. If to few customers are interested in a solution, not enough revenue is generated to cover the initial fixed cost such as software development costs. The *Segment Size Multiplier* attribute of the Stakeholder element describes the change of the Segment Size over time. Figure 4.3 shows the formula for the calculation of the successive Calculation Period. If the Segment Size Multiplier is set to 1.0, then the Segment Size is constant in all following Calculation Periods. The Segment Size is decreasing if the Segment Size Multiplier is between 0.0 and 1.0 and it is increasing if it is greater than 1.0.

$$SegmentSize_{t+1} = SegmentSize_t * SegmentSizeMultiplier$$

Figure 4.3: Calculation of the Segment Size for the Successive Calculation Period t+1

The Segment Size Multiplier gives the Stakeholder Segment a non-static character. It is necessary to model the decline and growth of demand and supply and can determine a NBBM. Table 4.3 shows examples of the dynamics that arise when altering the Segment Size or the Segment Size Multiplier.

Table 4.3: NBMF Element: Stakeholder - Dynamics of the Segment Size Multiplier

Segment Size	Segment Size Multiplier	Period 1	Period 2	Period 3
1000	1.0 (constant)	1000	1000	1000
1000	1.4 (40% growth)	1000	1400	1960
500	2.5 (150% growth)	500	1250	3125
1000	0.8 (20% decrease)	1000	800	640
8000	0.0 (100% decrease)	8000	0	0

Many products and services fail because they are not designed to serve a specific customer group. Therefore, Stakeholders have to be modelled as close to reality as possible. However as mentioned above, some solutions may require a minimum amount of customers. In this case, it is recommended to model characteristics of the first customer segment that is addressed but consider to attract new segments with the same solution. At different stages in the NBMF modelling process, Segment Size and Segment Size Multiplier can be altered to see the effect on the NBBM and its profitability.

4.3.3 Consumer Need

In order to provide the best possible Value Proposition, it is indispensable to truly know the consumer. A central aspect of every BM is to pinpoint the characteristics of the consumer and understand the needs, problems and desires. Products and services evolving out of a Consumer Need have more chances to succeed and generate revenues for a company or a business network [OPBS14]. Table 4.4 shows the attributes of the NBMF framework that define a Consumer Need.

Table 4.4: NBMF Element: Consumer Need

Consumer Need
Stakeholder
Title
Description
Existing Solution
New Solution
Spending Amount per Consumer

The *Stakeholder* attribute references the corresponding Stakeholder of the Business Network to whom the Consumer Need belongs. In most cases this Stakeholder is a private consumer, but it can also be a company in case of a B2B consumer. The Stakeholder attribute of the Consumer Need links the information to an existing Stakeholder of a Business Network.

The *Title* attribute and the *Description* attribute describe the Consumer Need. The title just gives a short hint about the need, e.g. "wants to be healthy". The description explains why it is a real need for the consumer and why it is worth to engage from a business perspective, e.g. "health means wellbeing for the consumer, an illness causes high cost in the long term and it is possible to charge high rates from the consumer because health is perceived as something priceless".

In many cases, a solution for a Consumer Need exists already in the market, but that solution may not be satisfying for the consumer or a better solution could be provided to increase consumer satisfaction. The *Existing Solution* attribute specifies already existing products and services that tackle the same consumer need. Subsequently, the existing solutions need to be elaborated in more detail: "What are the positive aspects of the existing solution and what are the negative aspects that can be improved?". By asking these questions the NBBM-Designer can ensure that the consumer really needs a new product or service and clarify how it should look like. As soon as this is clear that the design of a new NBBM is justified, the designer continues.

The reason for modelling a BM is that existing solutions did not satisfy the consumer adequately or that there is room for improvement of the BM. Therefore, the designer of the NBBM blueprints a new solution with better Value Propositions. With the *New Solution* attribute, the NBBM-Designer is forced to think about an alternative solution that is superior to the Existing Solution. The designer has to justify in a short description why the new product or service is superior. This avoids failure at the execution of the NBBM.

The *Spending Amount per Consumer* specifies how much the consumer is willing to pay for the New Solution. Traditionally it is often set as a one-time purchase of an asset or a service, e.g. purchase price of a computer. In digital industries, this is often a recurring fee, e.g. a subscription fee per month.

4.3.4 Value Proposition

Table 4.5: NBMF Element: Value Proposition

Value Proposition
Giving Stakeholder
Receiving Stakeholder
Title
Description
Type
(Block at Customer)
(Consumer Need)

A Value Proposition describes the value that is passed on from one Stakeholder to another Stakeholder. It is, besides the Financial Transaction, one type of a Value Transaction. The Value Proposition Element in the NBMF Framework corresponds with the value proposition block in the BMC as described in Section 2.2.1. In the BMC it is the most important of all nine building blocks. Also in the NBMF Framework it takes a crucial role. If the Receiving Stakeholder perceives a product or service as valuable then there is a high chance that the NBBM succeeds. The Value Proposition element in the NBMF Framework is composed of five attributes that are shown in Table 4.5 and explained in the following.

Although similar significance of the Value Proposition is given to the NBMF Framework, as in the block in the BMC, there is a decisive difference. Every Value Proposition in the NBMF Framework is determined by the *Giving Stakeholder* and the *Receiving Stakeholder*. Designing the Value Proposition in the NBMF Framework as a relationship between two Stakeholders implies a networking character. Although in the BMC it is the most important block, it does not necessarily relate to a specific customer of the customers building block. The NBMF Framework is more restrictive and requires a more rigorous mapping between a Value Proposition and the served customer.

The *Title* attribute depicts the Value Proposition only in a few words. It is used to mark the connections in Phase 2 (Network Solution), as described in Section 4.4.2. The *Description* attribute describes the details of the Value Proposition.

The NBMF Framework distinguishes between three different *Types* of Value Propositions: Product, Service and Data. The Product Type stands for a tangible, e.g. a mp3 music player, or intangible, e.g. song as mp3 file, product. Furthermore, the Service Type can be subdivided into digital service, e.g. music streaming service, and physical services, e.g. giving a live concert. Data is not only an important asset in digital industries, it is also increasingly perceived as value itself. Finally due to the digital focus of the NBMF Framework, data is outlined as separate Value Proposition Type.

A Value Proposition is the output of the business activities of the Giving Stakeholder. For the Receiving Stakeholder, it is perceived either as input, to again create its own

Value Propositions (in case the Stakeholder is a Company), or the value is consumed (in case the Stakeholder is a consumer). If the Value Proposition is received by a Company, i.e. the Stakeholder Type attribute of the Stakeholder is set to Company, the Stakeholder also has a *Block at Customer* attribute. The Block at Customer attribute describes what the incoming Value Proposition is used for by the Receiving Stakeholder. Depending on the use, the Block at Customer attribute is assigned to one of the following characteristics: Key Activity, Key Ressource, Customer Relationship or Channel. The four characteristics derive from the blocks of the BMC as described in Section 2.2.1 and describe the most important input for a Company. E.g. Amazon Web Services[1] provides the Value Proposition "Reliable, scalable, and inexpensive Cloud computing services" to Dropbox[2]. For Dropbox, the Cloud computing from Amazon Web Services are used as Key Resources to provide its own Value Proposition, i.e. file sharing, to its customers.

In case the Value Proposition is directed to a Stakeholder who has Consumer Needs, it also has a *Consumer Need* attribute. This attribute references a Consumer Need that the Value Proposition fulfils. Hence, also a relation between a Value Proposition and a Consumer Need exists. In Phase 4, all Value Propositions related to a Consumer Need can be aggregated and confronted. On the one hand, the problem (Consumer Need) is compared with the solution (Value Propositions) in a qualitative manner to check if the solution is suitable. On the other hand, also a quantitative comparison can be achieved by comparing the Spending Amount per Consumer attribute of the Consumer Need with the aggregated prices of all Value Propositions. If the total price exceeds the Spending Amount per Consumer then the solution may be too expensive for the Stakeholder and an alternative solution has to be designed.

Value Propositions are designed in Phase 2 to generate a Network Solution for Consumer Needs. In Phase 3 the Value Propositions are mapped to entries of the BMC building blocks. They appear both in the BMC of the Giving Stakeholder as well as in the BMC of the Receiving Stakeholder. In this way, it creates a strong semantical relationship between the Giving Stakeholder and the Receiving Stakeholder. Note that the explained relations, neither between the BMC block elements (Key Activity, Key Ressource, Customer Relationship and Channel) nor the Consumer Need element to the Value Proposition element are shown in the UML 2.0 class diagram for readability reasons.

4.3.5 Financial Transaction

A Financial Transaction is, besides the Value Proposition, the second type of Value Transaction. It is the correspondent counterpart to the Value Proposition, in the sense that Financial Transactions are given in return to a Value Proposition. Financial Transactions are designed in Phase 2. They are also essential elements for the generation of the income statement in Phase 4. Table 4.6 outlines the single attributes of a Financial Transaction.

[1] `https://aws.amazon.com/`
[2] `https://www.dropbox.com/`

Table 4.6: NBMF Element: Financial Transaction

Financial Transaction
Value Proposition
Paying Stakeholder
Receiving Stakeholder
Title
Description
Price (incl. Recurring Unit)
Amount Reference Stakeholder

Every Financial Transaction references a *Value Proposition*. A Financial Transaction can not exist on its own. Money or any other form of symbolic value object is always given in return for an action, object or a feeling, i.e. a form of value. Therefore, a Value Proposition has to be designed as foundation for a Financial Transaction. In the NBMF Framework, numerous Financial Transactions can reference the same Value Proposition but not vice versa. In Phase 4, this design decision allows the comparison of the Consumer Need attribute of a Consumer Need with the accumulated costs, i.e. accumulated Financial Transactions, for the Value Propositions tackling the Consumer Need. E.g. A telecommunication provider charges a 60 Euro setup fee (i.e. 1st Value Transaction) and additionally 29.99 Euro service fee per month (i.e. 2nd Value Transaction) for an unlimited 100 Mb/s Internet connection (Value Proposition). The Spending Amount per Consumer is set to 40 Euro per month. Accordingly, this NBBM is feasible because the average monthly costs on a one-year basis of 34.99 Euro are less than 40 Euro.

The *Paying Stakeholder* attribute accounts as the starting point and the *Receiving Stakeholder* attribute accounts as the end point of a Financial Transaction. For the Paying Stakeholder the Price is denoted as cost, whereas for the Receiving Stakeholder the Price is denoted as revenue. The direction of the Financial Transaction is especially important for the generation of the income statement in Phase 4.

The *Title* shortly depicts the Financial Transaction, e.g. “One-time setup cost”. The *Description* contains a longer text denoting the details of the Financial Transaction, e.g. “charged at the beginning of the contract from the customers’ credit card”.

The *Price* attribute sets a quantitative measurement for the Financial Transaction. The unit, i.e. the currency, for the Price is set globally by the Business Network for all Financial Transactions (see Section 4.3.1). Due to the focus on the service-oriented digital industry of the NBMF Framework, also a *Recurring Price* can be set: Instead of a one-time payment, the price is set as a recurring transaction, e.g. 29.99 Euro per month. In the case of Recurring Prices, the income statement generated in Phase 4 is strongly dependent on the Calculation Periods of the Business Network.

The *Amount Reference Stakeholder* gives the NBMF Framework the possibility to model more complex Financial Transactions. It gets useful when modelling NBBMs a Financial Transaction that is dependent on a third Stakeholder. Figure 4.4 shows an example of how the Amount Reference Stakeholder attribute is used. The example shows a use case for sponsoring an event. The Sponsor pays 5 Euro for every Participant attending the event to the Event Organiser. In this example the Sponsor is the Paying Stakeholder, the Event Organiser is the Receiving Stakeholder and the Participant is the Amount Reference Stakeholder of the Financial Transaction. When 500 participants attend the event, the Event Organiser gets 2500 Euro in total from the Sponsor.

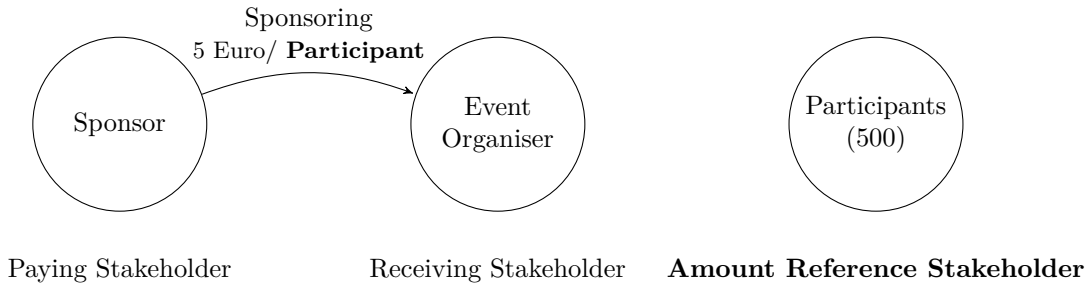


Figure 4.4: Example of the Amount Reference Stakeholder Attribute

The Amount Reference Stakeholder may seem unnecessary complicated in the beginning. But it allows the design of advanced Financial Transactions. Hence, this facilitates the creation of powerful NBBMs with higher potential of success and profit.

4.3.6 Key Activity

Table 4.7: NBMF Element: Key Activity

Key Activity
Stakeholder
Title
Description

The Key Activity element of the NBMF Framework conforms semantically to the Key Activity Block of the BMC, described in Section 2.2.1. It describes an important activity that a company needs to perform to provide a Value Proposition. Table 4.7 shows the attributes of a Key Activity.

Every Key Activity belongs to a stakeholder. Hence, the *Stakeholder* attribute of the Key Activity references to an existing Stakeholder of the Business Network. The *Title* denotes shortly what the activity is about, e.g. “design of a GUI”, and the *Description* explains it more detailed, e.g. “a simple and clean GUI for all B2C products is required”.

As described in Section 4.3.4, a Key Activity can also be represented by a Value Proposition for the Receiving Stakeholder.

4.3.7 Key Resource

Table 4.8: NBMF Element: Key Resource

Key Resource
Stakeholder
Title
Description

The Key Resource element correlates to the Key Resource Block of the BMC, described in Section 2.2.1. A Key Resource stands for the highly important resource that a company needs to generate a Value Proposition. In Table 4.8 the attributes of a Key Resource are depicted.

Each Stakeholder holds Key Resources, therefore the *Stakeholder* attribute references an owning Stakeholder. The *Title* annotates the Key Resource in a few words, e.g. "servers and networking equipment", and the *Description* specifies why the Key Resource is needed and how it is used, e.g. "includes hardware and necessary software licenses and it is used to host software applications for our clients".

A Value Proposition can also appear as Key Resource for the Receiving Stakeholder as explained in Section 4.3.4.

4.3.8 Customer Relationship

Table 4.9: NBMF Element: Customer Relationship

Customer Relationship
Stakeholder
Title
Description

A Customer Relationship element describes in which way a Stakeholder communicates and interacts with its customers. It is identical to the Customer Relationship block of the BMC by Osterwalder and Pigneur (see Section 2.2.1). The Customer Relationship element consists of the attributes Stakeholder, Title and Description, as shown in Table 4.9.

The corresponding Stakeholder is referenced by the *Stakeholder* attribute. The *Title* labels the relationship among Stakeholder and its customers, e.g. "personal assistance". The *Description* exposes more details about the relationship, e.g. "B2B-customers expect personal assistance for purchased products and services".

As noted in Section 4.3.4, a Value Proposition can be a Customer Relationship for the Receiving Stakeholder.

4.3.9 Channel

A Channel describes how a Stakeholder delivers a product or service to a customer. The semantic meaning of the element conforms to the Channels block of the BMC, as described in Section 2.2.1. The attributes of a Channel element in the NBMF Framework are shown in Table 4.10.

Table 4.10: NBMF Element: Channel

Channel
Stakeholder
Title
Description

The *Stakeholder* attribute references the corresponding Stakeholder. The *Title* denotes the type of the Channel, e.g. “sales force”, and the *Description* justifies the type of the Channel and offers more insights, e.g. “a specialised and skilled sales force ensures contract closing of high volume sales in a B2B market”.

Analogous Key Activities, Key Resources and Customer Relationships, also Channels can be constituted as Value Propositions. In such a case, the Receiving Stakeholder uses the Value Proposition of the Giving Stakeholder as Channel.

4.3.10 Cost

Table 4.11: NBMF Element: Cost

Cost
Key Activity, Key Resource, Customer Relationship or Channel
Stakeholder
Title
Description
Price (incl. Recurring Unit)
Amount Reference Stakeholder

The Cost element has similar attributes compared to the Financial Transaction element. The main difference is that the Financial Transaction describes a relationship between two Stakeholders and appears in return to a Value Proposition. Whereas the Cost element is a company-internal element that does not affect other Stakeholders.

The first attribute in Table 4.11 references the Cost element a *Key Activity*, a *Key Resource*, a *Customer Relationship* or a *Channel*. The second attribute references the corresponding *Stakeholder*. Therefore, any Cost of a Stakeholder cannot stay on its own and applies for one of the four elements specified above.

The *Title* depicts the Cost in a few words, e.g. “server and networking infrastructure” and the *Description* attribute reveals details for Cost element and some of the cost characteristics like fix cost, variable cost or economies of scale. A typical description looks like this: “Server and networking infrastructure are investments with high initial costs for the purchase of the hardware and during usage, various fix cost and variable cost apply”.

The *Price* attribute sets a quantitative measurement for the Cost element. The unit for the Price is set by the Currency attribute in the Business Network element. The NBMF Framework also allows setting a *Recurring Price*, e.g. 3000 Euro per month.

Like the Financial Transaction element, also the Cost element has an *Amount Reference Stakeholder* attribute. With this attribute, a variable cost structure can be accounted that adjusts itself to the size of a stakeholder segment. E.g. to provide personal assistance as customer relationship model causes cost of 100 Euro per year for each Customer C. In such a case the Amount Reference Stakeholder is referenced to the Customer C. So the NBMF Framework automatically calculates the Total Cost per year for the personal assistance, based on the segment size of Customer C. This configuration possibilities allow for more flexible NBBM scenarios.

4.3.11 Extension: Business Model Pattern

Table 4.12: NBMF Element: Business Model Pattern

Business Model Pattern
Title
Description
How
What
Who
Value
Company Examples

The Business Model Pattern element does not belong to the core of the NBMF Framework. It is an extension that supports categorisation of BMs. It is based on a catalogue of BMs developed in a cooperation of the University of St.Gallen and Bosch, called the Bosch IoT Lab [GFC13]. The catalogue is called St. Gallen Business Model Navigator and consists of 55 BM patterns that are defined and depicted with concrete examples. In the context of the NBMF Framework, it is first and foremost used as inspiration for NBBM-Designers. As the originators of the St. Gallen Business Model Navigator also note, many successful BM innovations of the past have been recombinations of existing BMs. Therefore, the catalogue was also incorporated into the NBMF Framework. In Phase 3 of the NBMF Framework predefined Business Model Patterns can be assigned to the BMC of a Stakeholder. In the long term, it makes it also simpler to compare various NBBMs or different versions of the same NBBM.

Table 4.12 shows the structure of the Business Model Pattern element. It equals the structure of the business model pattern of the St. Gallen Business Model Navigator catalogue [GFC13]. The *Title* attribute labels the Business Model Pattern, e.g. "Add-On". The *Description* explains the characteristics of the Business Model Pattern, e.g. "Customers benefit from a variable offer, which they can adapt to their specific needs".

The *How*, *What*, *Who* and *Value* attributes denote which dimension of the BM are innovative and contribute most to its success. They are represented as boolean checkboxes. The How dimension stands for an innovative orchestration of internal processes and activities in a company, e.g. the "Crowd-sourcing pattern" is characterised by the integration of the customer in internal processes. The What dimension designates a special perception or change of the value proposition, e.g. the "Peer-to-peer pattern" customers provide value for each other. The Who dimension marks a change of the customer base, e.g. with the "Make more of It pattern" capabilities of a company are not only used to build own products but also products for other companies. The Value dimension indicates a new revenue model or a new cost structure, e.g. with the "License pattern" a company may focus on R&D and license its IP to increase its revenue.

The four attributes denote what dimensions explain and characterise the BM. The How dimension stands for an innovative orchestration of internal processes and activities in a company. The What dimension designates a special perception or change of the value proposition. For the Who dimension, the definition of the customer is crucial. The Value dimension indicates a new revenue model or a new cost structure.

The *Company Examples* attribute includes a list of companies including the date when the BM was successfully applied. In some cases, the examples denote the first successful execution. In other cases, the attribute shows the example of very profitable companies who applied the BM.

4.4 The 4 Phases of the Framework

The NBMF Framework is structured in four phases:

Phase 1: Consumer Needs

Phase 2: Network Solution

Phase 3: Business Model Canvas

Phase 4: Viability Check

Each phase builds upon the previous one and the strength of the framework lies in the reuse of the elements. Many elements, e.g. Value Propositions, are created in an early phase of the NBMF and they are reused at a later phase. Due to the fact that the elements appear in different phases they are characterised by different viewpoints, e.g. in the Network Viewpoint, the NBBM-Designer sees the elements from various perspectives. Hence, the NBBM-Designer subconsciously checks the consistency of elements across different perspectives.

The NBMF is intended to design NBBMs by following the four phases sequentially. Nevertheless drafting BMs is usually a messy and unstructured process. The BM-Designer is advised to follow the phases as long as they do not hinder the creativity. As soon as the NBBM-Designer sees potentials to design more innovative BMs, the order of the phases can be neglected. For experimentation and fine-tuning of different parameters of the NBBM, switching views is even recommended to consider all potential optimisations.

To support the understanding of the four phases of the NBMF, concrete examples are provided for each phase. The different examples implement a use case through out the four phases. For Section 4.4 we consider the following use case scenario: According to the OECD, 70% of water used today, accounts for agriculture [OEC16]. Furthermore, the environment is polluted by excess nutrients and pesticides originating from agricultural activities. From an ecological perspective, this situation is very problematic and will have serious consequences for humanity. From a financial perspective, production cost for food will increase in the long run because of the decreasing quality of soil and the increasing price for water. Therefore, farmers need to be open for new solutions to decrease water consumption as well as the amount of fertilisers that is spread on the fields to decrease production cost. Potential solutions are based on technological innovations, e.g. granular soil data gathered by sensors is used to determine automatically the optimal amount of water and fertilisers.

4.4.1 Phase 1: Consumer Needs

Especially, but not only, in the digital economy, it is all about the consumer, solving its problem and serving its needs. The *consumer viewpoint*, i.e. putting oneself in the role of consumer, exposes the desired insights. Therefore, the NBBM design starts with a concrete problem or need of the consumer. In rare cases, when introducing a new product or service, no problem or need may exist yet because it is created by the innovation itself. It has to be assured that the need of the consumer is real because it is the basis and motivation to model a NBBM. Building products and services that do not satisfy a Consumer Need are likely to cause high cost for companies because little revenue will be generated. In the worst case, it can also ruin a company. E.g. Kodak went out of business because the company did not listen to consumers and refused to build digital cameras [GFC13].

The following actions have to be completed to accomplish Phase 1:

1. Create a Business Network as described in Section 4.3.1.
2. Create the Stakeholder that represents the Consumer Needs, as described in Section 4.3.2.
3. Create a Consumer Need as described in Section 4.3.3.
4. Ask yourself the question: Is the Consumer Need serious? If the question is answered with yes, continue modelling the NBBM.

Taking the previously described use case as an example, the following elements could be created in Phase 1:

- Business Network BN1 with a worldwide customer base and a Calculation Period of two years.
- Stakeholder S1: Segment of 400 Farmers, with an increase of 120% per year.
- Consumer Need CN1: Farmers want to decrease the use of resources and to increase the crop yield.

Phase 1: Know your Customer

Find out what problems and needs your potential customers have. Analyse characteristics and existing solutions for the problem.

Gathering detailed input or feedback from potential customers is necessary in this phase and avoids misconceptions about the demand. As soon as it is clear that the customer need is real, modelling is continued with Phase 2.

