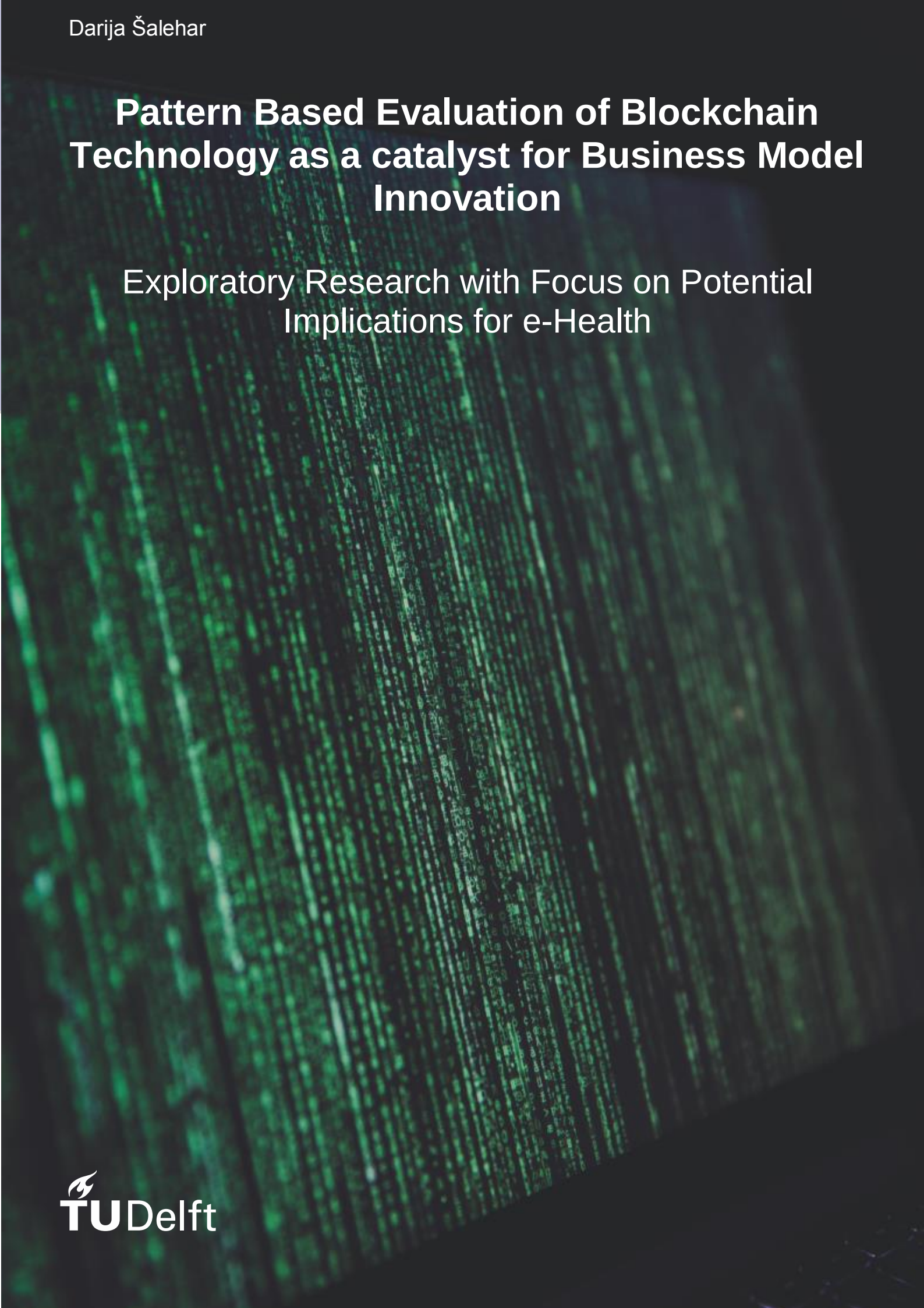
Darija Šalehar

Pattern Based Evaluation of Blockchain Technology as a catalyst for Business Model Innovation

Exploratory Research with Focus on Potential Implications for e-Health



TU Delft

Pattern Based Evaluation of Blockchain Technology as a Catalyst for Business Model Innovation

Exploratory Research with Focus on the Potential Implications for e-Health

By

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TU Delft

Abstract

As blockchain technology became more established in the financial arena, federal health IT officials, vendors and developers started looking at its potential and its use in the healthcare sector. Lately, there has been a major hype around the potential of the technology. It is described as a disruptive technology that could enable business model innovation with increased transparency, new models of partnerships and possible disintermediation. Business modelling was recognized as a potential tool to help the healthcare sector to determine a technology implementation strategy by involving all the important stakeholders in a value-driven dialogue about the way in which the technology should be utilized.

This research focused on exploring the potential of the blockchain technology for business model innovation with the use of business model patterns as a theoretical construct. From the scientific perspective, research contributed to a better understanding of the role of business model patterns as a construct with multipurpose character. The construct was used in a role of classification device to gain an understanding over the technology associated business model logics and in a role of instruments of scientific inquiry to explore potential technology implications. A two-way relationship between the disruptive technology and business models was considered. As a result, tokenization was proposed as a new business model pattern, specific to the blockchain technology. Moreover, value patterns (patient empowerment, privacy by design, security by design, transparency by design) were recognized as an important matter that is potentially impacting future business models. In the second step, business model patterns were evaluated in the context of e-Health industry specific moderators. A Discussion with the implication of the technology from the business model innovation perspective was provided.