4.4.2 Phase 2: Network Solution

Once the customer and its needs or problems are determined in Phase 1, the BM-Designer continues to model the solution approach. The BM-Designer is required to follow a *network viewpoint*. With a network viewpoint, the designer aims for a solution that is provided by a network of Stakeholders. This network viewpoint exposes new opportunities that derive from a high degree of specialisation and a close collaboration between Stakeholders. Traditionally, BMs were designed by pursuing a company-centric perspective. A company-centric perspective constrains possible solutions because of the lower degree of specialisation of a single company. BMCs are also dominated by competitive thinking that can hinder innovation originating from more open BMs. NBBMs foster innovation in a collaborative manner and allow for more complex revenue streams.

In the NBMF Framework, network partners play an essential role because products and services can often only be provided if all stakeholders collaborate. The output of the joint efforts creates value that can be offered to the customer. The only interactions among the value creating Stakeholders themselves as well as between the value-creating Stakeholders and value-consuming Stakeholders are Value Transactions. A Value Transaction can be a Value Proposition or a Financial Transaction. A Value Proposition exchanged between two Stakeholders is depicted as an arrow. The arrow denotes the direction of the value flow from the Giving Stakeholder to the Receiving Stakeholder.

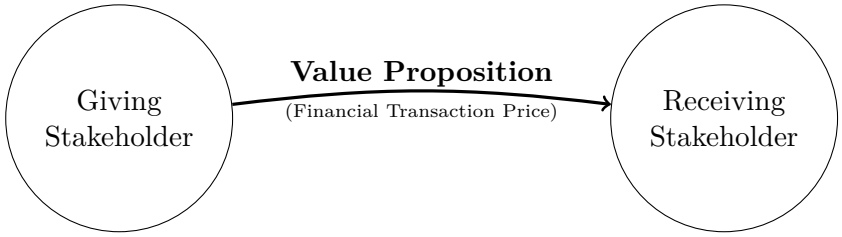


Figure 4.5: NBMF Phase 2 - Value Proposition is Exchanged between Stakeholders

A Financial Transaction can be seen as compensation for a Value Proposition. Although a Financial Transaction also flows from one Stakeholder to another, it is not modelled as an arrow to denote the greater importance of Value Propositions. The Price of a Financial Transaction is attached to the Value Proposition to denote the compensation. The graphical representation of value flows between two Stakeholders in the NBMF Framework can be seen in Figure 4.5.

The goal of Phase 2 is the design of Stakeholders and Value Transactions. Modelling starts based on the Stakeholder with the Consumer Need and is repeated until all Stakeholders are modelled. The NBMF recommends the following procedure:

1. Create the most important Stakeholder that provide the highest Value Proposition.
2. Create all Value Propositions to model the exchanged values as described in Section 4.3.4.

3. Repeat 1. and 2. to model all Stakeholders and Value Propositions.
4. Create Financial Transactions as compensations for the Value Propositions as described in Section 4.3.5.
5. Try to improve Value Propositions by experimenting with more complex Value Transactions.

It is important to keep the overview and not lose track of the essential parts of the NBBM because the size of a business network could be increased infinitely. Therefore, it is advisable to set a mental network boundary for the Business Network. A network boundary restricts the Business Network to the key actors of a NBBM. Stakeholders outside the network boundary do not provide important Value Propositions and can be easily replaced. Such external Stakeholders can be partners or suppliers with low collaboration. Therefore, they are not relevenat for a NBBM and do not have to be modelled in detail.

Given the use case from the beginning of this Section, the following elements could be created as part of the solution:

- Stakeholder S2: Is a company that provides high-tech farming equipment. It produces irrigation systems to lower water consumption.
- Value Proposition VP1: S2 provides an autonomous irrigation system to farmers S1 that can be supervised over the Internet. It reduces water consumption by 30% by applying weather forecasts and considering data gathered from sensors in the soil.
- Stakeholder S3: Is a software company that aggregates weather and geographical data and provides it as a service.
- Value Proposition VP2: Service Provider S3 provides the data to the equipment producer S2. The data is a key resource for S2 to develop the irrigation system.
- Financial Transaction FT1: Each Farmer S1 pays 5000 Euro per VP1 to the S2.
- Financial Transaction FT2: S2 pays 300 Euro/month for VP2 to the S3

Phase 2: Innovate Value Transactions

Value Propositions that satisfy Consumer Needs, guarantee success for a Business Network and each of its single Stakeholders. Value Propositions can lead to competitive advantage and innovative Financial Transactions drive long-term financial success.

The St. Gallen Business Model Navigator [GFC13] provides a large set of potential Value Propositions and Financial Transaction. These BMs that have been applied to other problems and different sectors may give some impulses for suitable solutions.

4.4.3 Phase 3: Business Model Canvas

Phase 3 of the NBMF Framework focuses on the value generating Stakeholders of the Business Network. The viewpoint in this phase is *company-centric*. The concept applied in this Phase has been integrated from the BMC by Osterwalder and Pigneur [OP10]. Some characteristics of the original BMC are altered and some limitations are introduced due to the network-based problem-solving approach of the NBMF Framework.

A BMC can not be drafted for every Stakeholder because only a company can be described by a BMC. A consumer does not act like a company and is not characterised by the building blocks of a BMC. Hence, a BMC is drafted for all Stakeholders of Stakeholder Type company.

Just as in the original BMC, the Value Propositions block is most important in the NBMF. In the NBMF, Value Propositions as well as Financial Transactions are designed in Phase 2. As shown in Figure 4.6, Value Propositions and Financial Transactions are mapped onto the BMC. Therefore, the BMC of every Stakeholder already contains some elements when modelling is continued in Phase 3. The mapping of Value Transactions to the BMC of a Stakeholder is accomplished according to the following rules. The examples derive from the use case described earlier in this Section:

- If the Stakeholder is involved as the Receiving Stakeholder in a Value Proposition (top left box in Figure 4.6), the Value Proposition element is mapped to one of the following Blocks: Key Activities, Key Resources, Customer Relationships or Channels. The Giving Stakeholder of the Value Proposition is mapped to the Key Partners Block.

  E.g. the API (Value Proposition VP2) is shown as Key Resource in the equipment producer (S2) and the software company that provides VP2 is shown in the Key Partners Block.

- If the Stakeholder is involved as the Giving Stakeholder in a Value Proposition (top right box in Figure 4.6), the Value Proposition element is mapped to the Value Propositions Block. The Receiving Stakeholder of the Value Proposition is mapped to the Customer Segments Block.

  E.g. the API (Value Proposition VP2) is shown in the Value Propositions Block of the software company (S3) and the equipment producer (S2) that receives VP2 is shown in the Customer Segments Block.

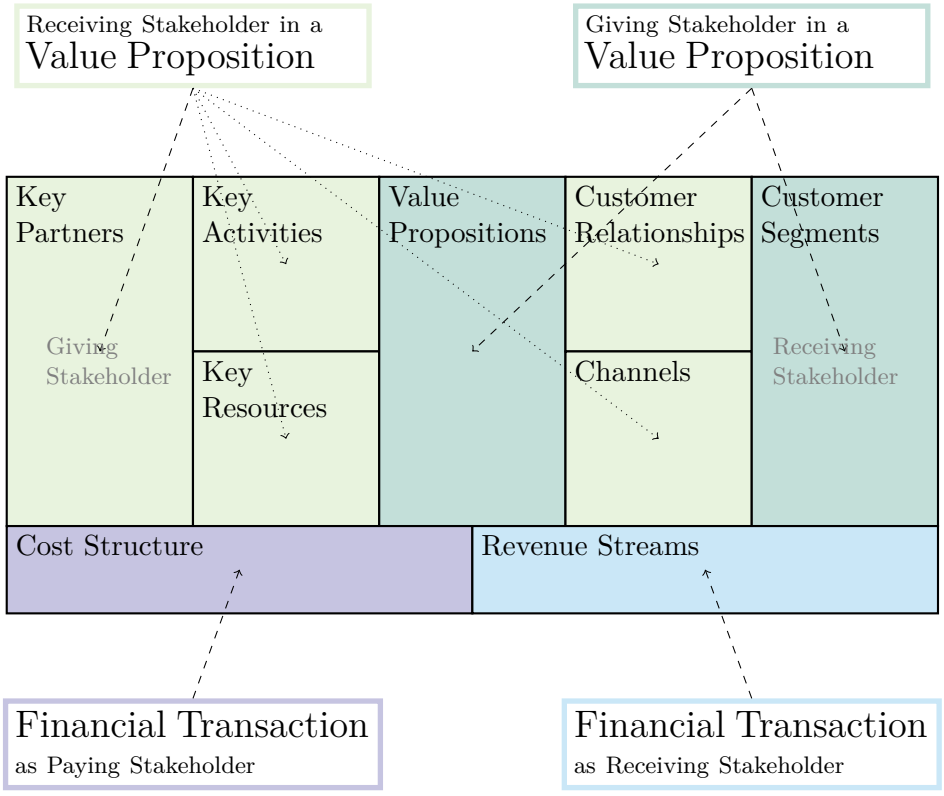
- If the Stakeholder is involved as the Paying Stakeholder in a Financial Transaction (bottom left box in Figure 4.6), the Financial Transaction element is mapped to the Cost Structure Block.

  E.g. the Financial Transaction FT2 of 300 Euro/month that compensates VP2 is shown in the Cost Structure Block of the software company (S3).

- If the Stakeholder is involved as the Receiving Stakeholder in a Financial Transaction (bottom right box in Figure 4.6), the Financial Transaction element is mapped to the Revenue Streams Block.

  E.g. the Financial Transaction FT2 of 300 Euro/month that compensates VP2 is shown in the Revenue Streams Block of the software company (S3).

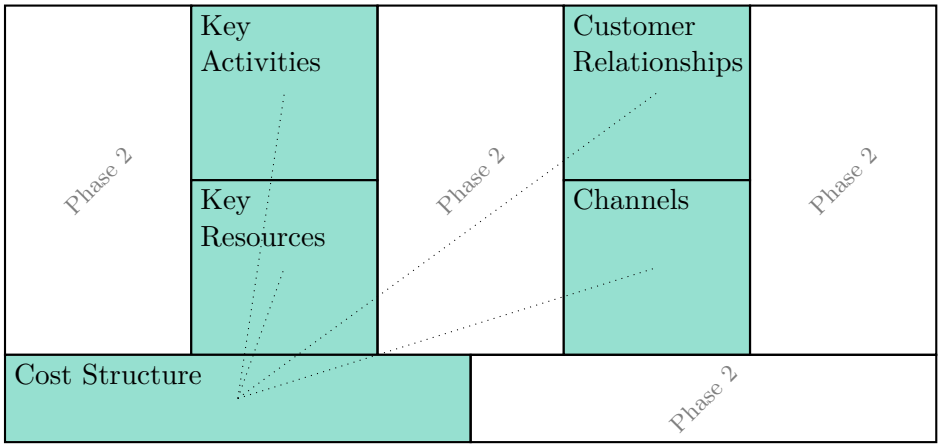
Due to the fact that a Value Transaction is conceived as a relation between Stakeholders, it appears in the BMC of two Stakeholders. E.g. the API results as a Key Resource in the BMC of the equipment producer and as Value Proposition in the BMC of the service provider.



Note: Boxes above and below the BMC are designed in Phase 2

Figure 4.6: NBMF Element-Mapping from Phase 2 to Phase 3

Not all Blocks of the BMC are edited in Phase 3. Figure 4.7 shows the Blocks that are completed in this phase of the NBMF Framework. Now the BM-Designer investigates from a company-viewpoint, what activities, resources, relationships and channels are needed to provide the Value Propositions that are displayed in the Value Propositions Block of the Stakeholder. The following list describes the modelling process in Phase 3, nevertheless it is not mandatory to follow the order stated.



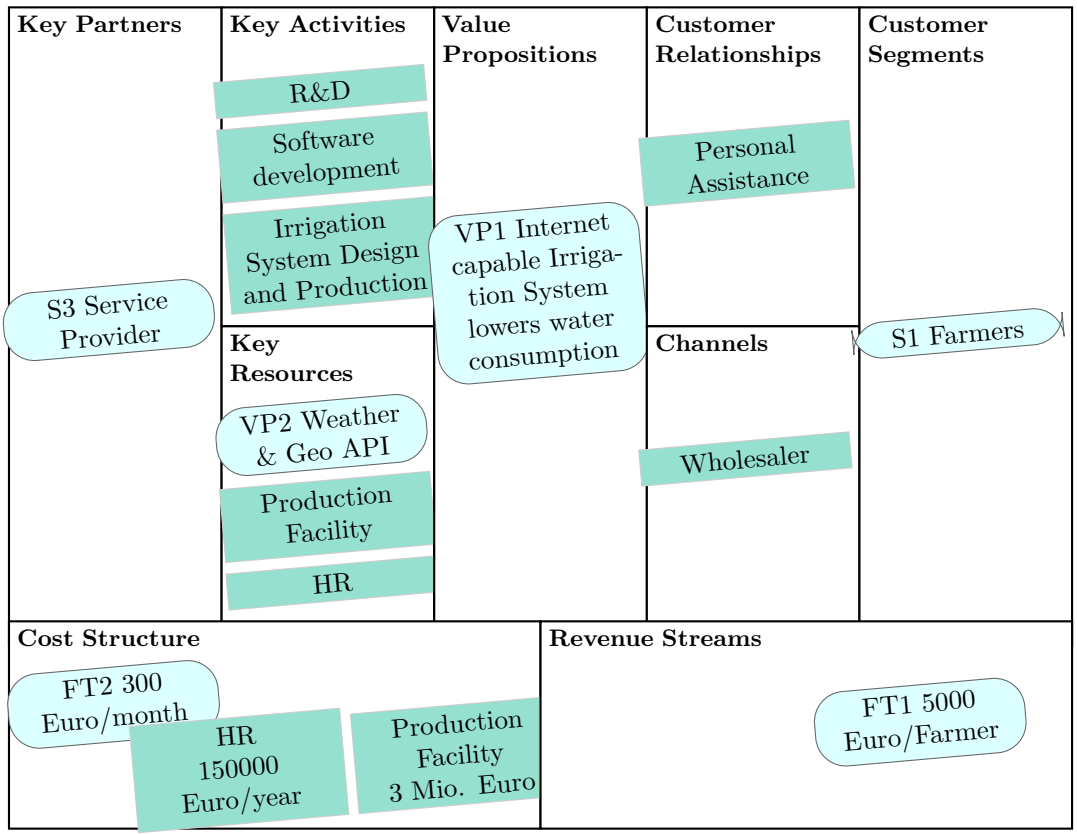
Note: Coloured blocks of the BMC are edited in Phase 3

Figure 4.7: NBMF Phase 3 - BMC-Blocks to complete

1. Take a look at the mapped elements that are derived from the Value Transactions and reason for validity
2. Determine what Key Activities need to be conducted to provide the Value Propositions. For more information see Section 4.3.6.
3. Determine Key Resources that are necessary to build the Value Propositions. For more information see Section 4.3.7.
4. Determine how the company keeps in touch with its customers and write it down in the Customer Relationships Block. For more information see Section 4.3.8.
5. Determine what Channels are used to reach the customer. For more information see Section 4.3.9.
6. Some Key Activities, Key Resources, Customer Relationships and Channels may cause costs that characterise the Cost Structure of a company. Create Cost elements that describe the expenses qualitatively and quantitatively. See Section 4.3.10 for details.
7. In case some important Stakeholders or Value Propositions of the Business Network have been overlooked or forgotten, return to Phase 2.
8. Compare your final BMC with the St. Gallen Business Model Navigator. What BMs are similar to your BMC? Tag your BMC with the corresponding BMs of the catalogue. See Section 4.3.11 for more details.

Cost can be added to the Cost Structure Block to account for expenses of Key Activities, Key Resources, Customer Relationships and Channels. In contrast to the original BMC, revenues can not be inserted in Phase 3 of the NBMF. The reason for this limitation is the fact that revenues are only derived from Financial Transactions. The BMC takes a one-sided company-viewpoint on elements, whereas a Financial Transaction is a two-sided element as it relates to Stakeholders with each other. Financial Transactions are only modelled from a multi-sided network viewpoint as part of the Network Solution in Phase 2. As a consequence of this design decision, Value Propositions and Financial Transactions are always perceived as relational elements. Hence, also from the company-centric viewpoint in Phase 3 the relational character of a Value Transaction is preserved.

Figure 4.8 shows an example of a simplified BMC of the equipment producer S2 that could have been designed in Phase 3. The elements with rounded corners in Figure 4.8 have been added in Phase 2 and are now mapped on to the BMC. The coloured elements are designed in Phase 3.



Legend: Elements of Phase 2 New Elements of Phase 3

Figure 4.8: NBMF Phase 3 - Example BMC of Stakeholder S2

Phase 3: Look at the Stakeholders

Answer the questions: What resources do the single companies need and what activities do they execute to build the Value Propositions? How do they deliver and what relationship do they keep with the customer? How much does it cost?

4.4.4 Phase 4: Viability Check

In Phase 4, profitability for the Business Network and its Stakeholder are examined. In this last Phase of the NBMF Framework, elements of the BMCs are mapped to Income Statements. All elements of the BMC Cost Structure Block are listed as cost and aggregated as Total Cost. All elements of the BMC Revenue Streams Block are listed as revenue and aggregated as Total Revenue. The most important outcome of Phase 4 is the net income. It is calculated by deducting the Total Cost from Total Revenue. The data, inserted in the previous phases of the NBMF, is sufficient to compose the Income Statement without further input of the NBBM-Designer. Whereas Phase 1, Phase 2 and Phase 3 focused on the generation of the NBBM (active), Phase 4 is all about its evaluation and proof of viability (passive).

Table 4.13 shows the Income Statement of the equipment producer S2 of the example presented earlier in this chapter. The Income Statement is calculated for two years as it was set in the Business Network in Section 4.4.1.

Table 4.13: NBMF Phase 4 - Example Income Statement of Stakeholder S2

	Year 1	Year 2	Total
FT2 Weather API	3600	3600	7200
Human Resources	150000	150000	300000
Production Facility	3000000	-	3000000
Total Cost	3153600	153600	3307200
FT1 Irrigation System	2000000	2400000	4400000
Total Revenue	2000000	2400000	4400000
Net Income	-1153600	2246400	**1092800**

The records in the Income Statement in Table 4.13 were calculated as follows:

- The cost for Human Resources of Euro 150,000 applies every year because it is a recurring cost
- The cost of Euro 3,000,000 for the Production Facility appears just in the first year because it is a one-time cost.

- The annual costs for the API (FT2) provided by the software company (S3) are calculated by multiplying the monthly cost of Euro 300/month by 12 months.
- The Revenue in the first year generated by the sale of the Irrigation System is calculated by multiplying 400 Farmers by Euro 5000/Farmer. In the second year the Farmer Segment increases by 120%, therefore the revenue for the second year is calculated by multiplying 480 Farmers by Euro 5000/Farmer.
- The Net Income of Stakeholder S2 at the end of the Calculation Periods is calculated by deducting the Total Cost of Euro 3,307,200 from the Total Revenue of Euro 4,400,000. The Net Income is with over 1 million Euro positive, therefore the BM of this Stakeholder is viable from a financial perspective.

A successful and sustainable NBBM must provide advantages for all Stakeholders involved in the Business Network. Value creating Stakeholders usually want to a make profit, i.e. the accumulated Net Income over all years must be positive. Hence, all value generating Stakeholders need to make a financial profit or reach their goals in case of a non-profit company. Value consuming Stakeholders want to solve their problems at a reasonable cost, i.e. the Value Propositions need to fit the Consumer Needs and Total Cost in the Income Statement can not exceed the Spending Amount per Consumer attribute of the Consumer Need. If the NBBM does not provide advantages for everyone, some Stakeholders may be not committed and the NBBM becomes unviable sooner or later [DVH+15].

For a qualitative viability check, i.e. check if the solution is suitable, external members (partners, customers, BM-experts, consultants) that have not been part of the NBBM design process should be asked for feedback.

After successful completion of Phase 4, the NBBM is ready for testing. Testing, evaluation and improvement of NBBMs are not covered by the NBMF Framework but methods, as described by Osterwalder [OP10], can be used.

Phase 4: Check for Viability

All value generating Stakeholders, i.e. companies, should profit in some way and the NBBM needs to be aligned with the companies' strategy. Also, make sure that the solution provides enough value to customers and that it is not too expensive. Ask for feedback and advise!

4.5 Software Implementation

The NBMF Framework presented in this chapter was implemented as a software tool with a GUI. The framework could also be used without the software, but it would be a lot less valuable for NBBM-Designers. With pen and paper, the framework would require a lot of copy-pasting. In practice, this would result in inconsistencies between views and it would be less intuitive. Furthermore, a lot of background and domain knowledge of the framework would be necessary. In the following, design decisions and technical explanations relating to the implementation of the framework are given.

4.5.1 User Experience

The software is designed as a web application. When the software is hosted on a web server on the Internet, the only technical requirement to the end user is a web browser with Internet connection. The NBMF is developed as "mobile-ready" website. It allows users to display the website from any screen with a minimum display size of 3 inches, i.g. smartphone. All elements such as text, images, input fields, buttons of the website adapt automatically to the screen size of the user. This conducts to a great user experience because it gives the possibility to use the software from different devices like smartphones, tablet computers, laptops and desktop PCs. As the software is designed as "mobile-ready" and not as "mobile-first", the use of a full-size screen with a minimal screen-width of 768 pixels and a display diameter of above 7 inches is recommended, i.e. tablet computers or larger. On smaller screen sizes, the illustration of the Network Solution (see Section 4.4.2) and the BMC (see Section 4.4.3) is suboptimal.

Figure 4.9 shows the landing page of the NBMF web application. Before the user can access the BM software, registration with a valid email address is required. This allows authenticated access and modification of modelling projects. For demonstration purposes of the software, an online example is provided. The example represents the Case Study of Chapter 5. Users can actively experiment with the example to get an idea on how the web app can be used. Also, the BM catalogue of the St. Gallen Business Model Navigator [GFC13] is incorporated into the software. The catalogue is filterable and searchable. It is used for inspiration and categorisation purposes as described in Section 4.3.11.

The architecture as a web application allows users to collaborate easily on a modelling project. The owner of the project just needs to give necessary access rights to another user, simply by adding its username to the project. Instantly, the invited user gets access and both can work simultaneously on the same project.

The software implementation serves the user as a design tool for NBBMs and it is also presented as such on the homepage. Therefore, usability is an issue. During the implementation process, feedback was constantly collected to improve the usability and the user experience. It was gathered over the integrated feedback feature of the software and over personal contact. However, the software implementation is still in a prototyping phase (beta version) because usability has to be improved further.

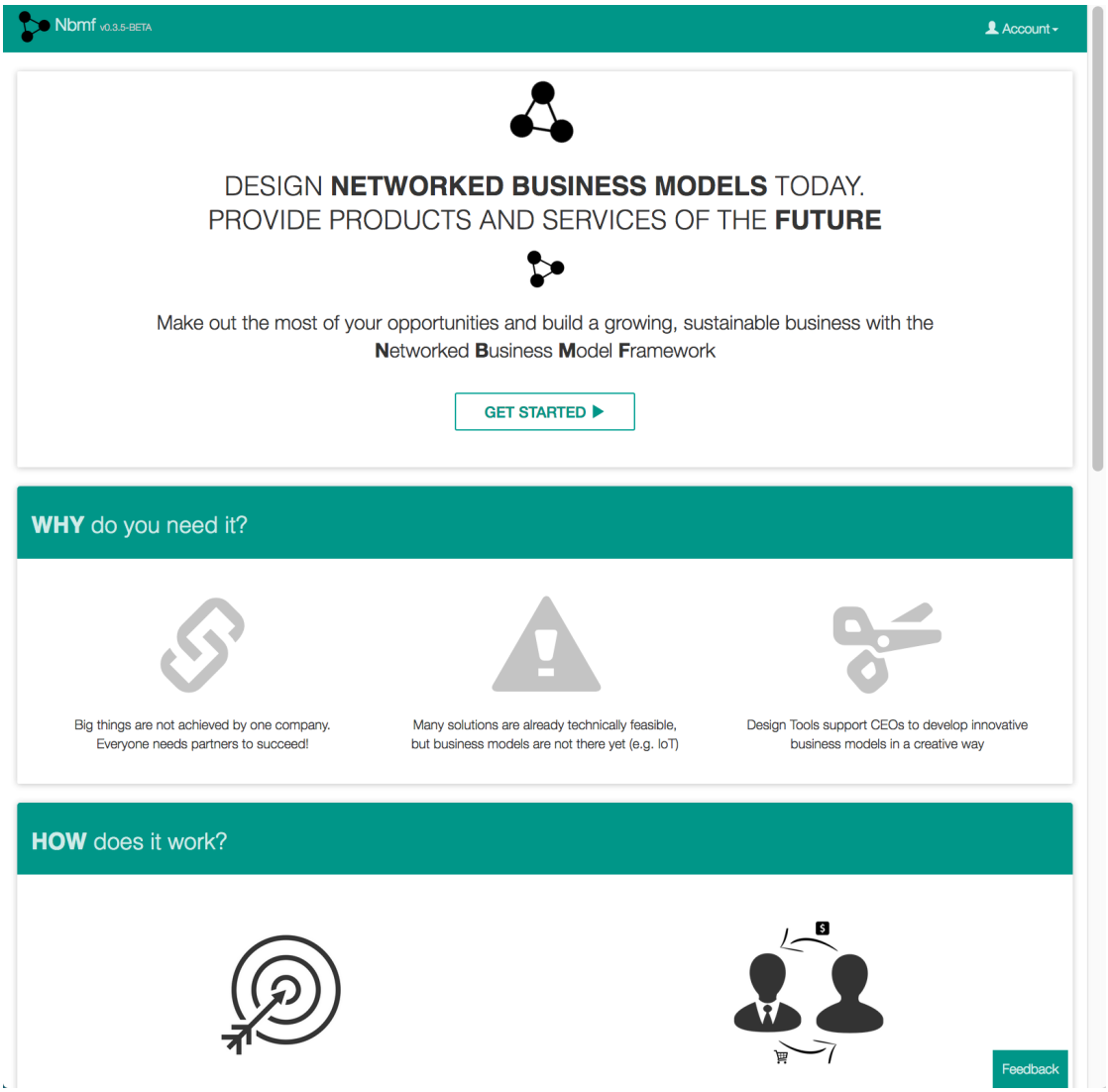


Figure 4.9: Landing Page of the NBMF Web Application

4.5.2 Software Architecture

The main target for the architecture of the software was the strict separation of the frontend from the backend. The separation of concerns between the frontend, i.e. the user interface, and the backend, i.e. the data access and business logic, increases the flexibility for the future development of the software and makes it easier to maintain.

The architecture of the software implementation is shown in Figure 4.10. The user interface is a single-page web application that follows the Model-View-Controller (MVC) design pattern. When the user accesses the web application for the first time, the full code of the frontend application is transmitted from the Server to the Client. From there on, no more code for the frontend, i.e. markup language, stylesheets or business logic, is transmitted. Once the frontend application is initialised in the browser, only data (text, images) is transmitted between client and server.

Whenever the user changes the data object in the frontend application, an event is triggered and the updated data is populated as JSON object[3] to the Web Server over a TCP-IP[4] connection. The gateway at the Web Layer of the Web Server, i.e. the REST API, accepts and serialises the data. Then, Business Rules are applied in the Service Layer. Data is checked for integrity and is persisted to the Database in the Data Layer. Authentication and Access-Control rules are checked and applied on all three layers.

The Database Schema in the Data Layer is used at the start of the Web Server to configure and setup the Database.

A multilayered architecture in the backend application contributes to separation of concerns. Loose coupling between the layers provides flexibility to swap technologies and code dependencies. The application and the database are embedded in a separate virtual environments, so called containers. The containers do not have to be located on the same virtual or physical machine and make the system very flexible and scalable. Horizontal scaling such as providing more instances of the backend application can be achieved with low efforts for configuration by duplicating the Application Container. Capabilities can adapt quickly when increased service levels are required or a higher number of clients increase the workload on the server. This concept of scaling up and down can be automated, i.e. elastic computing.

Furthermore, this architecture provides high flexibility to change or add ways for presentation in the frontend, i.e. the user interface. Since only raw data is sent over the Internet infrastructure, a second user interface, e.g. a Smartphone App, can be developed and integrated without affecting the backend.

[3] `http://www.json.org`
[4] `https://tools.ietf.org/html/rfc1180`

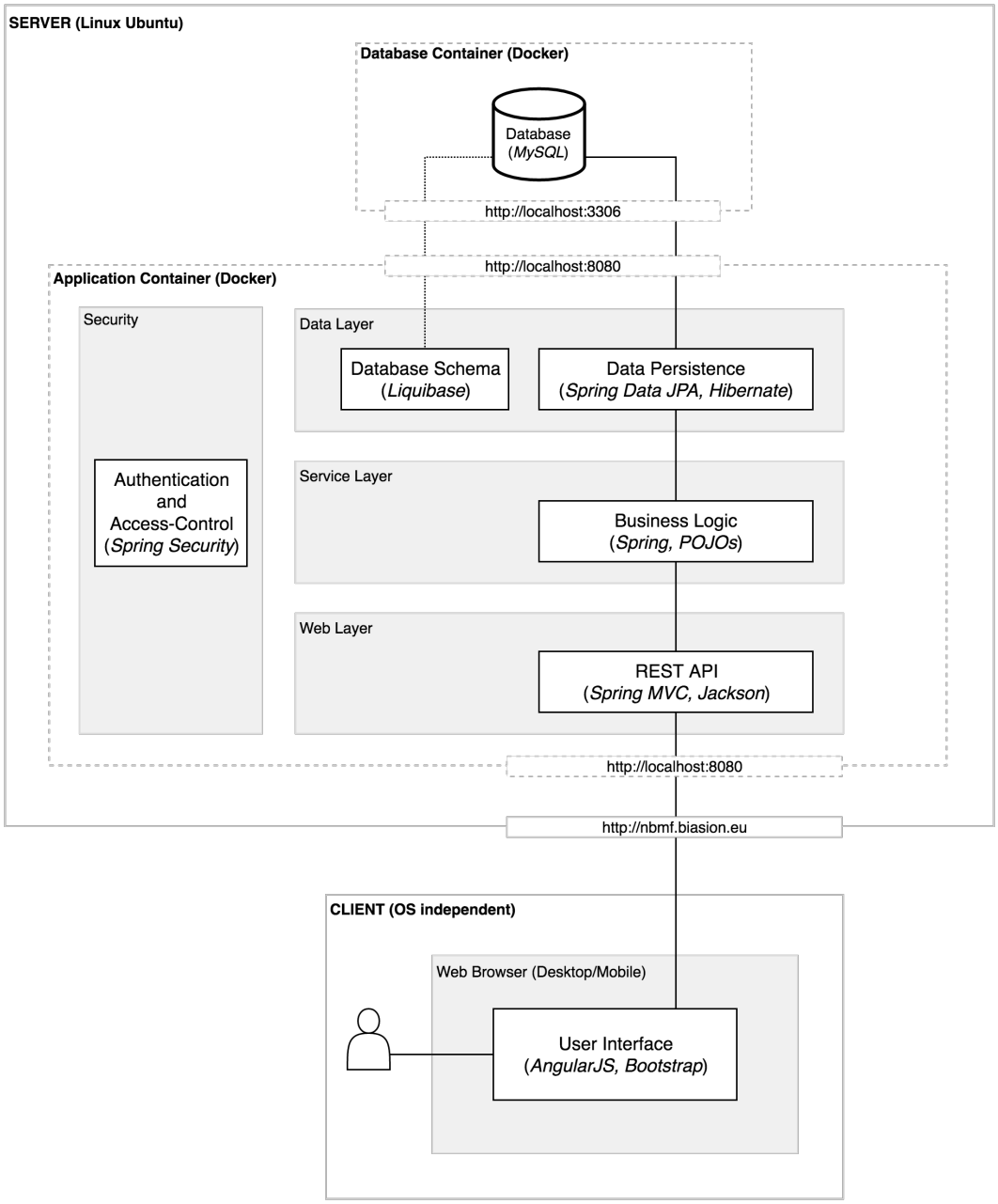


Figure 4.10: NBMF Software Architecture

4.5.3 Technologies and Tools

The software is developed in different languages by using different tools. The backend is written in Java[5] and the main programming language in the frontend is Javascript[6]. For the graphical presentation, the markup language HTML[7] is used in combination with stylesheets in CSS[8].

The free and open-source application generator JHipster[9] is used to build the web application. JHipster focuses on developer productivity, embraces the 'convention over configuration' mindset and includes various tools to realise web applications. It includes a proprietary JHipster Domain Language (JDL) to describe the data model. In the JDL data model, entities including their attributes (e.g. the elements in the NBMF) as well as relationships between entities are defined. The JDL data model is then used to generate boilerplate code when the application is set up.

All of the technologies presented in the following are part of the JHipster 3.5 toolchain.

Backend Development

The backend makes use of different modules of the open source Spring Framework[10].

Spring Boot[11] follows the 'convention over configuration' mindset to develop stand-alone Spring-based Java applications. The Web Server is embedded in Spring Boot already. Hence, Spring Boot is the basis for the backend and web applications are deployed directly.

Spring Security[12] is used for authentication and access-control. It provides protection against various attacks out of the box and can be integrated easily with the Spring Web MVC.

Spring MVC[13] is a request-based framework for web applications. It provides various interfaces for managing HTTP requests.

Spring Data JPA[14] makes part of Spring Data[15] that provides a consistent programming model for data access. Spring Data JPA implements JPA-based repositories and provides type-safe JPA queries.

[5] http://www.oracle.com/technetwork/java/javase/overview/java8-2100321.html
[6] http://ecma-international.org/ecma-262/5.1
[7] https://www.w3.org/TR/html5
[8] https://www.w3.org/standards/techs/css
[9] https://jhipster.github.io
[10] https://spring.io
[11] https://projects.spring.io/spring-boot
[12] http://projects.spring.io/spring-security
[13] https://docs.spring.io/spring/docs/current/spring-framework-reference/html/mvc.html
[14] https://projects.spring.io/spring-data-jpa
[15] https://projects.spring.io/spring-data

Liquibase[16] is an open source library for tracking, managing and applying database schema changes. It is database-independent and allows multiple developers to work on the same database even if code branches are different. Database changes are stored in structured text files such as XML, YAML, JSON or SQL.

Data is stored in a relational SQL database system. Two different database systems are used: the embedded database system H2[17] in the development environment and MySQL[18] in the production environment. Both are open source.

Frontend Development

The frontend is built with JavaScript framework AngularJS[19] v1.5. AngularJS is an open source frontend MVC framework for single-page web applications. It decouples the DOM manipulation from the application logic and detaches client side development of an application from the server side development. Furthermore, it provides more structure for designing the UI, for writing business logic, for fetching data from the server and for testing.

HTML5 Boilerplate[20] is used as the initial HTML5 front-end template. It contains extensive community knowledge and best practices for modern web design.

Twitter Bootstrap[21] is an HTML, CSS, and JS framework for developing responsive web pages. It fosters the "mobile first" principle and includes a set of HTML elements, CSS components and Javascript plugins. Bootstrap Material Design[22] is a theme that extends Twitter Bootstrap to imitate the Material Design by Google[23].

Bower[24] is a package manager which is used to manage the frontend dependencies. It follows a flat dependency graph and helps to reduce page load of the web application.

Thymeleaf[25] is a server-side Java template engine that is used in this project to generate emails for the registration of an account and to reset an account in case the password is forgotten.

[16] http://www.liquibase.org
[17] http://www.h2database.com
[18] https://www.mysql.com
[19] https://angularjs.org
[20] https://html5boilerplate.com
[21] https://getbootstrap.com
[22] https://fezvrasta.github.io/bootstrap-material-design
[23] https://material.google.com
[24] https://bower.io
[25] http://www.thymeleaf.org

Test, Build, Deployment and Documentation

The backend, as well as the frontend of the web application, were tested using different tools. In the frontend, Karma[26] is used for UI tests. In the backend, Spring Test Context framework[27] is used for integration tests.

Gulp[28] is a task runner that is used for live reload after code changes, for build and for optimisation. Typical tasks are the execution of UI tests, compression of images, linting (i.e. common bug checks) of Javascript and minification (i.e. removing unnecessary characters) of frontend code.

Maven[29] is a build automation tool for Java projects. In this project, it is mainly used for Java code compilation, dependency management, integration testing and packaging. Also, the application is started by a maven command.

Docker[30] simplifies the creation and operation of distributed systems. This technology is used during development of the software as well as in production. Docker runs on Linux[31] and isolates the execution environment of different software components, e.g. database and application. Docker containers are similar to virtual machines, but have the advantage of being hardware-agnostic, platform-agnostic and more lightweight. Due to the fact that the application Docker containers do not vary across different host environments, they cause less problems all over the software lifecycle.

At the moment of writing, the software is accessible on http://nbmf.biasion.eu. The application is deployed and managed on the Cloud PAAS Heroku[32] for demonstration and feedback purposes. The Heroku Cloud PAAS was chosen for simplicity reason but scaling up is expensive when compared to IAAS offers. An IAAS such as Amazon Web Services[33] or Digital Ocean[34] provides more flexible configurations for deployments at a lower price. The NBMF software is configured to run within Docker containers that can be deployed and scaled on IAAS servers with low efforts. The software architecture is already suited to serve thousands of users.

Documentation is done in form of Javadoc comments[35] in the Java source code and as Javascript comments in AngularJS code. Additionally, Swagger[36] is used to generate the documentation for the REST API from the Java source code. The data model is also documented in JDL and in derived JSON files.

[26] https://karma-runner.github.io

[27] http://docs.spring.io/spring/docs/current/spring-framework-reference/html/integration-testing.html

[28] http://gulpjs.com

[29] https://maven.apache.org

[30] https://www.docker.com/

[31] https://www.linux.com

[32] https://www.heroku.com/

[33] https://aws.amazon.com/

[34] https://www.digitalocean.com/

[35] https://docs.oracle.com/javase/8/docs/technotes/tools/windows/javadoc.html

[36] http://swagger.io/

CHAPTER 5

The NBMF Framework Applied in an Internet of Things Case Study

In this chapter, the NBMF Framework is illustrated by an IOT case study. The objectives and the scientific setup for the design of the case study are discussed in Section 5.1. In Section 5.2, an introduction to home automation is given before the stakeholders and characteristics of the industry are textually described. Finally, the case study is modelled in Section 5.3 by using the NBMF Design Tool.

5.1 Objectives and Design of the Case Study

The single case study presented in this chapter is descriptive and exploratory [Yin03]. It is designed within a realistic context by using multiple sources of evidence according to Robson [Rob93].

First and foremost, the case study shows the full functionality of the NBMF Design Tool as it was defined in RQ2. The modelling procedure of the NBMF including the mapping between the four phases has already been described in Section 4.4 based on simple examples. In Section 5.3, a complete case study is modelled with the NBMF Design Tool according to the description in Section 5.2.

Second, the case study is exploratory because influential constellations of BMs, i.e. NBBMs, may be discovered. As suggested in RQ3, the NBMF Design Tool may reveal insights into NBBMs in network-based markets such as the IOT. Although several scenarios with different goal settings have been proposed in RQ3, only a single NBBM is designed. One the one hand, the NBMF always follows the goal setting of providing value to the consumer by generating profit for the value creating stakeholder. On the other

hand, only one scenario, i.e. a single NBBM, was modelled due to the high complexity of NBBMs. The scientific setting of the case study is explained in the following paragraphs and the gathered insights about NBBMs in the IOT are presented in Section 6.2.

As described in Section 2.1, the research field of BMs evolved in the late 1990s. All of the BM ontologies and BM frameworks that are similar to the NBMF have even been published after the turn of the millennium as the following list shows:

- 2002: e3-value [Gor02]
- 2010: BMC [OP10] (based on the BMO 2004 [Ost04])
- 2013: St. Gallen Business Model Navigator [GFC13]
- 2014: Value Proposition Canvas [OPBS14]
- 2015: IoT Business Model Builder [Bos15]

When the proposal of the research questions of this master thesis was worded, the author aimed to reuse previously defined and conducted case studies from the literature. Due to the novelty in science, data of BMs and NBBMs is scarce. The BMC has ben applied for various case studies on BMs [OP10, MDOG13] and even for case studies on NBBMs [ZWB14, LN14]. Furthermore, case studies compare the capabilities of the BMC and e3-value [GOP05, DWHV15] to design NBBMs. Also, the BMC has also been applied in the context of IOT [JKA16]. The reuse of a single or of a combination of the here mentioned case studies would allow a comparison of the NBMF with other BM ontologies and BM frameworks in practice. A lot of fine-grained qualitative and quantitative data about customers, companies and the market is needed to complete all viewpoints of the NBMFF. However, the data of the case studies mentioned above is not sufficient to construct a complete case study for the NBMF.

The NBMF is strongly inspired by the IOT and hence, the case study presented in this chapter comprises a B2C scenario in the IOT. A scenario in the B2C field was chosen to collect as much data as possible. Consumer products and services can be observed relatively easy due to their worldwide attention in the media. Like the research area of BMs, also research area of IOT is evolving only in recent years. A study by Stojkoska and Trivodaliev [RT17] reveals that 130 scientific works have been published before 2010, whereas 7650 scientific works have been published between 2010 and 2016 with a title containing the keywords “Internet of Things”. Home automation is a major field of application for IOT technologies [SGFW10, BS11, PZCG14, WJ16]. As principally suggested by the NBMF, home automation solutions need to be designed with the consumer in mind, i.e. design thinking should be applied [Inc14a].

Also in the research area of home automation, case studies about BMs are scarce. Stojkoska and Trivod [RT17] propose a solution for a home automation system that is similar to the solution presented in this chapter. Even though the authors suggest a similar architecture as presented in Section 5.2, no suggestions for BMs are given. Solaimani et al. [SBI15] conducted a case study on a home automation ecosystem where the stakeholders are modelled similarly to the network graph in Phase 2 of the NBMF. The platform centric approach of the NBBM designed by Solaimani et al. is adopted in the case study presented in this chapter.

Furthermore, all five stakeholders proposed in Section 3.2 are part of the eight stakeholders modelled in the NBBM. The insights gathered during the analysis of the BMs of the stakeholders in Section 3.2 is applied to enhance the quality of the NBBM in this case study. As a consequence, also the differences when modelling a NBBM with the NBMF Design Tool in contrast to the design of single company BMCs can be observed.

The presented case study in the following section was composed without including experts in the field. To strengthen the scientific basis of the home automation case study, parts of the case studies presented in this section are included and extended whenever possible. Unfortunately, most quantitative parameters such as prices and stakeholder segment sizes had to be estimated on the basis of various non-scientific sources. The manufacturing prices are estimated according to prices found on Alibaba[1] and Quora[2]. The B2C product prices equal the prices of similar products on Amazon[3], BestBuy[4] or homepages of product sellers[5,6]. The B2C service prices are estimated by looking at prices on the Google Play Store[7]. Salaries are derived from Glassdoor[8]. The price for user data is very intransparent and no reliable sources could be found. Therefore, this price is only based on statements found in different online forums.

To conclude, the case study primarily shows the functionality of modelling NBBMs with the NBMF Design Tool. Furthermore, some insights into a potential NBBM for the IOT are revealed. Quantitative results, i.e. Income Statements, have to be interpreted with caution due to the unreliability of data sources in this case study.

[1] https://www.alibaba.com/
[2] https://www.quora.com/
[3] https://www.amazon.com/
[4] http://www.bestbuy.com/
[5] https://shop.smartthings.com/products/samsung-smartthings-hub
[6] https://nest.com/
[7] https://play.google.com
[8] http://glassdoor.com/

5.2 Home Automation Case Study: Description

The structure and the content of the case study presented in this section are reasoned in Section 5.1. A potential system architecture of a home automation system and some implications for the resulting NBBM are explained in Section 5.2.1. In the following Section 5.2.2, the background information to construct the case study and quantitative data to model the NBBM with the NBMF Design Tool are provided.

5.2.1 Introduction to Home Automation

Home automation is a major use case for the application of IOT technologies [Sta14]. The IOT technologies that are built into household products provide comfort to users by setting and adapting the environment to their habits accordingly. Also, consumption of resources such as electricity or water can be decreased, e.g. by using an intelligent thermostat [SGFW10]. Traditionally, the devices in a household are designed, produced and sold independently by different companies. The possibilities to extend and combine traditional products have been limited, e.g. light bulbs can not be controlled with a TV remote control, due to technical but also strategical reasons [AM15]. Nowadays, household products become more connected. The availability of standardised wireless networks, i.e. Wifi, enables devices to connect to the Internet. Devices include various technologies, e.g. sensors, and hence, pave the way for sophisticated applications [PH14].

Figure 5.1 shows how devices are interconnected in a home automation system as proposed by Stojkoska and Trivodaliev [RT17]. The single IOT devices in a household do not connect directly to the Internet. Usually, they connect to a Hub via wireless technologies such as Bluetooth[9], Wifi HaLow[10], Infrared[11], ZigBee[12] or similar. The Hub connects to the Internet over a router or a modem via Wifi or Lan [WJ16]. Most IOT devices have limited power supply in form of batteries or are work passively over induction. The devices use the unlimited power supply and the extended communication capabilities of the Hub to connect to the Internet. The Hub manages the devices, collects data and triggers events. Hence, the Hub acts as a gateway for the IOT devices [MMST16].

The Hub connects to the Hub Cloud, i.e. Servers of the Hub manufacturer. The Hub Cloud acts as an intermediary between a Remote Control and the Hub. It is characterised by an infrastructure with high performance and high availability [VER+15]. A mobile device, e.g. smartphone, can be used as Remote Control. On the one hand, the IOT devices can be controlled by the Remote Control, e.g. increase the temperature on a thermostat. On the other hand, information generated by the IOT devices can be consumed, e.g. average temperature over a time period [Sta14].

[9] http://www.ieee802.org/15/pub/TG1.html
[10] https://standards.ieee.org/develop/project/802.11ah.html
[11] http://www.irda.org/
[12] http://www.zigbee.org

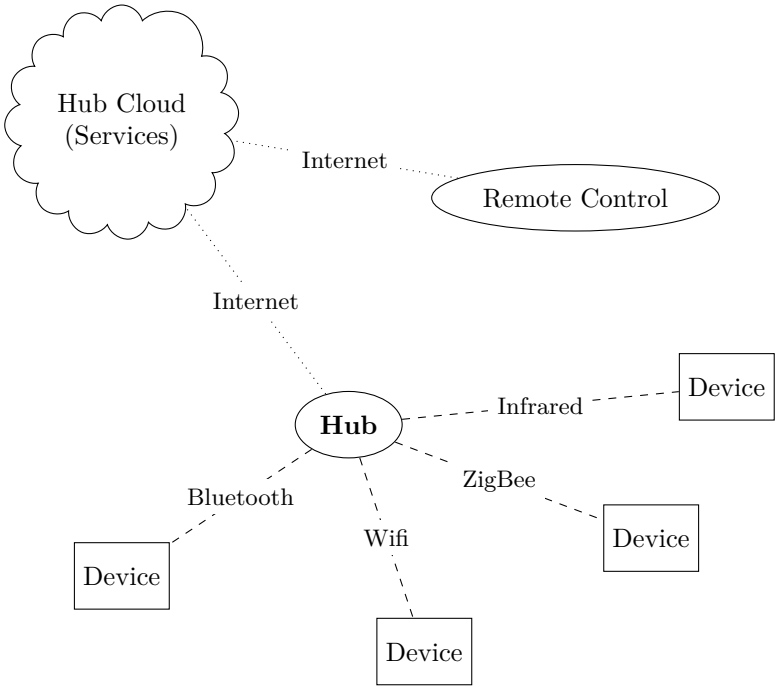


Figure 5.1: Architecture of a Home Automation System (adapted from [RT17])

The system architecture depicted in Figure 5.1 provides several advantages for companies providing the solutions and for customers using the solutions. Device manufacturers are able to ship products earlier and improve them over time. Traditionally, products needed to be tested extensively and features could not be improved after the product was shipped. Recalls in the case of technical problems are very expensive that can ruin a company. The connection to the Internet enables companies to update and improve their products remotely, even without notifying the customer. The possibility to apply changes after the delivery of the product matters because it lowers the risks for companies and it improves the customer experience at the same time. Products are not static objects anymore but they are improved over time [PH14].