Key words: Blockchain Technology, Innovation and Technology Strategy, Business Modelling, Business Model Innovation, Business Model Patterns, e-Health

Acknowledgements

"Blockchain. Never have so many people sought so much from a technology understood by so few. What makes it all the more significant is the fact that many of the most ambitious claims being made on behalf of technology touch on one of society's crucial keystones: trust."

World Economic Forum

Not a lot of days have passed in the last six months without blockchain technology being somehow present in my daily routine. If it was not due to the work on my thesis, I read about a new blockchain project in the news or had one of the many discussions with someone interested in the topic. I am really fascinated by such a huge interest and at the same time different views on the technology and curious about how will the technology development and adoption evolve in the future. With this research, I tried to take more critical stance to the technology from sociotechnical perspective and adaption of business model innovation perspective. All the complexities and novelty of the technology made this research project very challenging. Also finalizing this report does not seem like an end and still so many questions in my head related to the technology and surrounding phenomena are unanswered. However, every project needs a deadline and I also manage to finalize my master thesis with the help and support of many individuals that I would like to thank in next few lines.

First, I would like to thank my graduation committee Jeroen van den Hoven, Martijn Warnier and Mark de Reuver for all their support and advices during the master thesis process. I especially need to thank Mark, who spend the most time with me on developing this thesis project and help me to overcome many of the doubts that I had during the process. Thank you for always being critical, challenging me and along the process inspiring me for perusing with the research oriented career.

One of the best things in doing research on such a novel topic that everyone is curious about is that I had the chance to meet many professionals working in e-Health or on the blockchain projects. With many discussions, I got an opportunity to learn and discover interesting insights on the topic. I need to thank Marand for introducing me to the challenges and complexities of innovating in e-Health industry. I would like to thank Timber for the interesting insights on business model patterns and the theoretical background that I used in the research. And I would also like to thank Hamza, David, Guido, Helena, Gabriel, Jaco and Donika for their time and sharing with me their insights on the topic during the interviews.

Finalizing my master thesis also means an end of the period. Writing this I cannot believe how fast did the last two years pass. Moving to the new country is not always easy, you are always challenged to grow. Last two years in the Netherlands have been an amazing experience in all aspects and all thanks to extraordinary individuals and friendships that I have made along the way. First, I would like to thank Anne, Anthi, Zeynep and Thanos. Thank you for all your support, shared library time, life conversations and sharing so many nice moments and adventures in past two years. Next, I would to thank my crazy flatmates Mattia, Camila, Alessandro and Marcin for their incredible positive energy and spirit, all the Italian dinners, warm cups of thee and evening conversations. Also, thank you to Rocio for always making plans and life conversations and to Federico for all the intellectual coffees. The MOT master programme has been very unique experience also thanks to all the MOTers coming from all over the world.

Furthermore, I would like to thank my friends in Slovenia for supporting this thesis process from distance. Moreover, I owe a big thank you to my family Stanislav, Slavica and Dominik for their unconditional support, love and encouragement. Also, in the decisions that they sometimes don't understand at first.

Lastly, I would like to acknowledge Public Scholarship, Development, Disability and Maintenance Fund of the Republic of Slovenia for awarding me with Ad Futura Scholarship for Education and full coverage of all the expenses during my Master Studies.

I hope that you will enjoy reading this report!

Darija Šalehar
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INTRODUCTION AND RESEARCH APPROACH

1 Introduction and Research Approach

This chapter introduces the research topic, objective and approach. It is structured as follows. First, research motivation on why to study and evaluate blockchain technology from business model innovation perspective is explained. Second, research scope based on taking into account practical and scientific relevance is defined. Moreover, knowledge gaps on the topic are pointed out. Third, the research objective is formulated and research questions are defined. Fourth, research approach is described and visualized with a framework connecting research phases, main activities and research sub questions. Last, thesis structure is provided.

1.1 Research Background and Motivation

Blockchain is perhaps best known as the technology behind digital currency Bitcoin. Lately, there is a huge hype and the potential of the technology recognized by the media. Claims that the technology has the potential to transform industries operating models and enable new business models are stated in the grey literature (e.g. Dee, Bronwyn, & Ravi, 2016; Laurent, Laurent, Benoit, & Christian, 2016; Ream, Chu, & Schatsky, 2016). Furthermore, it is also viewed as an example of an enabling technology of the platform revolution trend (Michael, Nachiappan, Pattanayak, Pradan, Verma, Sanjeev, & Kalyanaraman, 2016). A Blockchain technology concept is based on a public decentralized ledger. It has the potential to enable any form of value to be exchanged between parties that do not trust each other in an encrypted format, without the need for intermediation by a centralized authority (Tapscott & Tapscott, 2016a). Some of the core recognized benefits of the technology are the potential for a substantial decrease of intermediaries, fraud, and access to real-time information without manipulations. Also, there could be a potential decrease in bureaucracy burden improving the time invested in these processes (Tapscott & Tapscott, 2016a). Technology is also recognized as the first native digital medium for value, just as the internet was the first native digital medium for information (Folkinshteyn, 2015). Possible implementation of the technology is wide: “any form of asset registry, inventory, and exchange, including every area of finance, economics, and money; hard assets (physical property); and intangible assets (votes, ideas, reputation, intention, health data, information, etc)” (Mattila & Seppälä, 2015).