The Hub manufacturer often offers a platform for IOT device manufacturers to connect their devices to the Hub. Device manufacturers only need to implement the standardised API that is proposed by the Hub manufacturer. This allows the device manufacturer to solely focus on the development of the hardware, while the Hub manufacturer is taking care of the connectivity to the Internet and the services built on top [KMO12]. This software architecture and the collaboration on the platform between the IOT device manufacturers and the Hub manufacturer open new possibilities for NBBMs. New services such as forecasting, analytics or process optimisation provide additional value to the customer [RT17]. The increasing value enables new possibilities for monetisation. The more products can be connected and the more additional services are provided, i.e. the greater the ecosystem around the Hub, the greater is the network-effect [AZ01]. On

top of the purchase price of devices, recurring revenue is generated with subscriptions for additional services. Also, with every new product or service a user purchases, an additional lock-in effect on a platform is created. Users hesitate to switch to a competitive platform because they already purchased products that are not compatible with other platforms [Rev14].

5.2.2 Stakeholders and Characteristics of the Hub Ecosystem

The case study describes the composition of stakeholders to realise a home automation system according to the system architecture shown in Figure 5.1 [SBI15, RT17]. Value propositions perceived by the customer and resulting financial transactions between companies and customers are specified. The case study includes eight stakeholders. Some are considered to be more and others are considered to be less important for the resulting NBBM:

(S1) *End User*: Is the consumer that makes use of the home automation system and the NBBM is driven by the End User. The involved companies have the ultimate goal to increase consumer satisfaction by solving the problems and addressing the needs of the End User. The End User may be a single person or a multi-person household. Technical interest and understanding are low or none existent. Therefore, the home automation system has to be very user-friendly by providing a GUI that increases the user experience and hides technical challenges. In this case study, the End User primarily wants to save heating costs and to increase security in his/her home. The solution to this needs has to provide a superior living comfort to be accepted by the End User.

(S2) *Hub Vendor*: Provides a modern and customisable solution in form of a home automation system to address the needs of the consumer. Due to the openness of the Hub Vendor to collaborate with other stakeholders, this stakeholder differentiates its home automation system from competitors. The Hub Vendor offers an App Store on its platform where all available services are presented. This App Store is innovative in comparison to other home automation system vendors because Online Service Providers can build own applications that use the Hub and devices that are connected to the Hub. All provided services run in the Hub Cloud, i.e. on the servers of the Hub Vendor. The Hub Vendor provides interfaces for its home automation system so 3rd party product manufacturers such as the Camera Vendor can integrate their products easily into the Hub Ecosystem.

(S3) *Camera Vendor*: Designs surveillance cameras that work with the home automation system by connecting them wirelessly to the Hub. The Camera Vendor is just one example of a company that offers a product for the Home Automation System. Other potential products could also be screens, motion sensors, light bulbs, sprinklers and household appliances.

(S4) *Online Service Provider*: Is a software company that implements services for the Home Automation System. Its services make use of data and capabilities of Hub and connected devices. E.g. a software detects persons on the images of the camera and triggers actions such as adjusting to the optimal temperature for all persons in the room.

(S5) Network Operator: Provides an Internet connection for the End User. A working Internet connection is required as a communication medium between the Hub and the Hub Cloud.

(S6) *Data Analyst*: Buys data from different sources, aggregates and analyses it. The data is then resold to the business customers of the Data Analyst. In this case study, the Data Analyst buys the data of End Users from the Hub Vendor.

(S7) *Product Manufacturer*: Produces the Hub for the Hub Vendor and the Camera for the Camera Vendor. The Product Manufacturer owns a factory to produce large volume batches of electronic products for different customers at the lowest possible price.

(S8) *Chip Manufacturer*: Is a high-tech company that designs computer chips and sells them to the Product Manufacturer.

The stakeholders S1, S2, S3 and S4 are inside the Network Boundary (similar to [SBI15]). Hence, these stakeholders are crucial for the success of the NBBM. The stakeholder S5, S6, S7 and S8 are outside the Network Boundary. They can be replaced easily and do not closely collaborate with stakeholders inside the Network Boundary.

Technically, the Hub Vendor sells a device with an included thermostat that collects data of the consumer by monitoring, e.g. the manually set temperature or routines. The collected data is sent to the Cloud infrastructure of the Hub Vendor [WTJ+11]. There the data is processed and by applying machine learning techniques the optimal settings for the thermostat are calculated. This knowledge is then used to automatically adapt the temperature to the consumer's preferences. Because of the knowledge about the consumer patterns, the potential of saving heating costs with such a smart device are superior to usual thermostats [Nes15]. The Hub device does not only include the thermostat but is also capable of connecting other devices via different wireless communication technologies. Thus, the Hub Vendor can offer additional IOT devices to the consumer that make use of the Hub. Such devices are usually cheap in production because they can make use of low energy and low-cost communication- and computation hardware [PH14]. Connectivity to the Hub, and hence also to the Internet, can be achieved easily, e.g. by pressing a button on the IOT device. No additional UI is needed because the device can now be managed over the GUI of the Hub [WJ16].

A consumer buys a product to solve a problem or to satisfy a desire. It is often not really important what exact features or what quality the product has. A product such as a thermostat or a camera for itself does not provide value for a consumer. Whereas the

capabilities of adapting to the desired temperature or the possibility to retain memories by taking pictures provide value [OPBS14]. Therefore, companies selling products need to communicate why the product will serve the consumer, i.e. what value it provides. The whole Hub Ecosystem is built on this approach. Products are not presented as physical devices to the End User but as a requirement for a service [Sin11]. In this case study, the targeted End User wants to save resources and increase security at his/her home. The End User may look for a solution to his/her problem by searching for "save heating costs" or "protection against burglars", not by searching for products such as "thermostat" or a "security camera". The Hub Ecosystem targets these consumer problems by providing a solution that is customisable and extendable.

To the consumer, the solution is presented as a service in the App Store of the Hub Vendor, e.g. "Save 10% heating and cooling costs". For the End User, it just matters *that* the solutions saves heating costs and at the same time increases comfort. It does not matter *how* it works. The price for the solution, e.g. a one-time setup cost of Euro 99.99 (similar to Samsung SmartThings Hub[13]), is really low. For the consumer, the investment is paying off in one year [Nes15]. The Hub Vendor sells the device for less than its production cost of Euro 110. The loss of Euro 10.01 can be interpreted as an investment in form of customer acquisition costs of the Hub Vendor because the sale of the device is just the beginning of a long lasting customer relationship. Once the Hub is installed at the End Users home, it is a lot easier to sell additional profit generating products and services, i.e. cross-selling [BEPV13].

For simplicity of the case study, the Hub Vendor holds several roles that are usually accomplished by different stakeholder because of its technical complexity:

- Hardware Provider: The hardware device, i.e. the Hub, is sold to and enables integration of other IOT devices [RT17].
- SAAS Provider: Software for the Hub and connected devices is developed by 3rd party developers. It is provided to consumers on a subscription basis on the Hub-App Store. The software makes use of the devices at the users home that are connected to the Hub. The software may be combined and reused in the form on a plugin system [AIM10]. The Hub Vendor manages the compensation, i.e. revenues, for the services sold in the App Store.
- Authorisation, Access Control, Security and Privacy: The Hub Cloud allows End User to register and authorise additional persons, e.g. the home automation system can be controlled by persons with different rights. Data transmission needs to be secure on all levels of the infrastructure. Also, the privacy of the End User has to be protected when using 3rd party software [Web10].

[13] `https://shop.smartthings.com/products/samsung-smartthings-hub`

- Identity Mapping, Preprocessing and Data Storage: Data arriving from a Hub at the Hub Cloud needs to be mapped to a certain identity, i.e. End User. Then the data needs to be preprocessed and stored persistently, e.g. in a database. Because of the diversity of the data in the system of the Hub Vendor data is often stored in data lakes by using different technologies [PH14].

Because of the huge variety of competencies and responsibilities, the Hub Vendor is crucial for the success of the NBBM. Building a platform such as the Hub Ecosystem is challenging but provides huge potentials for success in the long run. The Hub Vendor needs to attract both sides of the platform, i.e. consuming End Users and producing Service- and Product Providers [SBI15]. Increasing the user base by subsidising the Hub device and selling it cheaply to End Users, may convince Online Service Providers and Product Providers to join the Hub Ecosystem. Initially, the Hub Vendor needs seed capital to build up the platform and to finance the sale of the Hub at a loss [OP10]. Online Service providers may just make low revenue of their services and Product Vendors such as the Camera Vendor may sell few pieces until a critical mass of users is reached. Revenue increases exponentially while the platform scales and attracts more users [LBW16].

All value-creating Stakeholders in the Business Network need to support each other in their value-creating processes and offerings. From a marketing perspective, all value creating companies in the Business Network appear on the market as a consistent unit to promote the Hub Ecosystem. Collaboration focuses on the consumer and has the ultimate goal to provide better products and services to the End User [SS15].

The primary revenue streams in the Hub Ecosystem are building on recurring subscription fees. Traditionally, the main revenue stream for Product Vendors in the B2C market is the sales price of the product. The Hub Ecosystem promotes the possibility for Product Vendors to generate recurring revenue with their products. Hence, a product is provided as a service and offers new possibilities for Product Vendors. As also old devices still generate revenue, Product Vendors are interested in supporting and improving them [LWRS12]. For consumers, the cost for a value proposition is constant because a physical product is used longer (lower acquisition cost) but the service fees arise. Producers of products, i.e. Product Vendors, sell fewer devices because of the longer lifespan but compensate the lost profit with the recurring service fees. If multiple kinds of services build on top of a product, the Product Vendors have the opportunity to generate revenues from each of the services. E.g. a video camera can be used as surveillance camera but at the same time also serve as a motion detector for ambient lights. In contrast to today's practices such as planned obsolescence in physical products, it saves natural resources by promoting long-term use of physical products without sacrificing economic growth and welfare [PZCG14].

Recurring revenue for Product Vendors is enabled by a simple mechanism. Product Vendors implement the standardised open API of the Hub Vendor on their devices and provide it to the Hub Ecosystem. The functionality of devices, e.g. a camera taking a picture or measuring a sensor value, is abstracted and can be used at a service level.

Online Service Providers access functionality of devices by addressing the standardised open API [MMST16]. Whenever an online service makes use of the functionality of devices, the Product Vendor is compensated by the Online Service Provider [PZCG14].

In this case study, every End User purchases online services, so-called premium services, worth Euro 5.99 per month on average. As shown in Figure 5.2, 50% of the revenue, i.e. Euro 3.0, goes to the Online Service Provider. 5% of the revenue, i.e. Euro 0.3, goes to the Product Vendor that provides the functionality of its device to the Online Service Provider over the open API. The remaining 45% of the revenue, i.e. Euro 2.69, goes to the Hub Vendor for managing the Hub Ecosystem and providing the infrastructure. Thus, all stakeholders in the Business Network generate recurring revenue due to revenue sharing.

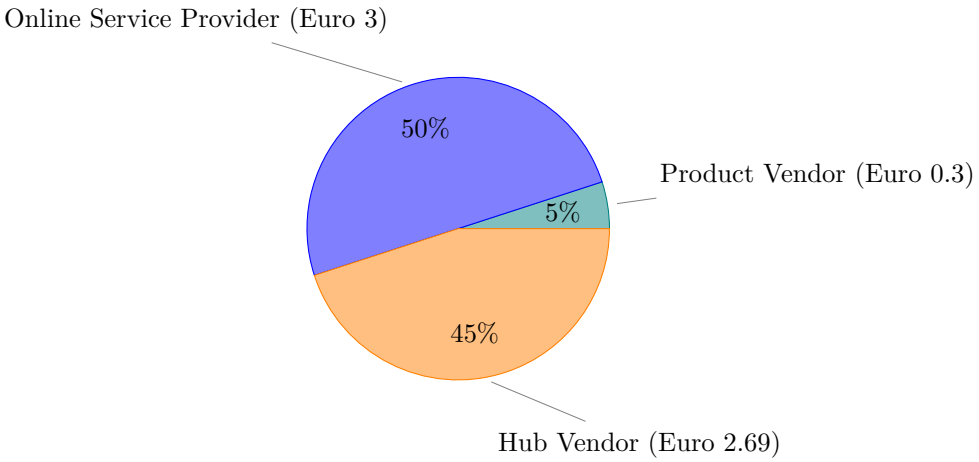


Figure 5.2: Revenue Sharing of Premium Service Revenue

From an outside perspective, all value-creating companies in the Business Network join forces. They appear on the market as one consistent unit to promote the Hub Ecosystem and compete with other solutions [GC14]. Inside the Hub Ecosystem, Online Service Providers compete against other Online Service Providers for the best service. Also, Product Vendors offering low-quality devices will be displaced by Product Vendors offering better hardware. Services as well as products are abstracted to such an extent that they can be exchanged easily like switching between different Email-Apps on a smartphone. A product is used by services of different Online Service Providers. A service uses products of different Product Vendors. This creates a many-to-many relationship between the stakeholders in the NBBM. Because the internal competition is healthy and barely any entry barriers for new companies exist, products and services improve constantly in an ecosystem. Finally, it is the consumer that benefits from innovative services and sustained, reliable and low-cost products.

5.3 Home Automation Case Study: Modelling with the NBMF Design Tool

The case study described in Section 5.2 is now modelled with the NBMF Design Tool[14]. The textual documentation is accompanied by screenshots of the web application. For details on the implementation of the Design Tool see Section 4.5.

The case study is not only presented in this master thesis. It can also be accessed by users of the web application and serve as inspiration on how to model NBBMs with the NBMF Design Tool. Users of the Design Tool can load and edit the example. All changes to the original example are persistently saved to the project portfolio of the user.

5.3.1 Phase 1: Consumer Needs

After the registration with a valid email address at the NBMF Design Tool, the user gets to the start screen of the application. A new *Business Network* for the Hub Ecosystem is created. The Hub Ecosystem plans to sell products and services *worldwide* and the *Currency* is set to *Euro*. The Income Statements are generated for the *Calculation Period* of *5 Years*. Figure 5.3 shows the created Business Network.

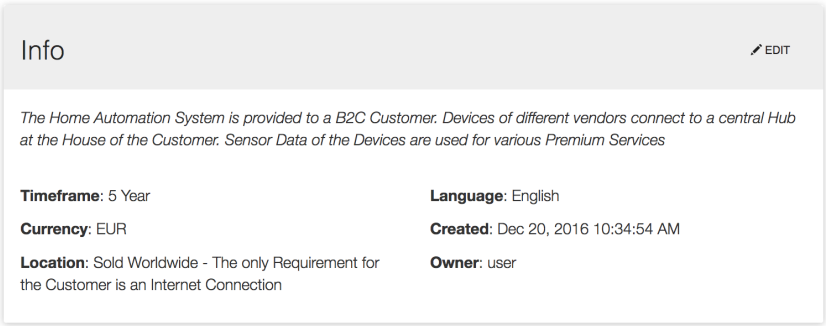


Figure 5.3: Home Automation Business Network

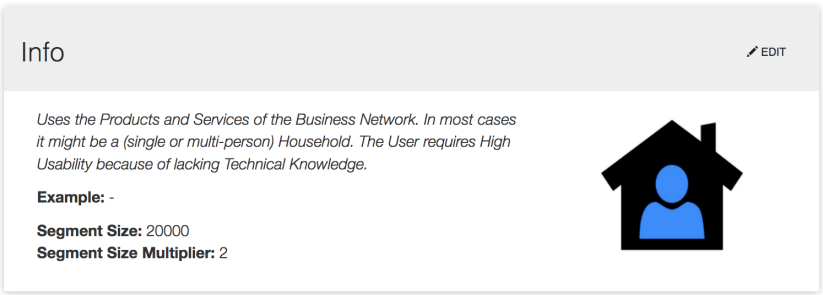


Figure 5.4: Home Automation Stakeholder - End User

[14] http://nbmf.biasion.eu

The consumers of the Hub Ecosystem are the End Users (S1) and Business Network has the ultimate purpose to serve this stakeholder. Therefore, the stakeholder S1 is created first as shown in Figure 5.4. The stakeholder has an initial *Segment Size* of *20,000* that it is expected to double every year (*Segment Size Multiplier* equals *2*). Hence, the Segment will grow to 40,000 End Users in the second year, to 80,000 End Users in the third year, to 160,000 End Users in the fourth year and to 320,000 End Users in the last year.

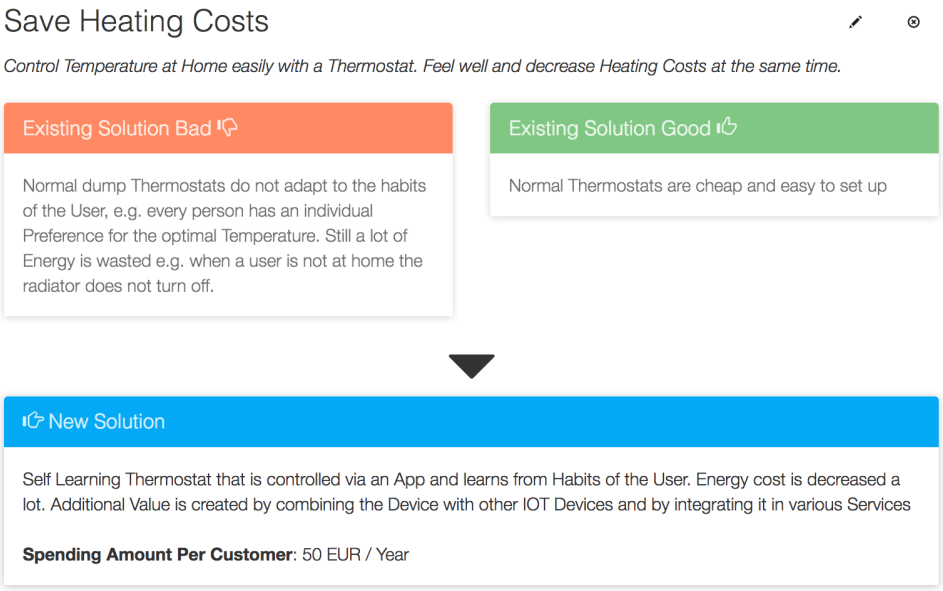


Figure 5.5: Home Automation Consumer Need - Thermostat

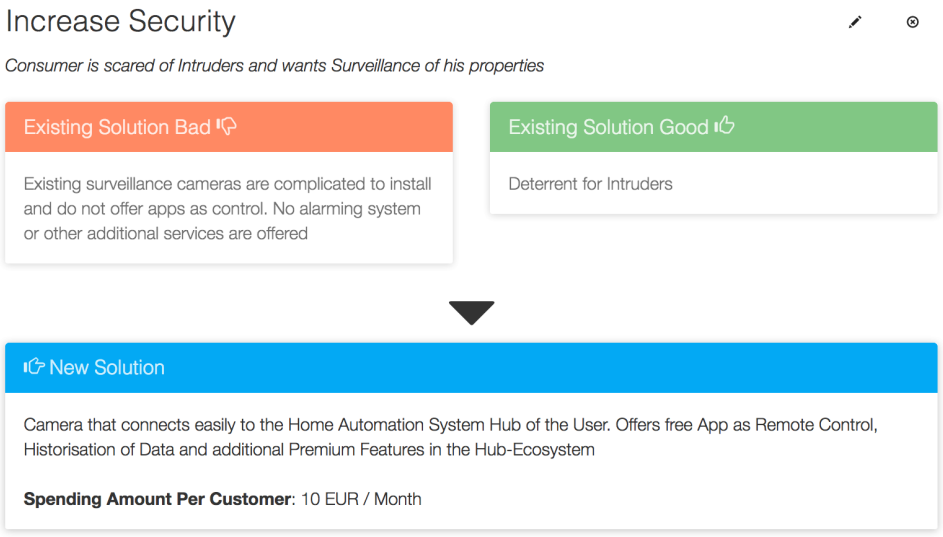


Figure 5.6: Home Automation Consumer Need - Camera

The End User has two Consumer Needs. The first Consumer Need is to *Save heating costs* as shown in Figure 5.5. Every End User could save about Euro 100 on heating and cooling costs a year when installing a smart Thermostat [Nes15]. Therefore it is estimated that an End User would pay *Euro 50 a year* for a solution. Hence, an End User would still save Euro 50 a year (Euro 100 savings minus Euro 50 for the solution). In addition, the End User also gets more comfort at its home.

The second Consumer Need is to *Increase Security* as shown in Figure 5.6. It is estimated that the End User may pay *Euro 10 a month* for surveilling its home and additional services such as data historicization or alerting.

When the Consumer Needs are determined and evaluated, Phase 1 is completed. The modelling process continues with Phase 2 where the solutions for the Consumer Needs are specified.

5.3.2 Phase 2: Network Solution

In this Phase, all Stakeholders and Value Transactions that solve the Consumer Needs are modelled. The final representation is a directed network graph where the Stakeholders are represented as the nodes of the graph. The Value Propositions are represented as the directed edges (arrows) that connect two Stakeholders with each other. The End User has already been created in Phase 1 together with its Consumer Needs. Therefore, this Stakeholder already appears as the first node in the network graph. The End User is the only consumer in this case study. All other Stakeholders are companies.

In the NBMF Design Tool, an image can be uploaded when a Stakeholder is created. The image is used as an icon for the Stakeholder to provide a visually appealing presentation on the network graph. Figure 5.7 shows the icons for each of the eight Stakeholders that are created in this case study.

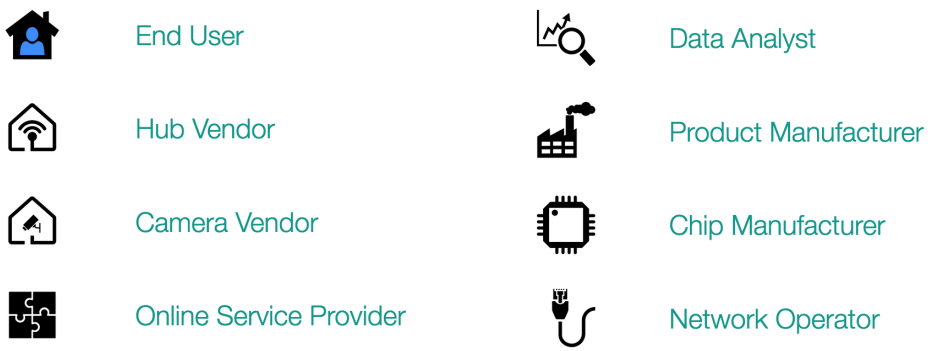


Figure 5.7: Home Automation Stakeholder Icons

The modelling in Phase 2 starts with the Stakeholder that provides the most important Value Propositions to the consumer. The *Hub Vendor* offers the Hub with an included Thermostat to help the End Users to save heating cost. Amazon and Samsung offer with the Echo[15] and SmartThings[16] a similar Value Proposition. Therefore, they could take the role of this Stakeholder. The Hub Vendor offers an End User the Value Proposition named *Hub Device with Thermostat*. It is the primary product that helps the End User to save heating cost. The End User pays the *Hub Sales Price of Euro 99.99* for this Value Proposition. The Hub can be controlled via the *Hub App* that is available for PCs or mobile devices such as smartphones or tablets. The Hub App can be downloaded from the App Store for free (*Hub App Price equals Euro 0*).

The *Camera Vendor* offers a *Camera* to the End User for a *Sales Price* of *Euro 69.99* that can be used for surveillance purposes as well as other applications. The Hub is required to use the camera because it is used to connect to the Internet and to enable the value-bringing applications. The camera is integrated into the Hub Ecosystem via an interface that is designed and managed by the Hub Vendor. The Hub Vendor provides specifications for the interfaces (Open API) to the Camera Vendor and other Product Vendors. The Camera Vendor makes use this specification and provides the *Open API Implementation* to the Hub Vendor. The implementation of the Open API allows the Hub and online services to access features such as taking a picture with the camera. The close collaboration with the Hub Vendor offers great advantages for the Camera Vendor. The Camera Vendor can fully focus on the development of the hardware, i.e. the Camera, and does not need to develop an own Cloud application for access management, camera features or similar tasks. Furthermore, the Hub Vendor is taking care of *Advertising* and sales promotion.

The *Online Service Provider* is a segment consisting of five Stakeholders. An Online Service Provider builds applications for the Hub Ecosystem. The *Open API Functionality* that is provided over the implementation of the Open API of Product Vendors such as the Camera Vendor abstracts the physical functionality of devices to a higher level. E.g. a face recognition software is developed that detects and recognises people within a room and adapts the temperature to a person's preferences. The Online Service Providers use the capabilities of the Thermostat in the Hub and of the Camera that is connected to the Hub. Hence, the Online Service Provider can purely focus on software development. Consequently, Online Service Providers develop applications for the Hub Ecosystem fast and with low cost. The applications of the Online Service Providers are advertised and sold in the Hub-App Store. Almost all applications are offered on a subscription basis to foster the "Everything as a Service" mindset of the Hub Ecosystem.

[15] https://www.amazon.com/Amazon-Echo-Bluetooth-Speaker-with-WiFi-Alexa/dp/B00X4WHP5E
[16] https://www.smartthings.com/

On average each End User purchases Premium Services of *Euro 7.99 per month*. 35% (Euro 2.8 per month) of every App Sale goes to the Online Service Provider. 5% (Euro 0.4 per month) goes to the Camera Vendor that offers the functionality of the camera to the Online Service Provider. 60% (Euro 4.79 per month) of the App Sale Revenue are earned by the Hub Vendor.

Transaction fees in app stores for smartphone applications such as the Apple App Store[17] or the Google Play Store[18] are about 30% and developers earn about 70% of the generated revenue. In this IOT case study, the transaction fees of the Hub Vendor are so high because of its versatile roles explained in Section 5.2.2. Besides solving many technological challenges, the Hub Vendor also takes investments for marketing and sales to foster the Hub Ecosystem. Also, the Hub Vendor sells the Hub Device at a loss to attract new End Users. As the main revenue model of the Hub Ecosystem is based on recurring subscriptions, all stakeholders (Hub Vendor, Camera Vendor and Online Service Provider) have to improve and promote the Hub Ecosystem together to compete with other Home Automation Systems.

Figure 5.8 shows the stakeholders that have been modelled so far. Only these stakeholders are inside the Network Boundary (see Section 4.4.2) and provide the most important Value Proposition to the consumer.

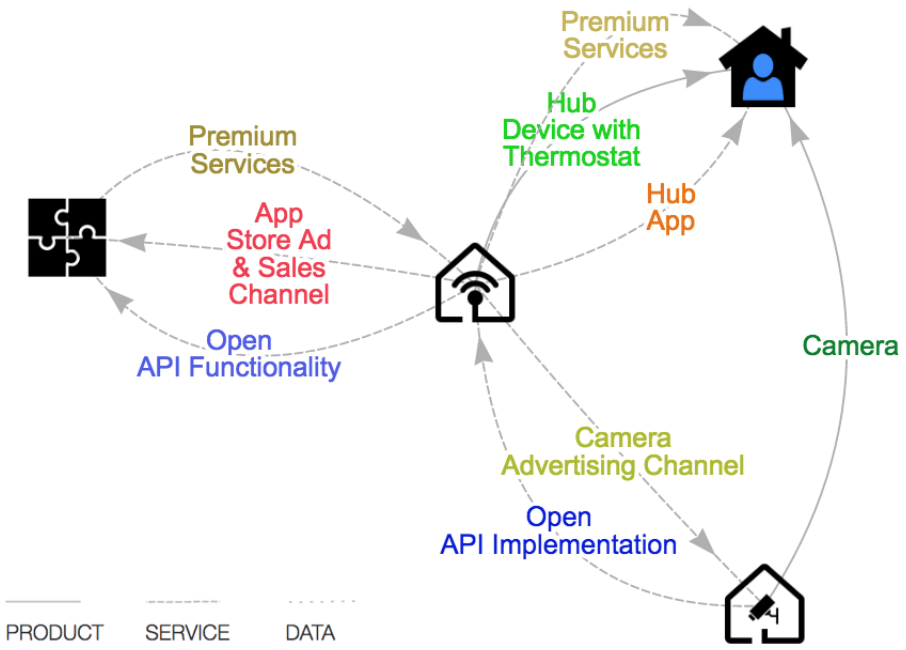


Figure 5.8: Home Automation Network Graph - Stakeholders inside the Network Boundary

[17] https://developer.apple.com/programs/whats-included/
[18] https://support.google.com/googleplay/android-developer/answer/112622?hl=en

As the hardware devices are not manufactured by the Hub Vendor and the Camera Vendor themselves, they need a partner for the manufacturing: the *Product Manufacturer*. The Product Manufacturer buys computer chips and sensors from the *Chip Manufacturer*. The *Chips for the Camera* cost *Euro 30* and *Chips for the Hub* cost *Euro 70*. The Product Manufacturer uses the designs and the chips to manufacture the devices in its factory. The Product Manufacturer sells each *Camera* for *Euro 60* to the Camera Vendor and each *Hub* for *Euro 110* to the Hub Vendor.

The End User requires an *Internet Connection* to use the Home Automation System. The *Network Operator* offers such a service for recurring subscription of *Euro 30 per month* and a one-time setup cost of *Euro 50* to the End User.

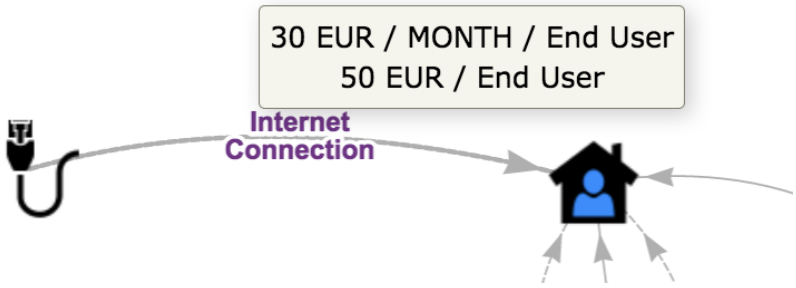


Figure 5.9: Home Automation Network Graph - Financial Transaction Pop-Up

The home automation system produces a high amount of data that provides insights into the behaviour and preferences of the End Users. The *User Data* is sold by the Hub Vendor to the *Data Analyst*. The Data Analyst is a segment that consists of 3 single stakeholders. Each Data Analyst pays *Euro 0.14 per month* for each End User to the Hub Vendor.

Figure 5.10 shows all Value Transactions that have been modelled in this case study. Each box in the figure represents a Value Proposition. The header of a box contains the title and is painted in the colour of the Value Proposition that was chosen during the design process. The content of a box contains the Value Transactions that compensate the Value Proposition. A Value Proposition can be compensated with no Value Transaction, e.g. Camera Advertising Chanel, with one Value Transaction, e.g. Camera, or with multiple Value Transactions, e.g. Internet Connection.

Figure 5.11 shows the Business Network in form of a network graph at the end of Phase 2. The stakeholders are represented by the images that were presented in Figure 5.7. The arrows denote the Value Propositions that flow between the stakeholders. The same colour that signals the Value Propositions in Figure 5.10 is used in the graphical illustration of the Business Network in Figure 5.11. The style of the arrow determines the type of an exchanged Value Proposition. A solid line designates a product, a dashed line designates a service and a dotted line designates data.

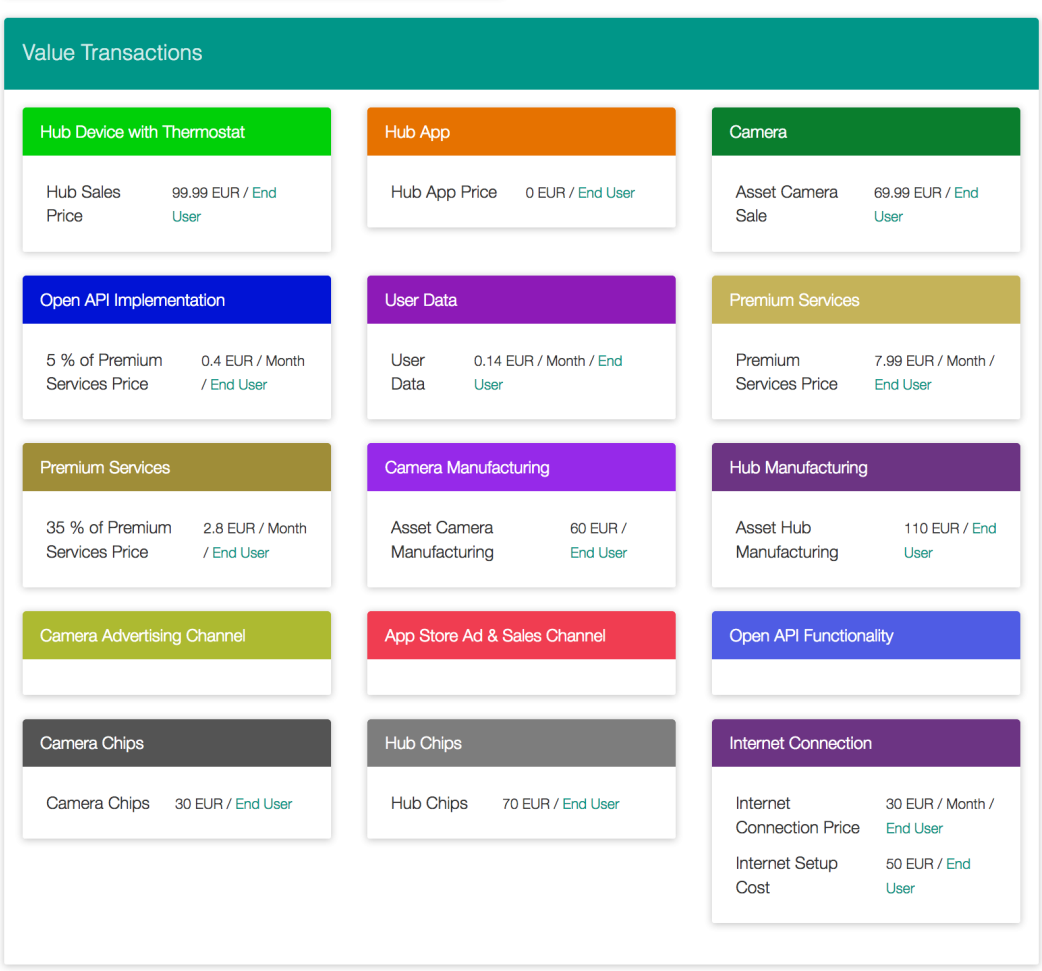


Figure 5.10: Home Automation Business Network - Value Transactions

The network graph in Figure 5.11 is built automatically from inserted Stakeholders and Value Propositions. By moving and zooming, the representation of the network graph can be adapted. To foster creativity and innovative thinking, the network graph is also interactive. By clicking on the network graph, the interaction feature is activated. Nodes, i.e. the Stakeholders, can be moved around via drag & drop to change the arrangement of the network graph. When clicking on a Value Proposition, a pop-up window shows up that denotes the corresponding Financial Transaction. Figure 5.9 shows the pop-up window above a Value Proposition containing two corresponding Financial Transactions.

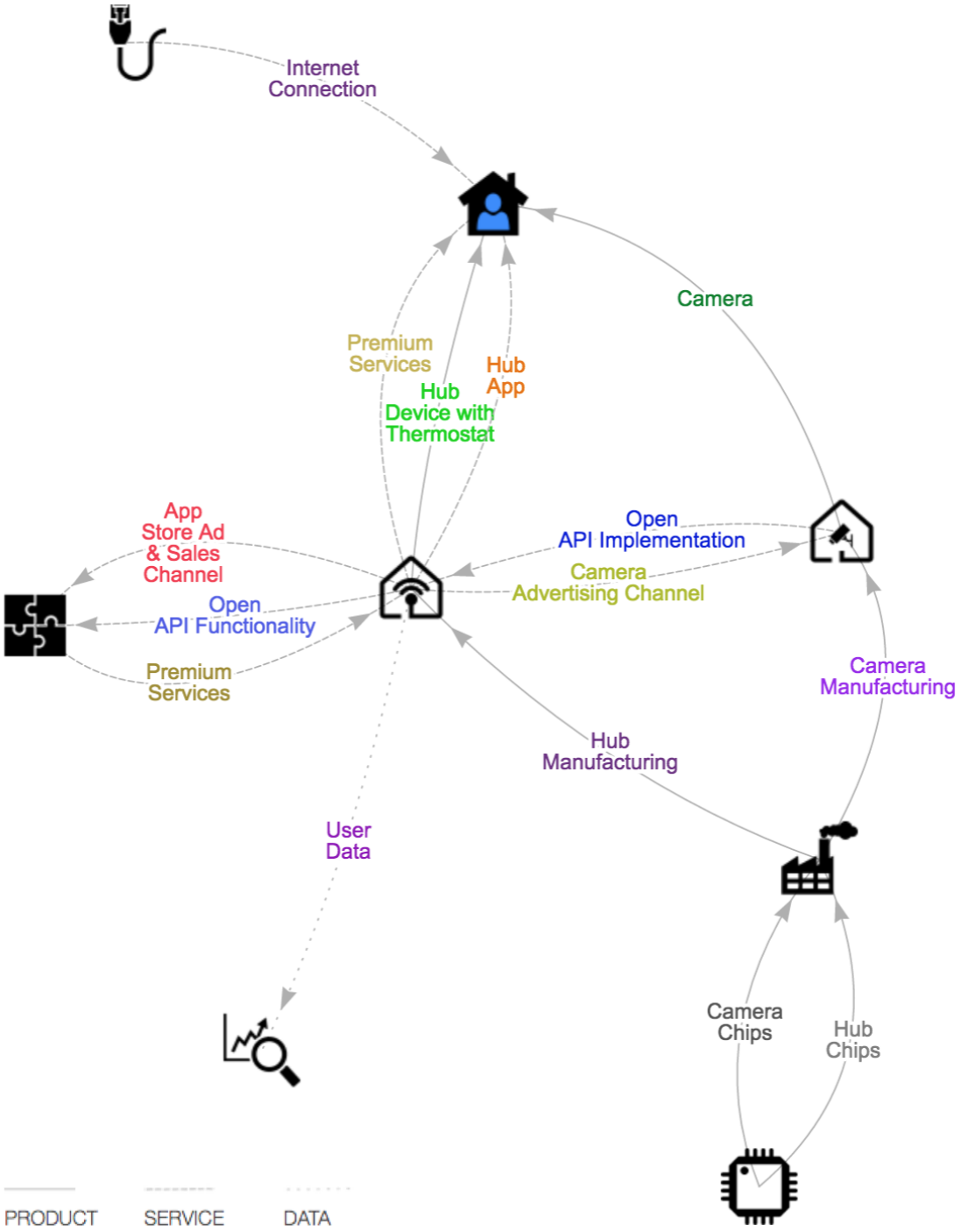


Figure 5.11: Home Automation Network Graph - Completed

5.3.3 Phase 3: Company Business Model Canvas

In this Phase, the BMC of every value-creating Stakeholder is elaborated to break down the network structure and to form concrete actions for the single Stakeholders. All elements created in Phase 2 are mapped onto the BMC of the single Stakeholders as explained in Section 4.4.3. Figure 5.12 shows an example of how elements are mapped from the network graph to a BMC. In this example, all Value Propositions and Financial Transactions that involve the Camera Vendor are mapped to the corresponding blocks of the Camera Vendor's BMC. Colours stay the same across the different phases and are a consistent optical recognition factor for the single elements. In the case study, the Hub Vendor provides the Camera Advertising Channel to the Camera Vendor. The Camera Advertising Channel represents a Value Proposition for the Hub Vendor and a Channel for the Camera Vendor. Hence, the Camera Advertising Channel is mapped to a Channels element and the Hub Vendor is displayed as a Key Partner on the BMC of the Camera Vendor as shown in Figure 5.12. The Camera Advertising Channel is provided without a compensating Financial Transaction to the Camera Vendor. Therefore, no cost related to the Camera Advertising Channel appears in the cost block of the BMC. The Camera Vendor provides the Value Proposition named Open API Implementation to the Hub Vendor. Hence, the Open API Implementation is displayed in the Value Propositions building block and the Hub Vendor is displayed in the Customers building block of the Camera Vendor's BMC. As compensation for the Open API implementation, the Camera Vendor receives 5% of the Premium Service Sales Price of all Premium Services. Similarly, the Value Propositions Camera and Camera Manufacturing are mapped onto the BMC of the Camera Vendor as shown in Figure 5.12. All the mappings described in this paragraph are accomplished automatically by the NBMF Design Tool.

Now, the missing building blocks of the Camera Vendor BMC that describe how the Value Propositions are provided and how the company is run, need to be completed. Most importantly, the Camera Vendor needs *Human Resources* that are mainly used for Key Activities such as the *Hardware Design* and the *Firmware and Software*, e.g. for the Open API implementation. The Camera Vendor spends *Euro 600,000/year* for these Human Resources. Since the consumers interact almost exclusively with the Hub Vendor, no close Customer Relationships exists. Consumers buy the Camera in the Online Store of the Camera Vendor (*Self Service*). *After Sales Support* is provided on the website with guides and tutorials. Just in rare cases of technical problems, direct customer contact is necessary. Figure 5.13 shows the final BMC of the Camera Vendor.

The BM of the Camera Vendor is classified to different BM patterns of the St. Gallen Business Model Navigator (see Section 4.3.11). Due to the online sales process and the independent installation by the End User, the BM of the Camera Vendor can be classified as *E-Commerce*. The Camera is also sold at a relatively low price to attract customers. Most customers will buy premium services to extend the functionality of the Camera such as storage or special alerts. This strategy is known as *Add-On* BM pattern and due to recurring Premium Services revenues, it is also classified *Subscription* pattern. The compensation for the Camera Vendor in form of a 5% share of the premium services is

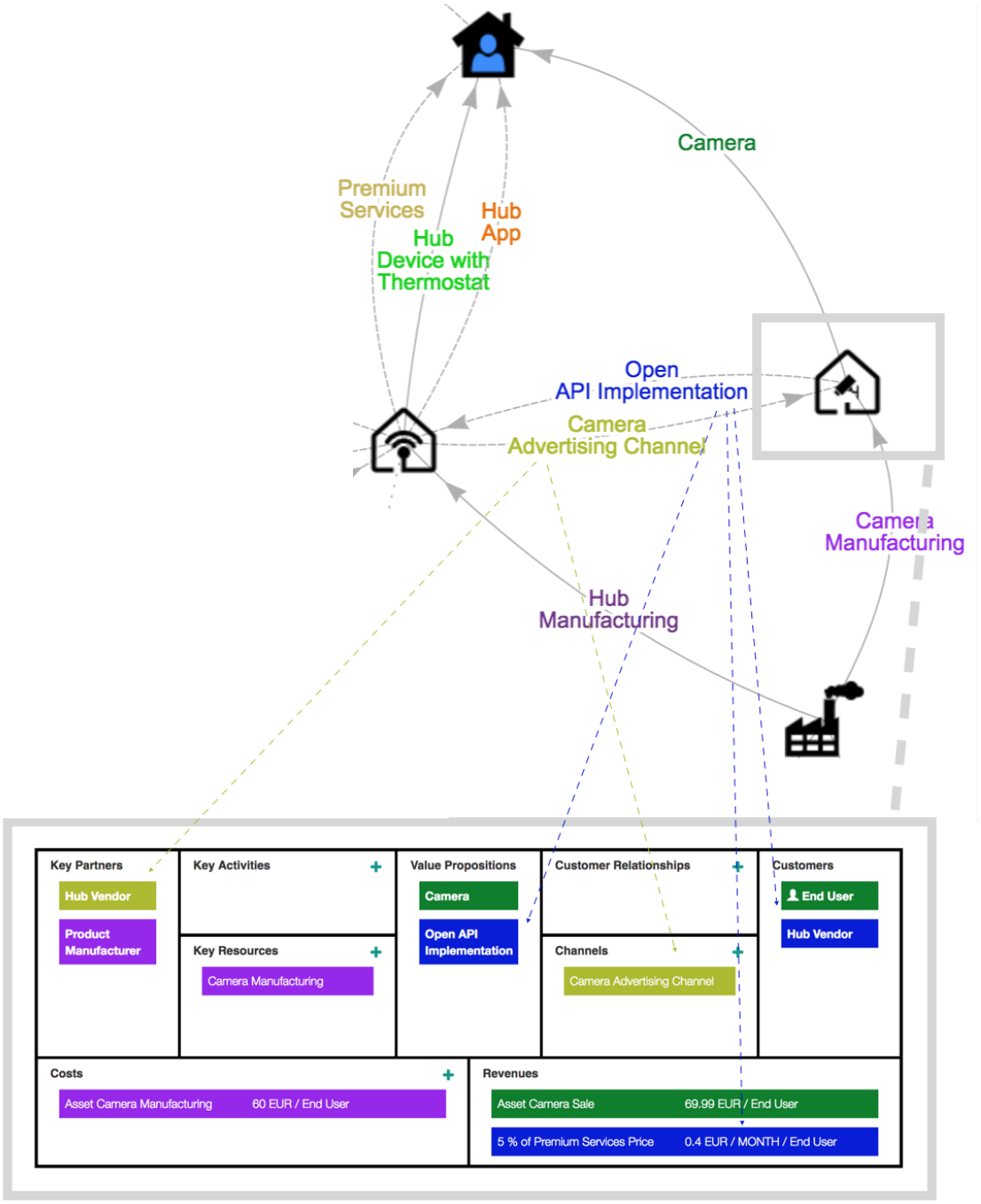


Figure 5.12: Home Automation - Example Mapping the Network Graph to the BMC of the Camera Vendor

not evident to consumers. Therefore, this BM pattern is called *Hidden Revenue*. Like all other Stakeholders within the network boundary, the Camera Vendor is characterised by an *Open Business Model* pattern due to the strong collaboration in the Ecosystem.

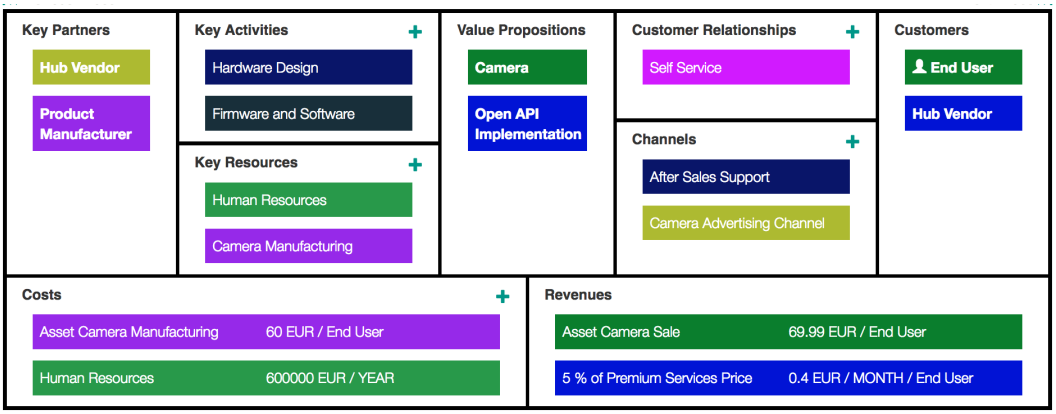


Figure 5.13: Home Automation - BMC of the Camera Vendor

The Hub Vendor is in the center of the Business Network and coordinates other Stakeholders. To provide all the Value Propositions, the capabilities of the Hub Vendor are versatile. The final BMC of the Hub Vendor can be seen in Figure 5.14. In case a customer receives multiple Value Propositions, the element in the Customers building block takes the colour of the first Value Proposition appearing in the Value Propositions building block. E.g. in Figure 5.14 the End User element takes the green colour of the Hub Device with Thermostat, even if the Value Propositions Hub App (orange) and Premium Services (olive green) also belong to the same customer. The Hub Vendor invests *Euro 1,700,000/year* in *Human Resources*. One of the Key Activities of the Hub Vendor is the *Hub Design* that is used by the Product Manufacturer to manufacture the Hub Device. Important Key Activities are also the *Platform Development*, i.e. the design of the API and implementation of the App Store, and the *Platform Promotion*, i.e. the propagation of the Hub Ecosystem on different media channels. For Platform Promotion and Marketing Activities the Hub Vendor spends *Euro 1,500,000/year*. The Customer Relationships are mostly *Automated Relations*. A recommender system is used to suggest new products and services to the End User. The Hub Vendor aims to build a *Co-creating Community* and involve End Users into internal processes for feedback and improvement purposes. Online material and guides are the main means of *Customer Support*, but also Email, Chat and Phone contact is provided. On average, the Customer Support costs *Euro 0.16/month/End User*. The main *Advertising Channels* are online, i.e. the own website and online ads. Furthermore, also traditional media channels such as TV are considered to target a broad market. The main sales channel is the Hub *App Store* where premium services are sold. The Hub App Store is also the main channel for the Online Service Providers because it is the only place to generate revenue.