According to Gartner Hype Cycle for Emerging Technologies blockchain still has five to ten years to mainstream adoption (Gartner, 2016). The investments in the technology are constantly growing and various stakeholders from governments, professional service providers, incumbents and start-up companies in various industries have all taken interest in the technology. As blockchain technology becomes more established in the financial arena, federal health IT officials, vendors and developers are also looking at its potential and use in healthcare. IBM claims that blockchain could enable business model innovation with addressing points as: interoperability, accessibility and data integrity; privacy and security; healthcare delivery models and costs; consumer engagement; and governance and compliance (IBM, 2016). However, some professionals from the industry stay very critical about success and potential impact of technology in healthcare (Reutzel, 2017). Their criticism and concerns can be supported by the observations of the researchers, who are emphasizing the problem that many eHealth technologies were not successful in realizing sustainable innovations in health care practices compared to other industries (Spil & Kijl, 2009; van Limburg et al., 2011).

This research will focus on evaluating blockchain technology potential as catalysts for business model innovation with the use of business model patterns as a theoretical construct. Scientific literature on the business model, technology strategy and business model innovation will be used as theoretical backbone

of the research. Potential of applicability of elicited business model patterns will be further examined in e-Health industry, which has recently taken interest in the technology.

The topic of the research is interesting in its timeliness: there is a hype around the blockchain technology, yet very little is known about its actual potential for business model innovation beyond financial industry. When companies are evaluating and exploring the possible opportunities and potential influences of this disruptive technology on their future business strategy they should according to Innovation and Technology management research combine the views of technology innovation and business model innovation (Baden-Fuller & Haefliger, 2013; Chesbrough, 2007, 2010). A better understanding of the potential impact of blockchain technology on business models and guidelines on the practical approach on how to evaluate the technology from business model innovation perspective could help companies to better understand and identify potential business opportunities.

1.2 Research Scope: Research Relevance and Knowledge Gaps

1.2.1 Definition of Practical Problem

Blockchain is in the industry and academia characterized as a new disruptive technology. Its disruptive potential is even compared to the revolutionary impact of World Wide Web on the businesses and industries (Folkinshteyn, 2015). Since blockchain technology is a new phenomenon which requires understanding of complex technological concepts there has been a lot of inconsistency in the literature and still not much is known about the potential technology implications from business and also societal perspective. Moreover, it also needs to be taken into account that the technology is at the time of the research at the peak of inflated expectations in the Gartner Hype Cycle. This makes the technology a challenging object of research due to limited information availability and also the fact that the limitations of the technology are often neglected by the enthusiasm (O'Leary, 2008).

The concept of disruptive technologies originates from Christensen work in which he refers to the concept as technologies that have a far reaching impact on the future structure of business and value creation (Bower & Christensen, 1995). As a basic characteristic, disruptive technologies lead to a severe shift in value creation networks giving rise to new market segments, enable business model innovation and even transformation of operation models in the industry. The main challenge that companies are facing when analysing disruptive technologies is to anticipate the new business logic that those technologies could enable. To successfully respond to the market changes the new business models or business model innovation is required in order to meet the changes in the business logic (Christensen, Grossman, & Hwang, 2009). As Chesbrough warns technology companies should include business model innovation is required in order to meet the changes in the business logic (Christensen, Grossman, & Hwang, 2009). As Chesbrough warns, technology companies should include business model perspective in their innovation processes to lower high costs and risks associated with R&D and also since a better business model has the potential to beat a better idea or technology (Chesbrough, 2007). However, many of the companies with the objective to exploit new technologies to stay competitive still only focus their initial resources on technological innovation and include business perspective much later.

As discussed the benefits of business models perspective are widely recognized by scholars since it can help managers and entrepreneurs to look beyond their company's existing system and encourages systematic and holistic thinking (Zott & Amit, 2010). Moreover, the concept and developed tooling are also to a certain extent used in practice. Nevertheless, there are many complexities related to utilization of business model thinking in practice reported by researchers. For instance, Frankenberger et al. developed a framework and identified key challenges that managers are facing in business model innovation process (Frankenberger, Weiblen, Csik, & Gassmann, 2013). In the ideation phase, which is the focus of this study, the following challenges were identified. First, managers have difficulties in overcoming the current

business logic and achieving out of the box thinking due to challenging industry regulation. Second, thinking in terms of business models is challenging as majority is used to think in terms of product or service innovation. Third, managers reported that they do not know many tools that support systematic thinking to support new business model ideas. All of these challenges are very relevant for the context of this research. Moreover, the complex disruptive characteristics of the technologies bring additional uncertainties when companies are evaluating the potential of utilizing new technologies. Therefore, some researchers approached this challenge with adopting existing tooling and methodologies for business model innovation or technology assessment to the characteristics of disruptive technologies (Amshoff, Dulme, Echterfeld, & Gausmeir, 2015; Baden-Fuller & Haefliger, 2013; Propp & Rip, 2006)

The link between business model and technology further assumes a particular relevance when analysing the introduction of technological innovations in a specific industry. Many researchers focusing on innovation in e-Health have emphasized that many IT/IS technologies are not successful in realizing sustainable innovations in health care practices due to mostly technology-driven focus instead of being focused on actual value creation (Mettler & Eurich, 2012; Spil & Kijl, 2009; Sprenger & Mettler, 2016; van Limburg et al., 2011). Moreover, Spill and Kijl argue that by giving business model innovation a high priority right from the beginning of a project and developing the business model in iterative loops, the failure rate of e-health service innovations may be lowered (Spil & Kijl, 2009). The reason for that is that the business model designs are expected to be more viable as a result of better alignment with available resources and capabilities as well their external environments.