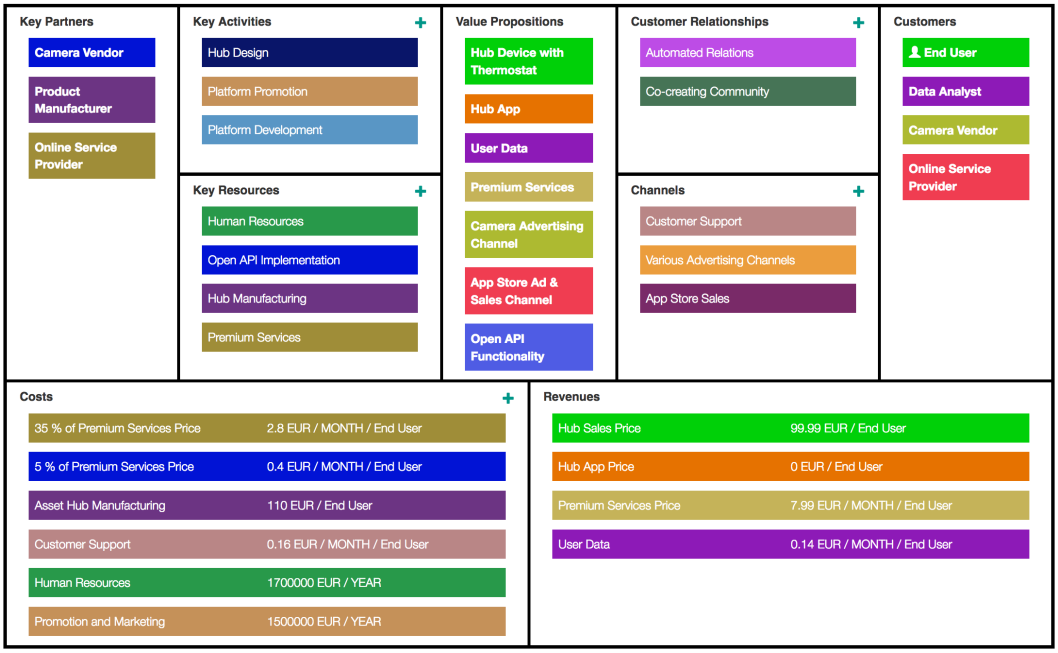


Figure 5.14: Home Automation - BMC of the Hub Vendor

The sale of the Hub Device at a loss is characterising for the *Razor and Blade* BM pattern of the St. Gallen Business Model Navigator. The Hub Device opens new possibilities for the Hub Ecosystem to sell additional devices and premium services. This sales strategy is known as *Cross-Selling*. Premium services sold in the Hub App Store generate recurring revenue, i.e. *Subscriptions*. The revenue of premium services is shared between the Hub Vendor, the Online Service Provider and the Camera Vendor. This *Revenue Sharing* promotes collaboration between the Stakeholders and in turn denotes an *Open Business Model*. The Hub Vendor acts as an *Integrator*, as it collects data generated in the Hub Ecosystem and provides a platform for Online Service Providers and Product Vendors. For the consumers, the Hub Vendor is a *Solution-Provider*, as it offers a broad range of solutions for Home Automation. The more products consumer purchase, the stronger the *Lock-In* effect becomes due to increasing switching costs. Finally, the sale of customer data to the Data Analyst also denotes the *Leverage Customer Data*.

Figure 5.15 shows the final BMC of the Online Service Provider. The most important and also most expensive Key Resource for the Online Service Provider are *Human Resources*. This Key Resource costs *Euro 500,000* that is spent for software developers. Other business activities such as marketing and sales are outsourced to the Hub Vendor. The Online Service Provider does not own *IT-Infrastructure* but makes use of PAAS and IAAS offers. As a consequence, no initial investments have to be taken and services can be scaled easily. Therefore, the cost for the IT-Infrastructure is calculated on a user basis, i.e. *Euro 0.15/month/End User*. The only Key Activity of the Online Service Provider is *Software Development*. Developers have access to user data of End Users produced in the

Hub Ecosystem. They are also able to control third party devices that are connected to the Hub of an End User. Premium services can be developed in less time because they can be composed of other premium services and revenues are generated when a premium service is used by other Online Service Providers. Customer Relationships to End Users are *automated* within the offered service. In most cases, no direct communication to the End Users exists because the premium service is advertised and sold in the Hub App Store.

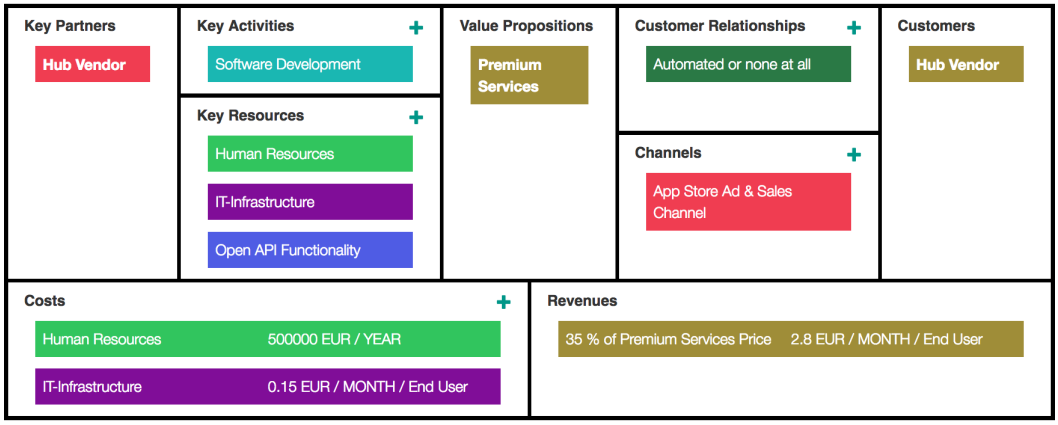


Figure 5.15: Home Automation - BMC of the Online Service Provider

The premium services are highly customisable, even if no direct communication between the Online Service Provider and the End Users exists. Numerous possibilities for customisation of digital services such as recommender systems are used for *Mass Customization*. Often the premium services replace physical products. E.g. the surveillance and historicisation features in premium services that make use of the camera may replace the need for a local video monitoring station at the user's place. Hence, the BM of the Online Service Provider is characterised by the *Digitization* BM pattern. As described above, premium services can be composed of third-party premium services. This allows Online Service Providers to focus on their core competences while making use of *Licenses* of other Online Service Providers. The revenue generated by premium services is recurring as described in the *Subscription* BM pattern and the collaboration of the stakeholders fosters an *Open Business Model*.

The BMCs of the Data Analyst, of the Product Manufacturer, of the Chip Manufacturer and the Network Operator, are not modelled in this case study because these Stakeholders are not crucial for the NBBM. They are outside the network boundary and the success of the resulting NBBM does not depend on them. Also, consumers such as the End User are not modelled in the form of a BMC because consumers do not have internal structures and building blocks like companies [OP10].

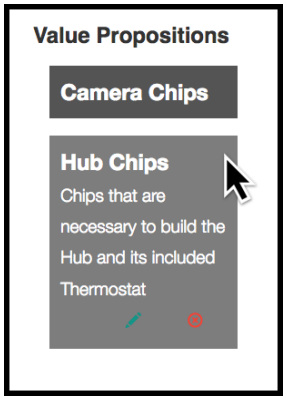


Figure 5.16: Home Automation - BMC Element Description

A BMC in the NBMF Design Tool is interactive. By hovering over (or on mobile devices clicking on) the elements in the building blocks, the description of the element appears and the element can be edited or deleted. Figure 5.16 shows the description of a Value Proposition element in a BMC by hovering over it.

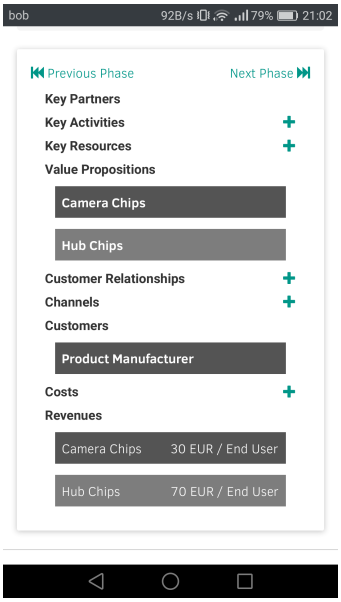


Figure 5.17: Home Automation - BMC View on a Smartphone

Due to the limited screen size on mobile devices, it is recommended to model Phase 3 of the NMBF on a computer screen. On mobile devices, the original view of the BMC is transformed into a simple list of the nine building blocks. This avoids zooming in and out on small screens but changes the vertical alignment of the BMC building blocks. Figure 5.17 shows the BMC of the Chip Manufacturer displayed on a smartphone.

5.3.4 Phase 4: Viability Check

In Phase 4, the NBBM is reviewed and previous design decisions are reflected. The NBMF Design Tool provides an automated evaluation feature for a BM by mapping all elements that appear in the Costs block and Revenues block of a BMC to an Income Statement. For every Stakeholder of the NBBM, an Income Statement is generated. Costs and revenues are derived from Financial Transactions inserted in Phase 2 and from Costs inserted in Phase 3. Hence, all elements of a Stakeholder that appear in the Cost building block and the Revenue building block of the BMC are mapped onto the Income Statement. Cost and Revenues are aggregated over the timespan that was set in Phase 1 as Calculation Period attribute in the Business Network element. An Income Statement in the NBMF is perceived from the point of view of a single Stakeholder, also if a Stakeholder is part of a Stakeholder segment.

The first column of the cost section in the Income Statement depicts the title either of the Financial Transaction inserted in Phase 2 or of the Cost inserted in Phase 3. The second column shows the Receiving Stakeholder in the case of a Financial Transaction element, i.e. the Stakeholder who gets the revenue from the Financial Transaction. The second column is empty in the case of a Cost element because a Cost is related to only a single Stakeholder. The third column denotes the price of the Financial Transaction or the Cost. The last column of the Cost section shows the total cost aggregated over all Calculation Periods. Column one, three and four of the revenue section are similar to the columns of the cost section. The second column of the revenue section shows the Paying Stakeholder, i.e. the Stakeholder who brings the incoming revenue.

By default, the Income Statement only shows the four column mentioned above. The "Show Details" button at the top of the page reveals in addition also the cost and revenue per Calculation Period. In this case study, the Calculation Periods timespan is set to 5 years (see Section 5.3.1). Therefore, five more columns (one for each year) appear when clicking the "Show Details" button. To hide the columns again, the "Hide Details" button needs to be clicked.

Figure 5.18 shows the Income Statement of the Hub Vendor in the detailed view. The first entry in the revenue section is the revenue of Euro 99.99 generated with the sale of the Hub Device. In the first year, this revenue amounts to Euro 1,999,800. The amount is calculated in the first by multiplying the sales price of Euro 99.99 with 20,000 End Users (the Segment Size of the End User). The End User segment grows with 100% (Segment Size Multiplier is 2) to the Segment Size of 40,000 End Users in year 2. In year 2, the revenue of the Hub Sale is again Euro 1,999,800 generated by new End Users in the Segment (40,000 - 20,000). In year 3, the segment grows again by 100% to 80,000 End Users. Consequently, the sales revenue of the Hub Device in year 3 grows to Euro 3,999,800 by multiplying the new 40,0000 End Users with Euro 99.99. In the following years, the revenues are calculated similarly. The revenues of all years are at the end added to the Total Revenue for the Hub Sales Price of Euro 31,996,800.

HIDE DETAILS

Costs

Title	Receiving Stakeholder	Price	Year 1	Year 2	Year 3	Year 4	Year 5	Total Costs
35 % of Premium Services Price	Online Service Provider	2.8 EUR / MONTH / End User	672,000	1,344,000	2,688,000	5,376,000	10,752,000	20,832,000
5 % of Premium Services Price	Camera Vendor	0.4 EUR / MONTH / End User	96,000	192,000	384,000	768,000	1,536,000	2,976,000
Asset Hub Manufacturing	Product Manufacturer	110 EUR / End User	2,200,000	2,200,000	4,400,000	8,800,000	17,600,000	35,200,000
Customer Support	-	0.16 EUR / MONTH / End User	38,400	76,800	153,600	307,200	614,400	1,190,400
Human Resources	-	1700000 EUR / YEAR	1,700,000	1,700,000	1,700,000	1,700,000	1,700,000	8,500,000
Promotion and Marketing	-	1500000 EUR / YEAR	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	7,500,000
		Total	**6,206,400**	**7,012,800**	**10,825,600**	**18,451,200**	**33,702,400**	**76,198,400**

Revenues

Title	Paying Stakeholder	Price	Year 1	Year 2	Year 3	Year 4	Year 5	Total Revenues
Hub Sales Price	End User	99.99 EUR	1,999,800	1,999,800	3,999,600	7,999,200	15,998,400	31,996,800
Hub App Price	End User	0 EUR	0	0	0	0	0	0
Premium Services Price	End User	7.99 EUR / MONTH	1,917,600	3,835,200	7,670,400	15,340,800	30,681,600	59,445,600
User Data	Data Analyst	0.14 EUR / MONTH / End User	33,600	67,200	134,400	268,800	537,600	1,041,600
		Total	**3,951,000**	**5,902,200**	**11,804,400**	**23,608,800**	**47,217,600**	**92,484,000**

Net Income

	Total	**-2,255,400**	**-1,110,600**	**978,800**	**5,157,600**	**13,515,200**	**16,285,600**

Figure 5.18: Home Automation - Income Statement of the Hub Vendor

The revenue from recurring Financial Transactions is calculated similarly to the revenue from one-time Financial Transactions but with one main difference. In the case of one-time purchases such as the Hub Sale, only new customers generate the revenue. In the case of recurring services such as the Premium Services, new customers but especially also existing customers generate the revenue. E.g. as shown in Figure 5.18, Euro 7,670,400 are generated in year 3 with Premium Services by multiplying all 80,000 End Users with the Premium Sales Price of Euro 7.99/month. In contrast, the revenue of the Hub Sale in year 3 is calculated by multiplying the new 40,000 End Users of year 3 with the Hub Sales Price of Euro 99.99.

User Data generates little revenue in this case study. With a growing user base and an increasing amount of sensor data the price per End User will increase further. The price of Euro 0.14/month/End User can amount to a multiple with the growth of the Hub Ecosystem. Furthermore, the End User data is a valuable internal asset for the Hub Ecosystem because premium services can be improved and additional revenue can be generated by providing better recommendations. Hence, the full revenue-generating and value-generating potentials of data are not shown in this case study.

The revenue of premium services is shared between the Stakeholder of the NBBM. The Hub Vendor gets 60% of the revenue generated by premium services. A 35% share of the premium services' revenue goes to the Online Service Provider that implemented the service. 5% of the premium services' revenue goes to the Camera Vendor because its API is used by the Premium Services. The main cost in the Income Statement of the Hub Vendor is the manufacturing of the Hub Device. The manufacturing of the Hub is a one-time cost that is calculated on a user basis. The total cost for the manufacturing accounts to Euro 35,200,000. The cost of Euro 8,500,000 for Human Resources and the cost of Euro 7,500,000 for Promotion and Marketing can be interpreted as fixed costs. These fixed costs recur each year and are constant over time. In contrast to fixed costs, the cost of Customer Support increase with the growing segment size of End Users. Thus, Customer Support can be interpreted as a variable cost.

In total, the Hub Vendor generates Euro 92,484,000 in revenue and spends Euro 76,198,400. This results in a profit of Euro 16,285,600. Therefore, the NBBM is not only viable (positive Net Income) but also provides a high return on investment from the perspective of the Hub Vendor. The Net Income of the Hub Vendor also shows an increasing trend over time. In year 1 and year 2, the Hub Vendor makes a loss because the high fix cost (Human Resources, Promotion and Marketing) can not be compensated by the sales of the Premium Services. Ongoing from year 3, the Hub Vendor makes enough profit to cover the cost.

HIDE DETAILS

Costs

Title	*Receiving Stakeholder*	*Price*	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Total Costs*
Asset Camera Manufacturing	Product Manufacturer	60 EUR / End User	1,200,000	1,200,000	2,400,000	4,800,000	9,600,000	19,200,000
Human Resources	-	600000 EUR / YEAR	600,000	600,000	600,000	600,000	600,000	3,000,000
		Total	**1,800,000**	**1,800,000**	**3,000,000**	**5,400,000**	**10,200,000**	**22,200,000**

Revenues

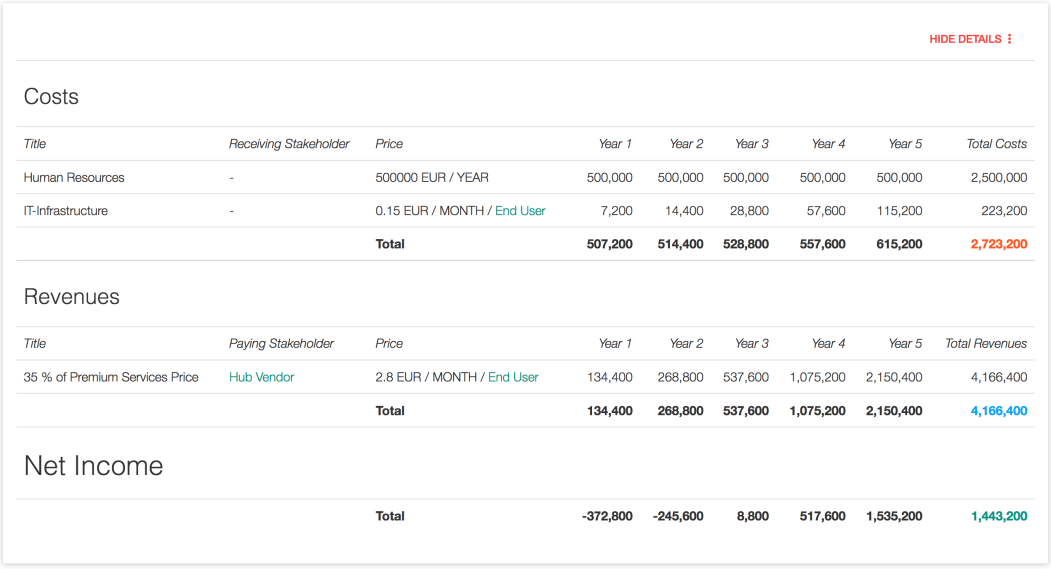
Title	*Paying Stakeholder*	*Price*	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Total Revenues*
Asset Camera Sale	End User	69.99 EUR	1,399,800	1,399,800	2,799,600	5,599,200	11,198,400	22,396,800
5 % of Premium Services Price	Hub Vendor	0.4 EUR / MONTH / End User	96,000	192,000	384,000	768,000	1,536,000	2,976,000
		Total	**1,495,800**	**1,591,800**	**3,183,600**	**6,367,200**	**12,734,400**	**25,372,800**

Net Income

	Total	**-304,200**	**-208,200**	**183,600**	**967,200**	**2,534,400**	**3,172,800**

Figure 5.19: Home Automation - Income Statement of the Camera Vendor

Figure 5.19 shows the Income Statement of the Camera Vendor. The only fix cost that applies to the Camera Vendor is the cost for Human Resources of Euro 600,000 per year. The main cost of the Camera Vendor is the outsourced manufacturing of the camera. In this case study, it is assumed that every End User buys one camera. The manufacturing cost for the camera is Euro 60 per camera and the sales price is Euro 69.99. Hence, the Camera Vendor makes a gross margin of Euro 9.99 per camera. As explained before in the context of the Hub Vendor Income Statement, the End User segment grows from 20,000 consumers in the first year to 40,000 in the second year, to 80,000 in the third year, to 160,000 in the fourth year and to 320,000 in the fifth year. E.g. the cameras manufactured and sold in year 5 cause cost of Euro 9,600,000 calculated by multiplying new End Users (320,000 - 160,000) times the manufacturing cost of Euro 60. The sales revenue of the camera in year 5 amounts to Euro 11,198,400 by multiplying the 160,000 new End Users times the sales price of Euro 69.99. The gross margin of Euro 9.99 for the camera is very low but the Camera Vendor gets additional revenue from premium services that make use of the API implementation. In total, the revenue premium service amounts to Euro 2,976,000. The gross margin of all camera sales of Euro 3,196,800 is calculated by subtracting cost of Euro 19,200,000 from the revenue of Euro 22,396,800. The comparison of the gross margin of the camera sales with the revenue of the premium service reveals the equal importance of the two revenue streams for the Camera Vendor. In the long run, the Premium Services will be of even greater importance because the market for cameras will be saturated and growth of hardware sales will stagnate. The dynamics and consequences of the difference between recurring and one-time revenue are explained in Section 6.2. The total cost over all years amounts to Euro 22,200,000 and the total revenue amounts to Euro 25,372,800. The resulting profit of Euro 3,172,000 indicates a viable NBBM for the Camera Vendor.



HIDE DETAILS

Costs

Title	*Receiving Stakeholder*	*Price*	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Total Costs*
Human Resources	-	500000 EUR / YEAR	500,000	500,000	500,000	500,000	500,000	2,500,000
IT-Infrastructure	-	0.15 EUR / MONTH / End User	7,200	14,400	28,800	57,600	115,200	223,200
		Total	**507,200**	**514,400**	**528,800**	**557,600**	**615,200**	**2,723,200**

Revenues

Title	*Paying Stakeholder*	*Price*	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Total Revenues*
35 % of Premium Services Price	Hub Vendor	2.8 EUR / MONTH / End User	134,400	268,800	537,600	1,075,200	2,150,400	4,166,400
		Total	**134,400**	**268,800**	**537,600**	**1,075,200**	**2,150,400**	**4,166,400**

Net Income

Total	**-372,800**	**-245,600**	**8,800**	**517,600**	**1,535,200**	**1,443,200**

Figure 5.20: Home Automation - Income Statement of an Online Service Provider

Figure 5.20 shows the Income Statement of an Online Service Provider. An Online Service Provider spends on average Euro 500,000 per year on Human Resources. In contrast, the cost for IT-Infrastructure is not constant but scales with the growth of the user base. In the first year, the IT-Infrastructure cost amounts to Euro 7,200 and increases to Euro 115,200 in the fifth year. A 35% share of the revenue generated by the sale of premium services in the App Store goes to the Online Service Provider. Premium services sales revenue is recurring revenue and increases exponentially as new End Users increase the customer base from year to year. Each of the five Online Service Providers makes Euro 4,166,400 revenue. Subtracting the cost of Euro 2,723,20, a net income of Euro 1,433,200 remains. Hence, the NBBM is also viable from the perspective of an Online Service Provider.