To sum up, this research will address challenges that companies are facing when exploiting and assessing blockchain technology for business opportunities. The starting assumption, on which the research is built, is as noted by academic scholars that companies should include business model perspective from the start, when exploiting business opportunities of disruptive technologies. Therefore, first the understanding needs to be gained about how the blockchain technology can trigger business model innovation. Next, practical issues related to business model thinking in practice need to be taken into the account. Also, how to deal with the differences in introducing the technology innovation to a specific industry need to be addressed. The application domain of this research is e-Health industry, which is specifically challenging due to high regulations and also low sustainable utilization of new IT/IS technologies.

1.2.2 Definition of Scientific Problem

Relation between business model choice and technology is two-way and complex and something that has received little attention from academic researchers so far (Baden-Fuller & Haefliger, 2013). Technology development can facilitate new business models and can be consequently recognized as the external antecedents of business model innovation (Foss & Saebi, 2016). In addition, developing the right technology and utilizing it in a profitable manner is a matter of business model decision. This research will incorporate and reflect on this two-way relationship in the context of blockchain technology with the use of business model patterns as theoretical construct and explore the applicability of identified patterns in e-Health domain.

Based on the practical problem of the research business model, patterns were chosen as a theoretical construct. The pattern concept stems from the work of Alexander in the architecture(Alexander, Ishikawa, & Silverstein, 1977), has been widely used in the disciplines such as software design and architecture but it is not yet widely used in the business model literature. The concept was chosen as a theoretical construct of this research due to the following reasons. First, a pattern approach offers flexibility in the analysis since the impact of the disruptive technology on the business models can be analysed at different levels of granularity. Second, since one of the key challenges with technological innovation is to anticipate the new business logic use of the business model patterns interpreted as proven business model, elements in already established companies can reveal valuable insights about used business logics (Amshoff et al.,

2015). Third, by being aware of different business model patterns managers can generate or adapt existing business models in a more systematic way (Gassmann, Frankenberger, & Csik, 2015; Lüttgens & Diener, 2016).

Usage of business model patterns in academic literature is scarce and a new topic. The idea of the concept was inspired by its use in other disciplines (e.g. architecture, engineering and software design) (Amshoff et al., 2015). However, not much is actually known about how the concept relates and compares to other existing approaches in the business model and business model innovation literature also aiming to support practitioners in business model analysis, design or innovation. Furthermore, understandings of the business model pattern concept varies by scholar and consequently the concept usage can be confusing and even contradictory, with the available collections of the patterns incomplete, overlapping, and inconsistently structured (Remane, Halet, Tesch, & Kolbe, 2016). The most extended work on the business model patterns as a tool for systemic business model innovation has been done by Gassmann et al. in his work Business Model Navigator, in which he identified 55 business model patterns (Gassmann, Frankenberger, & Csik, 2013). The work is based on the finding that 90 % of the innovations turned out to be such re-combinations of previously existing concepts (Gassmann et al., 2013). Amshoff et al. have recognized that the pattern based approach in general helps increasing efficiency in business models design processes, but especially lacks methodological support so far (Amshoff et al., 2015). For instance, Gassmann et al. do not provide a clear description on how they derived all the patterns.

Patterns have been in the technology management literature used to explain relevant business model opportunities in the context of new technologies or technological trends (Abdelkafi, Makhotin, & Posselt, 2013; Laurischkat, Viertelhausen, & Jandt, 2016; Rudtsch, Gausemeier, Gesing, Mittag, & Peter, 2014; Sprenger & Mettler, 2016). Finally, identification of new business model patterns evolved from digital transformation and recent advances in digital technologies can make an important contribution to theory and practice (Remane et al., 2016).

To conclude, this research aims to evaluate blockchain technology potential for the business model innovation with the use of business model patterns taking into account two-way relationships between business model and technology. More specifically, the use of the business model patterns as a theoretical construct will be explored in the context of new emerging digital technology. Its versatility as a unit of analysis for identification of implications of the new technologies in context of business model innovation will be explored.

1.2.3 Knowledge Gaps and Research Relevance

After identifying the practical and scientific problem the main knowledge gaps can be deduced and research relevance can be emphasized. First, blockchain technology is a new and complex phenomenon with potential sociotechnical consequences, which is gaining rising attention from the various industries and also academics from different disciplines. Consultancy companies and big technology companies are classifying the technology as disruptive technology, which has the potential to change future business models and even operating models of the industries. However, not much is actually known about the technology from the business model innovation perspective. Mostly only potential use cases are described with no further evaluation on implications of the technology on business models or comparison to existing solutions. Therefore, the research aims at contributing to the knowledge base about the blockchain technology from the strategic business perspective. Since business model innovation is in terms of novelty and scope dependent on the industry specific moderators it was chosen that attention will be given to further exploration of potential implications for e-Health sector, which just recently took the interest in the technology. Therefore, with application of identified patterns in the e-Health field the research aims to bring additional insights on the technology potential from the business model innovation perspective for that particular industry.

Second, business model patterns are a new concept in the business model innovation literature. They have been suggested as a useful theoretical construct in understanding business opportunities and new business logics brought by the new technologies. Moreover, scholars have recognized their benefits as a tool for systematic business model innovation. However, there is lack of knowledge in the research conducted so far on the methodological approaches of pattern identification, the concept exact role in the comparison to other approaches developed to support practitioners in business model innovation literature and also there is no reflection or consideration on two manner relationships between business models and technological innovation. Complex socio-technical character of blockchain technology and its uncertain implications on business models on different levels of granularity make the technology relevant practical setting for studying scientific knowledge gaps recognized. Finally, the identification of potential new business model patterns caused by the emerging digital technologies as blockchain would also be a relevant knowledge contribution.

1.3 Research Objective and Research Question

Based on the stated knowledge gaps the objective of this research is formulated as follows:

The aim of the research is to explore how business model patterns as a construct can support evaluation of the blockchain technology from the business model innovation perspective in e- Health.

From the research objective, the following research question can be formulated:

How can identification of business model patterns relevant for the context of blockchain technology support the process of technology evaluation from business model innovation perspective in e-Health domain?

In order to answer the main research questions, the following five subquestions are formulated:

SQ1: What is the current state of the blockchain technology and what are related innovation opportunities that could have implication on the business models discussed in the literature?

The first question addresses understanding of the current state of blockchain technology and its potential implications on the business models. Based on the literature review and desk research, the current state of the technology and related innovation opportunities that could have implications for the business model innovation will be described.

SQ2: How can business model patterns as a construct support evaluation of the blockchain technology from business model innovation perspective for e-Health industry?

The second question focuses on the theoretical background on the business model, business model innovation and business model patterns. Moreover, attention is given to exploration of the relation between those theoretical components and technological innovation. Based on the scientific literature review the role of the business model patterns will be examined as a unit of analysis that can help to understand business logics associated with the new emerging technologies. Furthermore, the role of the business model patterns in the scientific literature and its benefits and limitations as a tool supporting practitioners in business model analysis, design or innovation and related strategy creation will be explored. Lastly, how the industry specifics need to be taken into account also needs to be answered.

SQ3: Which are the relevant business model patterns in the context of blockchain technology that can be identified?

The third question addresses identification of the relevant business model patterns in the context of blockchain technology. First, the methodology for patterns identification will be built based on the outcomes of the first two subquestions. Next, identification of patterns will be conducted. The outcome of this research question will be collection of relevant business model patterns that were identified.

SQ4: To what extent can the usage of business model patterns help understand potential implications of blockchain technology for e-Health industry from business model innovation perspective?

With the identified patterns the potential of business model innovation triggered by the blockchain technology will be further explored for e-Health context. The evaluation of usage of identified patterns for evaluating the technology in e-Health domain will be conducted. This question will reflect on the insights gained about blockchain technology potential in the context of e-Health industry and the utility of business model patterns as a construct.

1.4 Research Approach and Structure

Based on the identified research problem and objective the research approach was determined. Focus on the new topic of interest is a characteristic of an explorative research (Bhattacherjee, 2012). An exploratory approach is adopted when there are no or only few earlier studies on the research problem to relay upon to predict an outcome. This research focuses on the new topic of interest from both domain and theoretical perspective. As presented in the scientific problem business model patterns were recognized as a construct that could support evaluation and business model design in the context of technological innovation. However, the construct is new in management literature and there were inconsistencies and knowledge gaps recognized related to its usage. Moreover, relevant existing studies using the construct were conducted in the context of specific technology. Therefore, the state and character of blockchain technology and its surrounding phenomena can bring additional constrains and limitations that need to be addressed in research methodology construction.

The major emphasis in exploratory studies is a generation of new ideas and assumptions, which can help determine the direction for future research and refine the issues for more systematic investigation (Kothari, 2004). Therefore, overall research approach must be flexible enough to allow consideration of different aspects of a phenomenon. Research approach of this study is divided into three main phases: exploration, research design and research execution. Based on those three phases and need for a flexibility due to exploratory design of the research the final research process was developed. The research structure connecting research phases, main research activities and research sub questions is visualized in the Figure 1.

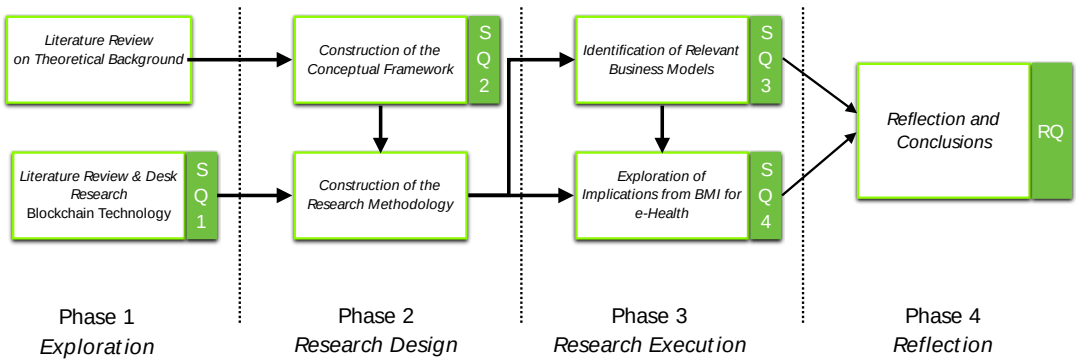

Figure 1: Research Structure

Phase 1: Exploratory phase

Exploratory phase is constructed from two individual steps. First, the focus will be given to the understanding of the domain of blockchain technology from technical and societal perspective (Chapter 2). Literature review and desk research on the technology will be conducted. Since the research topic is new also literature as master thesis, business books and grey literature will be reviewed. First step aims at describing the current state of the blockchain technology and innovation opportunities of the technology that have already been discussed in the literature. The outcome of this phase is the answer to the first research sub question.