HIDE DETAILS

Costs

Title	*Receiving Stakeholder*	*Price*	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Total Costs*
Hub Sales Price	Hub Vendor	99.99 EUR	100	0	0	0	0	100
Hub App Price	Hub Vendor	0 EUR	0	0	0	0	0	0
Premium Services Price	Hub Vendor	7.99 EUR / MONTH	96	96	96	96	96	480
Asset Camera Sale	Camera Vendor	69.99 EUR	70	0	0	0	0	70
Internet Connection Price	Network Operator	30 EUR / MONTH	360	360	360	360	360	1,800
Internet Setup Cost	Network Operator	50 EUR	50	0	0	0	0	50
		Total	**676**	**456**	**456**	**456**	**456**	**2,500**

Revenues

Title	*Paying Stakeholder*	*Price*	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Total Revenues*
		Total	**0**	**0**	**0**	**0**	**0**	**0**

Net Income

		Total	**-676**	**-456**	**-456**	**-456**	**-456**	**-2,500**

Figure 5.21: Home Automation - Income Statement of an End User

Figure 5.21 shows the Income Statement of the End User. The End User is the consumer of the NBBM that needs money to finance the solution provided by the value-creating Stakeholders. The revenue streams of the End User such as its salary is not modelled in the context of the NBBM. The main cost factor of the End User is the cost for the Internet Connection that amounts to Euro 1800 plus a one-time setup cost of Euro 50. It assumed that an End User does need not purchase the Internet Connection for the only purpose of operating the Home Automation System. Consumers as the End Users use the Internet mainly for information and communication purposes. According to eMarketer [eMa16], over half of the worldwide population will have Internet access in 2018. Hence, the price for the Internet connection is ignored in the quantitative evaluation of the NBBM.

The consumer needs of the End Consumer "Save Heating Costs" and "Increase Security" have been defined in Section 5.3.1 and are shown in Figure 5.5 and Figure 5.6. They are also displayed at the bottom of the Income Statement of the End User in the NBMF Design Tool. The Spending Amount per Consumer for the consumer need "Save Heating Costs" is set to Euro 50 per year and the Spending Amount per Customer for the consumer need "Increase Security" is set to Euro 10 per month. Now, the final solution and its cost are compared to the Spending Amount per Customer in a timespan of 5 years. The consumer need "Save Heating Costs" is satisfied with the Thermostat that is included in the Hub and the Hub App. If the End User uses the Thermostat for two years, the price for the Hub is within the limit of Euro 50 per year. The consumer need "Save Heating Costs" is satisfied with the Camera and the Premium Services. For this consumer need, the consumer is willing to spend Euro 600 in 5 years (Euro 10/month * 12 months/year * 5 years). The total price for the solution of Euro 550, calculated by adding Euro 480 for the Premium Services and Euro 70 for the Camera, is lower than Euro 600. As a consequence, the NBBM is viable from the perspective of the End User.

SHOW DETAILS

Costs

Title	*Receiving Stakeholder*	*Price*	*Total Costs*
		Total	**0**

Revenues

Title	*Paying Stakeholder*	*Price*	*Total Revenues*
Internet Connection Price	End User	30 EUR / MONTH	223,200,000
Internet Setup Cost	End User	50 EUR	16,000,000
		Total	**239,200,000**

Net Income

		Total	**239,200,000**

Figure 5.22: Home Automation - Income Statement of the Network Operator

So far, all Income Statements of Stakeholders within the Network Boundary have been evaluated and NBBM turned out to be viable. The Income Statements of Stakeholders outside the Network Boundary, namely the Product Manufacturer, the Chip Manufacturer, the Data Analyst and the Network Operator seem very profitable. Figure 5.22 shows the Income Statement of the Network Operator. No costs appear because the BMCs of the Network Operator and other Stakeholders outside the Network Boundary have not been modelled in Phase 3. Therefore, the Income Statements of the Stakeholders outside the Network Boundary have no validity and are not part of the evaluation in this Phase.

The modelling process in the NBMF Design Tool is now complete. To continue, the NBBM has to be discussed with the different Stakeholders and tested in practice.

CHAPTER 6

Discussion

In this chapter, the findings of this master thesis are presented and discussed. The results contribute to two distinct research areas in the context of business modelling. To make the contribution to each research area explicit, the results are explained in two distinct sections.

First, the NBMF presented in Chapter 4 extends the research area of BM ontologies and BM frameworks. Although the NBMF aims to suit especially the IOT, the framework will probably applicable to a variety of BM use cases in network-based industries. Section 6.1 justifies the design decisions of the developed framework and proves its academic foundation by comparing the used concepts to similar approaches in BM research. Furthermore, the evaluation and the limitation of the NBMF are discussed.

Second, the NMBF is inspired by the IOT and aims to foster innovation of NBBMs in industries that are influenced by the IOT. The literature review, as well as the analysis of common stakeholders in the IOT in Chapter 3, yield insights in the area of BMs in the IOT. The case study conducted with the NBMF Design Tool and presented in Chapter 5 reveals some dynamics about NBBMs in the IOT. The gathered insights into BMs and NBBMs in the IOT is discussed in Section 6.2.

6.1 A Practical Framework based on Existing Theories

The NBMF presented in Chapter 4 attempts to fill a gap in BM research. In Section 2.4, the term NBBM is defined and the rising requirements for multi-company BMs are explained. The need for a NBBM framework for the IOT is explicitly proposed in the literature and has to be addressed to fill the gap in research [TBGF14]. Although frameworks for NBBMs have been proposed in the literature, they are not applied in practice (see Section 4.1). In contrast, frameworks and tools for BMs presented in Chapter 2 are widely known. The differing degree of awareness may derive from the fact

that the prevalence of NBBMs did only increase in recent years, whereas the BM concept is already mature [WN13]. However, a major reason for the relevance of BM concepts in practice is the availability of intuitive tools. Ontologies such as the e3-value and the BMO presented in Chapter 2 are not only well-founded in theory. The e3-value evolved to a software tool [Gor06] with quantitative profitability evaluation and the BMO evolved to the graphical management tool known as BMC [OP10]. Hence, tool support increases the probability for success of BM theories.

6.1.1 Reasoning the Design Decisions of the Framework

The aim of the framework is on the one hand to provide a theory that is well-founded. On the other hand, a major focus is to develop a practical tool that is used by BM researchers and especially by CEOs in practice. Hence, the theoretical framework presented in Sections 4.1-4.4 is designed with the ultimate goal to provide a software tool. The framework is implemented as a web-based graphical design tool (see Section 4.5) to address modern software requirements such as multi-device support.

The limited scope of a master thesis does not allow the foundation of a stand-alone ontology for NBBMs. Therefore, the NBMF makes use and builds upon existing BM ontologies and BM frameworks. As a consequence, the NBMF is not an ontology by itself but a BM framework that builds upon BM ontologies. Furthermore, recommendations from the literature are taken into consideration for the structure of the NBMF. The sequence of the four phases of the NBMF is influenced by the proposal of Fu et al. [FQQ06] as explained in Section 2.4.3. The authors recommend to determine the value object first, construct the network that creates the value object, analyse the internal conditions of companies or relationships and finally choose a strategy for execution of the BM. The NBMF follows a very similar importance of the network role because the value objects, i.e. Value Propositions, are designed within a network of stakeholders in Phase 2. Furthermore, the BMC in Phase 3 of the NBMF analyses the internal conditions of companies. Figure 6.1 extends Figure 4.1 of Chapter 4 and shows important concepts of ontologies and frameworks that are similar to the NBMF.

Phase 1 of the NBMF follows similar principles as the Value Proposition Canvas by Osterwalder et al. [OPBS14]. The Value Proposition Canvas is a management tool that aligns products and services to customer needs. It integrates with other management tools such as the BMC. Just as the BMC, the Value Proposition Canvas incorporates the design thinking principle to foster BMI by following a customer viewpoint. The Value Proposition Canvas is more fine-grained than the NBMF because the NBMF just makes use of some basic concepts.

Phase 2 is based on the e3-value ontology presented in Section 2.2.2. It is well-founded and evaluated. The e3-value ontology gives the NBMF a network-based character due to the detailed modelling of the exchanged value between stakeholders. For more details on the integration into the NBMF see Section 6.1.2. The concept of the network graph in Phase 2 is also similar to the network graph in the IoT Business Model Builder [Bos15]

which is more simple compared to the e3-value. The similarities of the NBMF to the IoT Business Model Builder are illustrated in Section 6.1.3.

Phase 3 is based on the BMC by Osterwalder and Pigneur presented in Section 2.2.1. The BMC evolved from the BMO and is one of the most common management tools for BMs. It describes the BM of a company in a structured way. The main structure of the nine building blocks in the BMC has not been altered when being integrated into the NBMF. However, the BMC is more restricting but also more powerful in the NBMF because relations between elements of different building blocks can be added. For more details on the integration of the BMC into the NBMF see Section 6.1.2. The BMC of a stakeholder can finally be classified according to the St. Gallen Business Model Navigator [GFC13] as described in Section 4.3.11. The classification describes a BM in a keyword and helps to detect the most successful BM patterns in the long term.

Phase 4 includes the concept of income statements [Itt98] to estimate the profitability of a BMC. Usually, a sustainable NBBM provides profit opportunities, i.e. net income, for every stakeholder. The net income in an income statement is calculated by subtracting the total cost from the total revenue. A similar financial report to estimate profit is also provided in the software tool of the e3-value ontology (see Section 2.2.2).

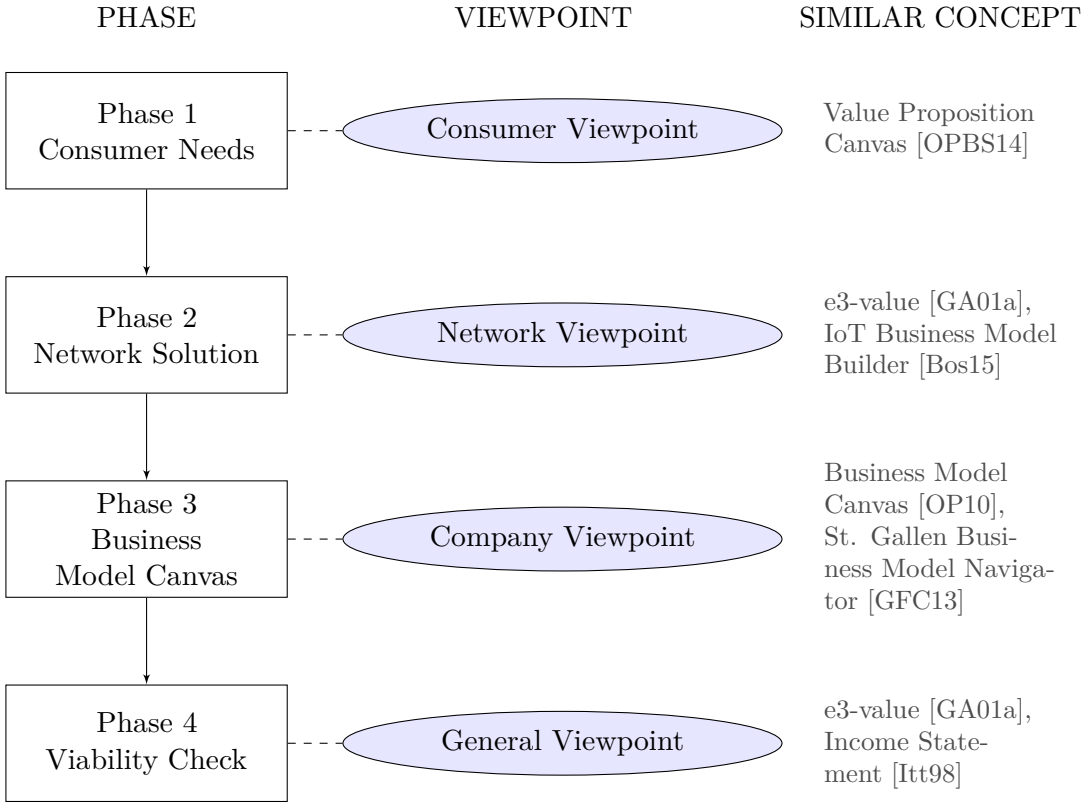


Figure 6.1: Phases, Viewpoints and Similar Concepts of the NBMF Framework

Visualisation aspects are of high importance in the NBMF Design Tool because visualisation add expressive power to the NBBM and contribute the customer experience. The representations in form of a network graph, a BMC or a financial report help the BM-Designer to better understand the characteristics and challenges of an NBBM. The feature to upload icons for the stakeholders make the GUI generally more appealing and enhance the graphical representation of the network graph. Furthermore, colours are used consistently across the different phases in the NBMF Design Tool to provide recognition value.

6.1.2 Integration of the Business Model Canvas and e3-value

As described in Section 2.2, an ontology is a well-founded theoretical artefact that is useful for BM research. The BMO and e3-value are BM ontologies that focus on e-BMs [GOP05]. Both are designed as BM ontologies and have been further developed for an easier use in practice. The BMO evolved to the BMC [OP10] and the e3-value ontology evolved to a software tool with a GUI [Gor06]. The practical relevance of the ontologies is beside their theoretical foundation a major argument for the integration into the NBMF. Furthermore, the e3-value has already been used successfully to design a NBBM for the IOT [GSV14]

Table 6.1 shows the comparison of the NBMF, the BMO and the e3-value ontology. The integration of the BM ontologies increases scientific value and makes the NBMF robust due to their theoretical and practical evaluation. Additionally, the prevalence of the two ontologies and their tools [MMB+16] pave the way for the propagation of the NBMF. Practitioners such as CEOs can use the NBMF Design Tool more intuitively due to previous experiences with the underlying concepts of the ontologies. Due to the technology focus and implementation as a design tool, the NBMF is defined in UML 2.0 [BJR99] as shown in Figure 4.2 in Section 4.3. The e3-value is defined in UML 2.0 and additionally in RDF/S [MMM04], whereas the BMO is defined in OWL [DS04]. As described in Section 4.5 the NBMF has free software support in form of a web-application[1]. Initially, the BMO did not offer any software support. The BMC is released under the creative commons licence [Com07] and therefore, third parties implemented software versions of the BMC[2,3]. Furthermore, the author of the BMO founded the company Strategyzer which offers a commercial web-application for the BMC[4]. The e3-value offers an offline modelling tool implemented in Java that is accessible as free download[5]. With the e3-value software, NBBMs can be designed and a profitability statement is generated automatically.

When modelling with the BMO, the company is in the focus to design single-company BMs [Ost04]. Whereas the e3-value has a network focus and it is used to design NBBMs [PGW06]. The NBMF unites the two ontologies focusing on the network. The

[1] http://nbmf.biasion.eu/
[2] https://canvanizer.com/
[3] https://bmfiddle.com/
[4] https://strategyzer.com/app
[5] http://e3value.few.vu.nl/tools/

Table 6.1: Comparison of the Charactersitics of the NBMF, BMO and e3-value (adapted from [GOP05, Lam10, DVH+15])

	NBMF	**BMO**	**e3-value**
Foundation	Framework	Ontology	Ontology
Concept Definition	UML	OWL	UML, RDF/S
Software	Yes	Yes	Yes
Focus of BMs	Network	Company	Network
Consumer Viewpoint	Yes	No	No
Stakeholder Viewpoint	Yes	Yes	Little
Network Viewpoint	Yes	No	Yes
Profitability Evaluation	Yes	No	Yes
Classification of BMs	Yes	Little	No

network focus derives from the fact that in the NBMF the value propositions are designed within a network of stakeholders (see Section 4.4.2). In contrast to the e3-value ontology and the BMO, the NBMF also includes a consumer viewpoint (see Section 4.4.1) to understand its needs and design value propositions accordingly [OPBS14]. Also, the BMO and the e3-value ontology focus on the customer but the customer's needs and preferences are implicit, i.e. not modelled separately [DVH+15]. The BMO primarily aims to design a BM for a single company. The ontology also includes networking concepts such as external partners, suppliers, customers and value propositions. These concepts are modelled from the viewpoint of a company [Ost04], whereas in the NBMF and in e3-value the concepts are modelled in the context of a network. The company viewpoint may prevent a farsighted perspective when relationships between stakeholders are modelled [GOP05]. In contrast, the e3-value has a strong network viewpoint because it focuses on the design of a value constellations within a network of stakeholders. Additionally, the e3-value has also a limited stakeholder viewpoint that is described by the value activity element. A value activity element is a business process of a stakeholder that increases its utility or which is conducted to make a profit [GA03].

The NBMF, as well as the BMO and e3-value, have the primary purpose to design and visualise BMs. To estimate the profit potential and hence also the viability of a BM, the NBMF and e3-value include a feature for profitability calculation [Gor02]. Originally the BMO does not provide such a feature [GOP05]. However, the web-application for the BMC by Strategyzer[6] offers a quantitative evaluation feature that uses the elements of the cost building block and the revenues building block to calculate the profitability statement. In contrast to the two BM ontologies, BMs in the NBMF can be classified according to a predefined set of BM patterns [GFC13] as described in Section 5.3.3. The BMO does not provide an explicit BM classification scheme but BMs may be classified according to BM elements [GOP05].

[6] https://strategyzer.com/app

Table 6.2: Element Mapping between NBMF, BMC and e3-value (adapted from [CAB+15])

NBMF Element	**BMC Building Block**	**e3-value Concept**
Business Network	-	-
Stakeholder	Customer Segment, Key Partner	Actor, Market Segment
Consumer Need	-	Stimulus
Value Proposition	Value Proposition	Value Interface
Financial Transaction	Cost, Revenue	Value Transmission
Key Activity	Key Activity	Value Activity
Key Resource	Key Resource	Value Object
Customer Relationship	Customer Relationship	-
Channel	Channel	-
Cost	Cost	-
Business Model Pattern	-	-

Table 6.2 shows the mapping between the elements of the NBMF, the building blocks of the BMC and the concepts of the e3-value ontology. The NBMF aims to merge the most important aspects of the e3-value ontology and the BMO. Therefore, concepts of the ontologies are reused in the NBMF whenever possible. However, the concepts of the e3-value ontology are included without making use of similar naming or definitions. This decision has the goal to reduce the inherent complexity of the e3-value ontology elements presented in Section 2.2.2. The elements of the NBMF are rather based on the elements of the BMC and extended with the concepts of the e3-value ontology. All building blocks of the original BMC are identical to the BMC of the NBMF and many elements in the NBMF are named after the building blocks. As an addition to the original BMC, the NBMF introduces an additional layer on top of the BMC to express the relational character between elements. Possibly, the relations may restrict the original BMC because elements are inserted in a determined sequential order, i.e. stakeholder need to be created before value propositions can be created. This consequence is not yet evaluated and the relations between the elements are necessary to integrate the BMC in the NBMF.

Also, Fritscher and Pigneur [FP15] propose relationships between the elements of the BMC by tagging relating elements with the same colour. The authors follow an approach which is, like the original BMC, stakeholder-oriented, i.e. elements may relate to other elements of the same BMC. In contrast, the NBMF follows a more extensive, network-oriented approach including relations between multiple stakeholders, i.e. an element may relate to elements in the same BMC or to elements in the BMC of a partner or customer. Figure 6.2 denotes all possible relations between elements in the BMC of the NBMF. The elements in the Key Partners, Key Activity, Key Resource, Customer Relationship, Channel and Cost Structure building blocks may contain relations to the BMC of a

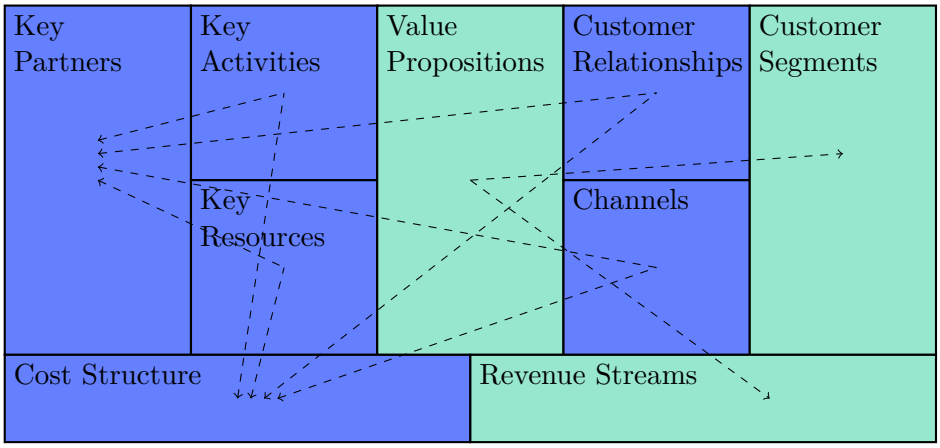


Figure 6.2: Relationships of Elements in the BMC of the NBMF

partner or company-internal elements. The elements in the Value Propositions, Customer Segments and Revenue Streams building blocks are always related to a customer. The following list explains how the elements in the BMC of the NBMF are created and how they may relate to other elements:

- A Key Partner element is only created in Phase 2 of the NBMF. Every Stakeholder providing a Value Proposition appears as Key Partner.
- A Key Activity, a Key Resource, a Customer Relationship or a Channel element is created in Phase 2 as Value Proposition or in Phase 3 as a company-internal element in the BMC. Only an element created in Phase 2 is related to another stakeholder and its related costs are inserted as Financial Transactions. Elements created in Phase 3 may have related costs that are inserted as Cost elements.
- A Value Proposition element is only created in Phase 2 of the NBMF and is always related to a Stakeholder of the customer segments block. Furthermore, a Value Proposition may have a relation Financial Transaction as compensation, i.e. the price for a Value Proposition, appearing in the Revenue Streams block.
- A Customer Segment element is only created in Phase 2 of the NBMF. If a Value Proposition is provided to another Stakeholder in the network, this Stakeholder appears in the Customer Segments block.
- A Cost Structure element is created in Phase 2 as Financial Transaction or in Phase 3 as Cost. Hence, an element in the Cost Structure block always relates to an element in the Key Activity, the Key Resource, the Customer Relationship or in the Channel building block. If a Cost Structure element is created as Financial Transaction, it also relates to the Stakeholder who receives the Financial Transaction.

- A Revenue Streams element can only be created as Financial Transaction in Phase 2 of the NBMF. Hence, an incoming Financial Transaction appears as an element in the Revenue Streams block.

Some of the explained relations are also described by Lund and Nielson [LN14]. In a case study, they show the appearing dynamics when designing NBBMs with the BMC. However, the relations are not explained in detail but only pointed out on an abstract level. A similar approach of connected BMCs is also presented by Garner who depicts the appearing dependencies on external parties such as competitors, customers, channel partners or financiers [Gar15]. Garner only denotes the reasons to draw the BMC of external partners, e.g. to understand competitive advantages but no management guidelines are provided and relations between the stakeholders are not described. Neither Lund and Nielson nor Garner present theoretical mappings or integrated frameworks on how to use related BMCs to design NBBMs. However, Lund and Nielson conclude that the BMC lacks a layer for the network dimension [LN14] that needs to be investigated.

D'Souza et al. [DVH+15] evaluate different BM ontologies such as the BMO and the e3-value ontology according to a list of criteria. Summarising their analysis, no ontology fulfils all criteria to design NBBMs but the e3-value ontology is the most appropriate to design and evaluate NBBMs in terms of viability. The authors propose to combine the strengths of different BM ontologies to design complex BMs in a distributed setting, i.e. an ontology for NBBMs, without adding too much complexity. The NBMF addresses this open research topic by providing a simple framework for NBBMs based on the two ontologies presented here. Due to the popularity of the BMC and the expressiveness of its building blocks, the NBMF elements are based on the building blocks of the BMC. The strength of the e3-value is the quality of the ontology, the feasibility to express complex constellations in a networked context and the quantitative evaluation feature in the form of a profitability statement. The NBMF reduces the complexity of the elements in the e3-value ontology and still provides the same feature-set.

6.1.3 Similarities to the IoT Business Model Builder

The IoT Business Model Builder [Bos15] by the Bosch IoT Lab is a development approach for NBBMs in the IOT. It is composed of different tools that are applied to various design phases of a NBBM. The authors present important characteristics that also denote the NBMF:

1. Extending the viewpoint from the company level to an ecosystem, i.e. network, level
2. Visualisations of complex value streams in the network of stakeholders
3. Considerations of value propositions for every stakeholder
4. Data is an asset

The approach by the Bosch IoT Lab is divided into three successive phases for the design of a BM named ideation, preparation and evaluation. For every phase, different tools are recommended that are used to support modelling. The Bosch IoT Lab also recommends all tools that are included in the NBMF design process. In contrast to the NBMF, the tools are just presented in the IoT Business Model Builder but not integrated into a continuous process. In the ideation phase, the authors suggest using the 55 BM patterns defined in the St. Gallen Business Model Navigator [GFC13]. In the NBMF, the same patterns are used for ideation and for categorisation of the BMs (see Section 4.3.11).