In the second step, extensive literature review on the theoretical concepts used will be conducted (Chapter 3). This step aims at identifying main theoretical components and relations between them. Those will be later used to construct research conceptual model. Literature search based on the following key words will be conducted: business models, business model innovation, business model patterns, technology innovation and business models. Subsequent search engines and databases will be used to collect literature: Google, Google Scholar, Web of Science and Science Direct.

Phase 2: Research Design Phase

The research design phase is about creating a blueprint of the activities that need to be conducted in order to address the research question (Bhattacherjee, 2012). First, research framework and conceptual model will be developed based on the theoretical background (Chapter 4). The research builds upon the theoretical components to understand the relationship between technological innovation, business model, business model patterns and business model innovation. Next, the research methodology is built (Chapter 5) based on the application of research conceptual model and also consideration of the current state of the blockchain technology. The relevant data for analysis is found and collected. The second research subquestion will be answered after this phase.

Phase 3: Research Execution and Presentation of the Results

In the last phase research will be executed based on the developed methodology with analysing collected data as defined. The results will be presented and discussed (Chapter 6 and Chapter 7). Third and fourth research sub questions will be answered. After this phase is concluded the main research question can be answered. Moreover, conclusions and recommendations will be developed and suggestions for the further research will be provided. Last, limitations of the research will be emphasized and knowledge contribution will be highlighted.

1.5 Thesis Structure and Reading Guide

Thesis structure follows the research approach presented. This introduction chapter presents an overview of the research background, research objective, research questions and overall approach that was taken to conduct this research. The rest of the report is structured as follows. The first part focuses on the results of exploratory part based on the literature study. Chapter 2 provides the insights of the literature review on the blockchain phenomena. In the Chapter 3 the literature review on the theoretical background is presented. The second part describes research design phase. Chapter 4 presents research framework and development of the research conceptual model. Next, chapter 5 describes the developed research methodology. Last phase focuses on presentation of the results and its reflection. Chapter 6 describes identified patterns relevant for the context of blockchain technology. Chapter 7 focuses on the evaluation of the use of patterns when exploring the potential of the technology from business model innovation perspective in the e-Health context. The thesis concludes with Chapter 8 where conclusion and reflection on the results is provided.

The reader should be aware that each chapter is structured as follows. Chapter starts with a short introduction explaining its aim and structure. At the end, a short conclusion is provided summarizing the main contribution of the chapter to overall research. The thesis structure is presented in the Table 1.

	Chapter 1 *Introduction & Research Approach*
Phase 1	**Chapter 2** *Blockchain Phenomena*
	Chapter 3 *Theoretical Background*
Phase 2	**Chapter 4** Conceptual Framework
	Chapter 5 *Methodology*
Phase 3	**Chapter 6** *Identified BM Patterns relevant for the context of Blockchain Technology*
	Chapter 7 *Evaluation of Blockchain Technology as a Catalyst of BMI in e-Health*
	Chapter 8 *Conclusion and Reflection*

Table 1: Thesis Structure

EXPLORATION

2 Explanation of the Blockchain Phenomena

This chapter aims at presenting blockchain technology and its surrounding phenomena from sociotechnical perspective. First, emergence of the technology is briefly described. Second, the technology overview is given. Detailed definitions of technological concepts that can help a reader gain better understanding of basic technological concepts can be found in the Appendix A. Further, particular attention is given to the previous work that offers a starting point for further socio-technical analysis. Third, the current state of the blockchain technology is presented. The fourth part dives into the hype and interest on the technology from the business perspective. The focus is given on the possible implications of the technology for businesses and society by reflecting on the literature discussing the potential effects of the use of technology on the micro level (end users/consumers), the meso level (corporations), and the macro level (society). Last, the technology innovation opportunities recognized relevant for the context of this research are emphasized.

2.1 The Emergence of the Blockchain Technology

The blockchain phenomena stared in 2008 with the paper introducing bitcoin, a peer to peer electronic cash system (Nakamoto, 2008). Components that constituted a proposed solution were not novel itself, however their unique and novel combination led to the realization of functional crypto currencies system with solving the double spending problem. The innovation has continued with the realization that the technology behind the bitcoin could be separated from the currency system realization and have further evolved with the concept of smart contracts embodied in a second-generation blockchain, development of different consensus mechanisms and research on the technology scaling. In 2015 the majority of financial institutions publicly announced interest in the technology. The innovation landscape of blockchain technology conducted until now represents only last 10 years of work by intersection of computer scientists, cryptographers, and mathematicians (Gupta, 2017c).

According to Gartner Hype Cycle for Emerging Technologies blockchain technology still has five to ten years from mainstream adoption and is at the moment of this research placed at the peak of the cycle (Gartner, 2016). As noted by the researchers when technology is at the peak usually first generation products are already available at the market and the negative press begins, afterwards the trough of disillusionment follows (O'Leary, 2008). Similar can be noted about the current state of the blockchain technology. Due to the hype around the technology there is a lot of inconsistency and also misunderstanding of the technology capabilities and terms explaining the concepts related to it. This makes the technology a challenging object to study. Therefore, this chapter will serve as a basis of this research in terms of understanding the whole phenomenon and focus will be given on explaining and summarizing the key findings that were so far suggested in the literature in terms of potential opportunities for the innovation.

2.2 Understanding of the Blockchain Technology

The term blockchain is in grey literature (Dee et al., 2016; Laurent et al., 2016; Ream et al., 2016; Swan, 2015, UK Goverment, 2015) usually used when referring to one of the following concepts: distributed ledger in Bitcoin, competitive solutions to Bitcoin stack, rebranding of distributed ledger technology or futuristic middleware technology that will enable realization of concepts as smart contracts and decentralized autonomous organizations (DAOs). Furthermore, when examining the blockchain based systems from software architectural point of view, one has to note that the technology realization consists of several pieces of functionalities: a database, a software application, a network of computers, consensus algorithm, clients to access it, a software environment to develop on it, tools to monitor and more. This report refers to this as blockchain technology stack.

A Blockchain is essentially a public ledger, which maintains a continuously growing list of ordered records called blocks that are stamped and linked together. It is built based on the orchestration of the following three technologies: private key cryptography, P2P network (distributed network) and blockchain protocol. Important concept to understand is consensus mechanism, which is the process in which a majority (or in some cases all) of network validators come to an agreement on the state of a ledger. In this way, the control on the state of database is distributed and there is no third-party validation needed. Furthermore, there is a single, globally accepted view of events, which makes the ledger immutable and the entire network's activity transparent, verifiable and auditable. Existing and potential activities regarding blockchain technology can be broken down to three categories: Blockchain 1.0 (currency), Blockchain 2.0 (contracts) and Blockchain 3.0 (applications) (Swan, 2015). From the technical view, blockchains that support the bitcoin – style transactions (UTXO model) are uniquely suited for the transfer of and tracking of digital tokenized assets, whereas blockchains that support the account-based model take this further and give the means to run arbitrary logic, also known as execution of smart contracts, and establish verifiable multi-step processes (Christidis & Devetsikiotis, 2016).

The current research on the blockchain technology is very scarce and has consequently limitations that have to be taken into account. First, most of the scientific work done on the technology so far is taking monodisciplinary perspective and is also mostly only focusing on bitcoin blockchain systems (Glaser, 2017; Yli-Huumo, Ko, Choi, Park, & Smolander, 2016). Second, the perspectives of analysing the potential of blockchain technology in the literature so far vary in terms of abstraction taken on systems architectural level and lacks common understanding of specific innovative features of the technology that could be used as initial point for researchers in non-technical disciplines. Authors have explored the potential of the technology as an architectural basis for industrial platforms (Johansen, 2016; Mattila, Seppälä, & Holmström, 2016); software connector (Xu et al., 2016); network of smart products and services in the connection with internet of things (Christidis & Devetsikiotis, 2016; Mattila & Seppälä, 2015; Zhang & Wen, 2015) and a new type of distributed database (Morabito, 2017; Tapscott & Tapscott, 2016a).

As stated, the aim of the first step of exploration phase concerning the blockchain technology is to provide a satisfactory starting point for evaluation of the potential technological impact from the sociotechnical perspective. Three academic articles were found that comply with this intention and will be presented further on. First, Seebacher and Schurtz conducted the first structured literature review of the peer-reviewed articles choosing service system as a unit of analysis since one of the main design component of the technology is peer-to-peer network, which is enabling collaboration between different parties (Seebacher & Schüritz, 2017). The key characteristics and its underlying elements are visualized in the Figure 2.

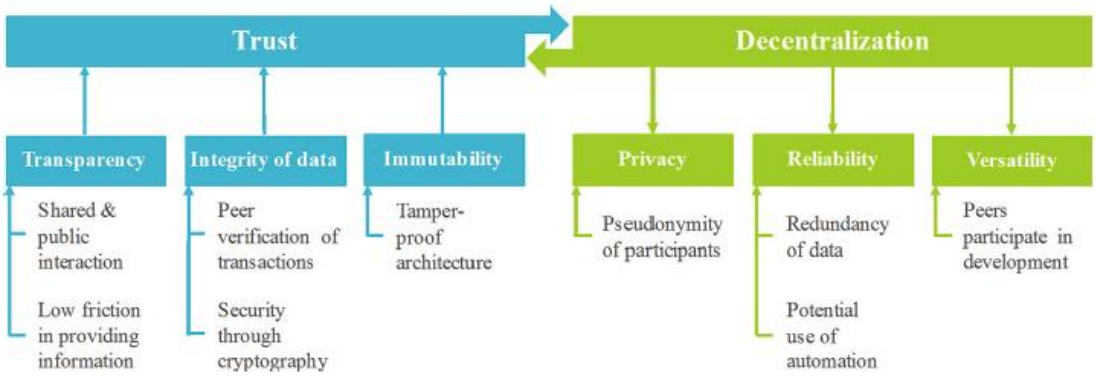

Figure 2: Visualized Set of Key Characteristics of the Blockchain Technology Based on the Systematic Literature Review (Seebacher & Schüritz, 2017)

Two main characteristics trust evoking and decentralized nature of the technology are in the case of the blockchain technology interrelated (Seebacher & Schüritz, 2017). Mechanisms used to establish trust are needed that the decentralized network can be established in which a reliable transaction can take place. On the other hand, decentralization provides a mean with which the users can join the network and which establishes the foundations for consensus mechanism and, consequently, there is no need for a third party in the case of public blockchains as bitcoin. This interrelated relationship between two main technology attributes makes it impossible to generalize what the overall benefits or characteristics of the technology are since those are highly depended on the design decisions taken in individual application or system.