In the preparation phase of the IoT Business Model Builder, the authors propose to draw a network graph including all stakeholders and value transactions. Also, the Business Network in Phase 2 of the NBMF is represented as a network graph but gives the BM-Designer more possibilities for customisations. Table 6.3 depicts similarities and differences in the representation of the network graph in the NBMF and the IoT Business Model Builder.

Table 6.3: Comparison of the network graph in the NBMF and the IoT Business Model Builder

	NBMF	**IoT Business Model Builder**
Node semantic	Stakeholder	Stakeholder
Node categories	Company, Consumer	Business Owner, Customer, Supplier, Partner
Node depiction	Custom Image	Node Category Icon
Arrow semantic	Value Proposition	Supply/Service, Revenue
Arrow categories	Product, Service, Data	Supply/Service, Revenue
Arrow colour	Custom Colour of the Value Proposition	Supply/Service (black), Revenue (blue)
Arrow line	Product (solid), Service (dashed), Data (dotted)	Strength indicates Importance of the Relationship

The NBMF distinguishes Stakeholders between companies and consumers, while the IoT Business Model Builder distinguishes between business owners, customers, suppliers and partners. In the IoT Business Model Builder, Value Propositions, i.e. Supplies/Services, as well as Financial Transactions, i.e. Revenues, are denoted by arrows. The arrows link the nodes, i.e. stakeholders and form an interconnected network graph.

In contrast, in the network graph of the NBMF, the only connections between the Stakeholders are Value Propositions. However, hovering over a Value Proposition in the NBMF Design Tool reveals the Financial Transactions that are compensating the corresponding Value Proposition. Hence, the NBMF incorporates similar information in the network graph such as the network graph in the IoT Business Model Builder. The NBMF follows a different approach for representation to emphasise the importance of the Value Propositions. In the IoT Business Model Builder, the Stakeholders are represented by the predetermined icon of the stakeholder category, e.g. the customer icon.

In contrast to the IoT Business Model Builder, the NBMF makes use of custom images for the representation of Stakeholders and custom colours for the representation of Value Propositions. Whereas, the IoT Business Model Builder makes use of the arrow strength to symbolise the importance of the relationship. Furthermore, the NBMF includes an additional dimension for arrows (solid, dashed, dotted) that denote the type of Value Proposition (product, service, data). Summarising the differences of the network graphs, the NBMF provides more recognition value by using colours and custom images whereas the IoT Business Model Builder is denoted by a standardised presentation.

The Bosch IoT Lab suggests drawing a BMC for every stakeholder after designing the network graph. Equally, the NBMF suggests the same procedure, i.e. after the network graph in Phase 2 is complete Phase 3 starts with the design of the BMCs. In contrast to the IoT Business Model Builder, the NBMF provides an automated mapping of the elements, i.e. Stakeholders and Value Transactions, from the network graph to the BMC as described in Section 4.4.3. The IoT Business Model Builder just recommends independent tools and does not provide any software tool support. Hence, BM experiments are burdensome and time intensive in the IoT Business Model Builder because the mapping process is repetitive. Furthermore, the elements of the cost and revenue building blocks of a BMC are not used to generate Income Statements. In the NBMF, the mapping step from the BMC to the Income Statement of a stakeholder is done automatically to check for viability of the BM as described in Section 4.4.4.

In summary, the aim of the NBMF and the IoT Business Model Builder is similar, i.e. design NBBMs for the IOT. However, the scope of the two approaches is quite different. The IoT Business Model Builder is a guideline to construct workshops that range from the ideation phase of a business opportunity to the evaluation phase of the NBBM and include a variety of independent tools. The scope of the NBMF is more narrow and focuses on selected aspects out of the preparation and evaluation phases of the IoT Business Model Builder. In contrast to the IoT Business Model Builder, the NBMF provides an integrated toolchain with clearly defined subprocesses and software support.

6.1.4 Evaluation of the Framework

The NBMF Design Tool was implemented applying the lean software development. The lean software development derives from lean manufacturing founded by Toyota and makes use of agile software development methods [PP03]. The NBMF Design Tool has been developed in short cycles to complete features as fast as possible. With this method, a working prototype can be achieved in short time and the developer focuses on a defined feature that is easily manageable. As a consequence, short development cycles help to improve customer experience regularly by asking for feedback. During development, external feedback has been collected on a regular basis from researchers in the BM domain, startup founders and master students. The feedback was received in personal interviews during beta tests, via mail and over the feedback form in the NBMF Design Tool. The incoming improvement suggestions have been implemented in the subsequent development cycle.

The formal evaluation of the NBMF consists of two main parts: First, the evaluation of the single phases of the framework and second, the evaluation of the framework overall. All of the concepts of ontologies and frameworks applied in the four phases have been evaluated already in their original form. The respective evaluation methods and results of the evaluation are accessible in the primary sources. Therefore, it is not necessary to evaluate the concepts of the single phases individually. The evaluation of the overall framework is conducted in Chapter 5 by applying the case study evaluation method as described by Yin [Yin03]. The case study is based on previous case studies on techniques for BM and in the research field of home automation as explained in Section 5.1. Also, the insight gathered in Chapter 3 are reused to construct the case study. Due to the scarcity of reliable data in the literature, the resulting explorative NBBM only has limited scientific value. Insights into characteristics of NBBMs in the IOT derived from the case study are described in Section 6.2.

In summary, the case study shows how the NBMF Design Tool can be used in practice to design NBBMs for the IOT. The successful modelling of the case study with the NBMF Design Tool shows the functional completeness of the software implementation and the underlying theoretical framework. However, the NBMF still lacks systematic evaluation. More case studies need to be applied with researchers and practitioners to proof the validity of the framework. The IOT is a paragon example of a network-based market [TBGF14, WLR14, SS15, JKA16] and hence, general applicability of the NBMF for a network-based market is presumed. To proof general applicability, the NBMF needs also to be applied to network-based markets that are not directly influenced by IOT technologies.

6.1.5 Limitations of the Framework

Designing BMs in a networked context, i.e. NBBMs, is complex. Different aspects such as the market structure or capabilities of a company play a role when designing NBBMs [DVH+15]. In RQ1 stated in Section 1.3, an influence of macroeconomic parameters such as data protection laws, subsidies or the GDP on BM is anticipated. Such parameters may influence a BM and contribute to its success or failure. However, these parameters are not subject to the classical, microeconomic interpretation of a BM described in Chapter 2. Therefore, macroeconomic concepts and parameters are neither investigated in the literature review in Chapter 2 and Chapter 3 nor addressed with the NBMF presented in Chapter 4. Instead, the NBMF makes use of already investigated and evaluated microeconomic parameters and unites them into a single framework.

The design process of a BM includes a variety of tasks and is often unstructured and chaotic [OP10]. The NBMF just includes the modelling task of the BMI process described in Section 2.3. Tasks such as testing, adaptation and improvement cycles are not covered by the NBMF but nevertheless, they are important in a BMI process. BMI may cause a shift in the culture of a company, change its structure and alter its processes. Often, practitioners realise that implementing a new BM is a lot more difficult than they expected when designing it [HK12].

Open collaboration is required in a NBBM to share resources and competencies across company borders. Therefore, CEOs and managers need to investigate their current BM to assess the possibilities for the transformation from a single company BM to a NBBM [PT13]. In the short term, NBBMs can be designed and resources can be managed without major coordination efforts. As soon as new companies enter the NBBM or other circumstances demand more coordination, the company providing the most critical core competence may lead the stakeholder cooperation [HHT08]. E.g. in the case study presented in Chapter 5, the Hub Vendor would be the best-suited leader for the NBBM. However, the NBMF does not define in which manner the NBBM is designed in collaboration with participating stakeholders. A collaboration feature in the NBMF Design Tool (see Section 4.5) could improve the quality of the NBBM and create a common sense between the participating stakeholders. The architecture of the NBMF Design Tool is already designed to support multiple stakeholders on a modelling project. However, at the moment of this writing, such a collaboration feature is not fully implemented yet.

The main goal for the NBMF Design Tool at this stage is to provide a fully functional prototype as noted in RQ2. However, the NBMF Design Tool needs to be improved in terms of usability. On the one hand, test users recognised the purpose of the software and were able to start with the modelling by themselves. On the other hand, the transition between the four phases were often not obvious to test users due to missing background information about the framework. Primarily, the GUI needs to be revised and simplified so that the user is guided trough the phases of the NBMF. Furthermore, additional background information about the underlying NBMF needs to be provided to reason about design decisions. Visual representations in form of diagrams could facilitate the quantitative evaluation and reveal new insights about the dynamics of BMs and NBBMs. Also, key performance indicators such as the break even point, the return on investment, the customer acquisition cost or the customer lifetime value should be shown in diagrams to increase expressiveness.

The NBMF is restraining modelling in terms of dynamic behaviours and shifting parameters. The only way to model dynamic behaviour is to set the Segment Size Multiplier attribute in the Stakeholder element to smaller or greater than 1 as described in Section 4.3.2. As a consequence of increasing or decreasing segments, revenues and cost adapt accordingly over time. The NBMF and the NBMF Design Tool are also limited in terms of modelling pricing mechanisms. The IOT but also other industries are characterised by complex pricing mechanisms such as price segmentation [GS15] that can not be modelled in the NBMF. Also, not only revenues but also cost could be calculated more fine-grained, e.g. to model economies of scale cost effects.

The limitations mentioned in this section should be investigated in further research of the NBMF. Also, all changes to the theoretical basis of the NBMF need to be implemented accordingly in the NBMF Design Tool.

6.2 Characteristics of IOT Business Models

Generally, a BM is very case specific due to its multifaceted components. However, researchers classified BMs by their characteristics to reuse them as patterns in the ideation phase for BMI [GFC13]. Even so, BMs can not simply be adopted because too many aspects and components of a BM are customised.

The IOT is an umbrella term for technologies such as sensors and microchips, networks and data analytics. The fields of application of these technologies are widely dispersed. A major field of applications in the B2C sector is home automation [SGFW10, BS11, PZCG14, WJ16, RT17]. In the B2B sector, smart production (Industry 4.0), transportation and retail will be transformed by IOT technologies [BS11, PH14]. Also in the B2G sector great business opportunities are arising with the IOT such as in the area of smart cities [GBMP13, PZCG14]. As described in Chapter 3, the IOT does not only require technical solutions. In order to realise the solutions and provide long-term perspectives for companies, innovative BMs are key. An IOT solution typically includes a variety of stakeholders due to the versatility and the complexity of the tasks [BS11]. BMs including multiple stakeholders are known as NBBMs. Due to the fact that the IOT comprises so many sectors and roles of stakeholders, it is not possible to generalise NBBMs. However, in Section 3.2 the BMs of common stakeholders in IOT are investigated in the form of BMCs. For some stakeholders, use cases are defined to illustrate the components of the BM and to circumvent the impossibility of generalisation. The resulting BMCs as well as the case study conducted with the NBMF Design Tool in Chapter 5 revealed new insights into potential BMs and NBBMs for the IOT.

To sum up, the characteristics explained in the following list derive from the BMs designed in Section 3.2 and from the NBBM designed in Chapter 5. General applicability of the characteristics in the IOT is limited due to the qualitative research method that is used. In BM literature, researchers face the same problem and note its limited validity [PT13]. In studies, researchers conduct concrete use cases of the IOT that have limited scope in the first place [BRB$^+$13, GSV14]. In the following, the revealed characteristics of IOT BMs are described:

- Stakeholders are not able to provide complete solutions due to the versatile responsibilities and the comprehensive technology stack shown in Figure 3.1. Communication, collaboration, sharing of capabilities and resources between stakeholders is common for NBBMs in the IOT. A viable NBBM has to be beneficial, i.e. provide opportunities for profit, for all included stakeholders to be successful in the long run. Otherwise, disadvantaged stakeholders are not committed to the NBBM.
- Data will become an essential asset in the IOT. On the one hand, data is used to gain knowledge about the customers to tailor the offered products and services. On the other hand, data can be sold to companies complying with legal constraints.

- Relationships to customers are automated and channels are digital, especially in the B2C sector of the IOT. Although relationships and channels are online, the interaction with the customer is very personalised. Machine learning techniques are applied on customer data to reveal new insights about customers. Derived consumer preferences and habits are then used to personalise automated communication, e.g. bots or emails, and to tailor offers to individual customers, e.g. recommendations and price segmentation.

- Cost and revenue characteristics are similar to the ones in the software industry. The IOT is denoted by relatively high fix cost and decreasing marginal cost. Also, depending on the complexity of the solution, the number of customers has to exceed a critical mass to reach the break even point. After reaching the break even point, a large part of the marginal revenue typically results as profit. Therefore, in the IOT it is important to increase the customer base and scale up to get a great financial reward.

- Subscriptions are commonly used to enable recurring revenue in the IOT. Recurring revenue gives the company the ability to predict future revenues reliably and hence offers more security for planning. Moreover, companies providing high-quality solutions get rewarded in the short term but especially also in the long term for improvements that lead to customer satisfaction. Also, customers do not have to make huge upfront investments but can decide monthly or yearly on a recurring purchase. The hurdle for the first purchase is lower because less risk is involved and non-satisfying services are cancelled without major aftereffects. Hence, subscriptions do not only provide advantages for the companies regarding planning security and long-term opportunities for profit. Also, consumers avoid sunk costs and just pay for solutions they really need. As a consequence, companies focus on customer oriented solutions and constantly improve them to reach their financial goals.

- In the IOT, the concept of Product as a Service will become more common. Hence, also hardware sellers can benefit from the pricing strategies and recurring revenues such as subscriptions. The concept of Product as a Service has already been adopted successfully by the automobile industry in the form of car sharing [LWRS12]. The IOT is especially suited to sell products as services because the price for devices including sensors, microchips and network capabilities is decreasing rapidly [PH14]. Low prices allow the hardware sellers to give away devices for free and to switch to service BMs that provide possibilities for recurring revenues. The services are built on top of the devices and make use of the capabilities of the hardware, such as sensors or the UI. Customers perceive the great value from the services and not from the devices. Hence, customers can be charged for the solution in a service-like manner. As a consequence, companies providing the devices have incentives to provide long-term support and to increase customer satisfaction even after the purchase of the device.

- NBBMs in the IOT facilitate hidden revenue streams and revenue sharing. E.g. in the case study presented in Chapter 5, a hardware seller gets rewarded with recurring revenue for implementing an API on its devices so services can access the functionalities of the devices. As a result, devices are sold cheaper what in turn increases sales. Devices required for IOT solutions such as sensors will hence diffuse more rapidly.
- Platforms such as the Home Automation Ecosystem modelled in Chapter 5 will gain significance due to their key role as integrator, identity manager or data provider. In the past, the Apple App Store has been essential for the success of the iPhone and hence for the propagation of smartphones and tablet PCs. Similar solutions are needed to promote solutions for the IOT. In contrast to the smartphone technologies, the technologies and requirements in the IOT are much more complex and dispersed [SFV13]. Platform providers face financial risks due to high initial investments to build up a platform. In the long run, taking this risk is rewarded with great opportunities for financial success due to economies of scale effects.

CHAPTER 7

Conclusion

In this chapter, the main findings are summarised and advice for future research is given.

7.1 Main Findings

This master thesis comprises two major research topics: the innovation of BMs driven by the IOT and the foundation of a framework for NBBMs. The challenges and business opportunities in the IOT serve as motivation for the foundation of a NBBM framework.

The most common stakeholders, i.e. companies, for an IOT solution are component manufacturers, product manufacturers, product makers, network operators and online service providers. The core competencies of all stakeholders are needed to provide a complete solution for the IOT but especially the role of online service providers will increase in importance, e.g. as service platforms or identity providers. The BMs of the stakeholders are diverse in terms of key activities, key resources, customer relationships, channels, cost structure and revenue streams but the BMs are usually driven by technology. Due to the complexity of the IOT technology stack, IOT solutions are usually provided by a number of companies that work closely together. The intense collaboration between the individual companies leads to strong dependencies between the BMs. Hence, the BMs of companies are aligned forming a NBBM that shows how the network of companies creates value.

Based on the insights of IOT-driven BMs, a framework for NBBMs called NBMF has been designed to foster BMI in the IOT. NBMF is short for networked business model framework and follows the mindset that value is created in a network of stakeholders, i.e. that products and services are created jointly by multiple companies and consumers. This mindset results in a more open view on how products and services may be invented, produced and delivered to consumers. Although the NBMF follows a network viewpoint for value generation, it also incorporates the viewpoint of the consumers and of the

companies within the framework. Therefore, the NBMF is split into four phases that follow different viewpoints. The first phase aims to define the needs of the consumer which the network of stakeholders tries to solve, i.e. the reason to design a NBBM. In the second phase, value streams among the stakeholders are designed with the purpose of solving the consumer need. In the third phase, the BMC of every value generating stakeholder of the network is drafted. The BMC describes which core competencies each stakeholder requires. In the last phase, the viability of the resulting NBBM is evaluated quantitatively by inspecting the income statement of each company and qualitatively by revising design decisions.

The NBMF builds upon existing BM ontologies by integrating their concepts into a single network-based framework. The building blocks of the BMC [OP10] serve as the basis for the elements of the NBMF and the of e3-value ontology [GA01a] adds a strong network viewpoint to the problem solution. The BMO (i.e. the academic foundation of the BMC) and the e3-value ontology are not only well-founded in theory but also extensively applied in practice. Additionally, concepts of the Value Proposition Canvas [OPBS14], the IoT Business Model Builder [Bos15], the St. Gallen Business Model Navigator [GFC13] and income statements [Itt98] are reused in the developed framework. To sum up, the NBMF picks crucial concepts of existing theories and aligns them in a coherent process for business modelling.

BMs are concepts that describe how companies or networks of companies create, deliver and capture value. The research questions indicate the influence of institutional regulations such as data protection laws or economic effects such as the growth of GDP on BMs. However, these parameters only influence the execution of BMs. Even though the examination of these influences has been defined as a subgoal in the research questions, it has not been investigated due to its inferior relevance in the context of BMs.

A major goal of this master thesis was also to provide tool support for the NBMF to simplify the use of the framework and propagate its application in practice. The software is implemented as a web-based design tool[1] with a GUI that can be accessed with any modern web browser. The NBMF Design Tool is presented in this master thesis in the form of an IOT case study. On the one hand, the case study shows the capabilities of the NBMF to model NBBMs and to demonstrate the full functionality of the NBMF Design Tool. On the other hand, the case study presents a NBBM for a home automation ecosystem that is determined by IOT technologies.

[1] `http://nbmf.biasion.eu/`

7.2 Future Research

Generally, BM theory is lacking a clear definition of BM concepts and research is scattered among different fields like strategy and management theory. The research field of NBBMs is suffering even more from this issue as it extends BM theory. Different approaches have been tried to tackle the issue but common sense is not reached yet [GOP05, Lam10, CAB+15, MMB+16]. The definition of higher-level (L_2 and L_3) meta-models for BMs [AMIN13] may unite the different concepts and avoid ambiguities.

The NBMF is missing a systematic evaluation and more case studies have to be conducted to show the validity of the framework. Case studies have to be conducted with researchers in the domain of BMs and with practitioners such as CEOs. Furthermore, the theoretical foundation of the NBMF can be strengthened by defining a stand-alone ontology for NBBMs.

A major contribution to existing BM theory is the introduction of intra-company and inter-company relationships of building blocks in the BMC. Even if the NBMF has the broader scope of designing NBBMs, the defined relationships between the building blocks may be reused in the BMC of a single-company BM. Also, the mapping of elements in the building blocks of a BMC to elements of an income statement may be applied to the original BMC to provide profitability calculations of a BMC.

The NBMF can be used to discover new NBBMs for the IOT. Outgoing from the home automation case study, additional scenarios can be tested by varying parameters and changing parts of the NBBM. Also, case studies for other industries that are influenced by the IOT may be conducted with the goal to find new dynamics and patterns. Furthermore, the NBMF Design Tool may be used as tool support for the IoT Business Model Builder [Bos15] due to the same purpose and similar mindset of the two frameworks.

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Glossary

after-sales describes an action that takes place after the sale (and often delivery) of a product or service. 28

Cloud is a network of remote resources on the Internet. It consists of a shared pool of configurable computing resources (e.g. networks, servers, storage, applications and services). 1, 27–29

CRM system is short for customer relationship management system .It is a software solution that allows the management of information and data about relations to customers. 13, 27, 46

cross-selling is the practice to sell complementary or related products to a customer. 35, 84

DDoS is short for distributed denial-of-service. It is a cyber-attack where the perpetrator paralyses a computer network or server with data sent simultaneously from many individual computers. 29

economies of scale describes the cost advantages of increasing size, output, or scale of operation. Costs per unit decrease with increasing scale because fixed costs are spread over more units. 12, 15, 16, 23, 31–38, 58, 120, 123

ERP system is short for enterprise resource planning system. It usually consists of a set of integrated management applications for production planning, inventory, marketing and sales. 23, 27, 46

Moore's law is an observation by Gordon E. Moore that says, that computing power doubles every year. 12

Network-based Business Model is a business model which is designed to work out in a network environment. Such a business model does not only try to serve the purpose of the own firm but should be beneficial for the whole network. 2, 134

PLM system is short for product lifecycle management system. It is a software solution that manages the lifecycle of products from the inception to the disposal. 27, 46

up-selling is the practice to sell higher-end products compared to products the customer desired to buy or already possessed. 35

yield management is a variable pricing strategy determined by the behaviour of the customer. The goal is to sell a product or service to the right customer at the right time for the right price. 14

Acronyms

API Application Programming Interface. 64, 65, 67, 69, 76, 81, 85, 86, 97, 103, 104, 123

B2B Business to Business. 13, 14, 30, 38, 44, 51, 56, 57, 121

B2C Business to Consumer. 30, 33, 34, 38, 44, 55, 78, 79, 85, 121, 122

B2G Business to Government. 121

BM Business Model. 2–7, 9–13, 15–17, 20, 21, 23, 24, 30, 31, 33–39, 41–48, 50, 51, 58–60, 62, 63, 65, 66, 69, 70, 77–79, 95, 97–99, 101, 109–113, 116–122, 125–127

BMC Business Model Canvas. 4–6, 11, 13, 16, 30–37, 43, 52, 53, 55–58, 62, 64–68, 70, 78, 79, 95–101, 107, 110–116, 118, 121, 126, 127, 129–131

BMI Business Model Innovation. 9, 20, 21, 110, 119, 121, 125

BMO Business Model Ontology. 4, 10, 11, 78, 110–114, 116, 126, 131

CEO Chief Executive Officer. 11, 17, 110, 112, 120, 127

COO Chief Operating Officer. 17

CTO Chief Technology Officer. 17

GDP Gross Domestic Product. 119, 126

GUI Graphical User Interface. 46, 55, 70, 82, 83, 112, 120, 126

HR Human Resources. 33, 67

IAAS Infrastructure as a Service. 76, 98

IOT Internet of Things. xiv, 1–7, 16, 25–30, 35, 39–44, 49, 77–81, 83, 84, 91, 109, 112, 116, 118–123, 125–127, 129

IP Intellectual Property. 37, 38, 59

MVC Model-View-Controller. 72, 75

NBBM Network-based Business Model. 2, 4–7, 21–24, 41–52, 54, 55, 58, 60–63, 68–70, 77–83, 85–87, 99, 101, 103–107, 109–112, 116, 118–121, 123, 125–127

OBMI Open Business Model Innovation. 21

PAAS Platform as a Service. 76, 98

R&D Research and Development. 29–31, 35, 38

REA Resource Event Agent. 10

RFID Radio Frequency Identification. 1, 25

RQ Research Question. 4, 30, 77, 119, 120

SAAS Software as a Service. 2, 3, 37, 38, 84

UCM Use Case Map. 19

UI User Interface. 34, 76, 83, 122

WSN Wireless Sensor Network. 1, 25

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