Second, Glaser recognized the lack of common knowledge base and developed a framework for communication and guided analysis of blockchain applicability (Blockchain 2.0 and 3.0), taking into account that truly innovative character of technology lies in its openness and technologically driven capability to pervade multiple layers of digital ecosystem architecture (Glaser, 2017). The developed framework represents layers of blockchain systems and is visualized in the comparison to the commonly used 3-Tier architecture in the software design in the Figure 3.

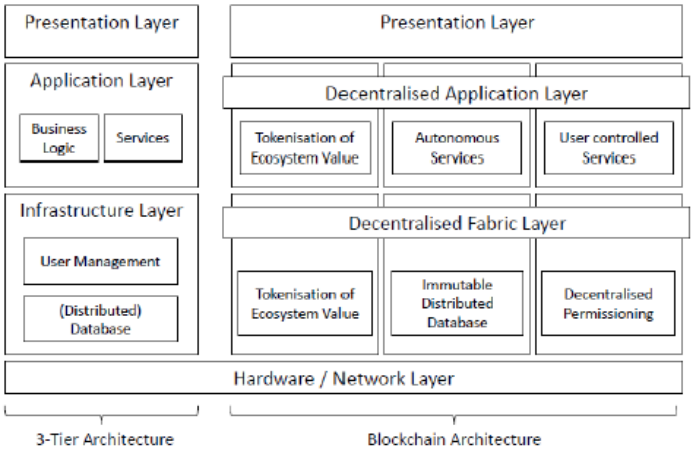

Figure 3: Layers of Blockchain Systems (Glaser, 2017)

The framework importantly distinguishes between decentralised fabric layer, decentralised application layer and presentation layer. The decentralized fabric layer represents the blockchain code base and consists of: communication layer, public key infrastructure, data structures to construct and maintain the database and execution environment for smart contract languages. It is important to understand the centralisation of the control in this layer since whoever develops and maintains the fabric layer has the ultimate control of the system. In contrast to fabric layer, the code of application layer can be written and bound to the system by

any participant and consequently the control of this layer is pushed into the hands of decentralised user space where its control is equally decentralised. The common notion of “trustless systems” therefore refers to the combination of decentralisation of control and immutable representation of the transition of system states (Glaser, 2017).

Third, in order to understand the design decisions that need to be taken into account in the blockchain based system architecture, different configurations and variants need to be considered. Developed taxonomy by Xu et al. captures major architectural characteristics and impact of the design decisions taken (Xu et al., 2017). The taxonomy describes design decisions regarding four categories (Xu et al., 2017):

- Decentralization (partial decentralization based on permission and verification)
- Storage and Computation (item data, item collection, computation)
- Blockchain Configuration
- Deployment and Other (anonymity, incentive, deployment)

There is a range of possibilities between centralization and decentralization that can be achieved in regard to permission (joining the network, initiation of the transaction, mining) and verification (single verifier trusted by network, M of N verifiers trusted by the network or ad hoc verifier). Based on the distinction on who has access to the network following three functional design versions can be derived. First, *public permisonless* design (fully decentralized), where there are no restrictions on reading and submitting the transaction and on who can take part in the consensus (e.g. the Bitcoin blockchain). Second, *public permissioned* design, where there are no restrictions on reading and submitting the transaction, however, there is the restriction on who can participate in the consensus mechanism. Third, private *permissioned blockchain* owed by institution or consortium (e.g. IBM blockchain). It has to be noted that permission management itself may become a potential single point of failure (Xu et al., 2017). Main design decisions regarding data storage and computation address what should be placed on chain and what should be kept off-chain. Blockchain configuration decisions refer to the choice of blockchain scope (public, consortium, private), data structure, consensus protocol and protocol configuration. Moreover, it is also relevant to consider the anonymity and incentive design. Last, the deployment of blockchain also has an impact on the quality attributes of the system.

Overall it is important to emphasize that some of the design decisions also require trade-offs between the fundamental properties of blockchain (immutability, non-repudiation, integrity, transparency and equal rights) (Xu et al., 2017). Nevertheless, with some of the design choices main limitations as data privacy and scalability in systems can be enhanced.

To conclude, the blockchain technology is built on three basic pillars: decentralization, consensus, and cryptography. There are technological attributes recognized as decentralization, trust & provenance and resilience & irreversibility (Morabito, 2017). Furthermore, as Mougayar argues blockchain is offering programmable assets, trust, ownership, money, identity and contracts and this offers many opportunities how technology can affect business logic (Mougayar, 2016). Technology has also been named as a general purpose technology (Kane, 2017) and authors also recognized that the utilization of blockchain technology may, at a later point, allow novel complementarities, such as data science and machine learning on encrypted product data (Mattila et al., 2016) or enhanced functionalities in terms of internet of things (Christidis & Devetsikiotis, 2016; Zhang & Wen, 2015). However, there is still no clear evidence or source comparing technology functionalities to traditional approaches beyond conceptual level and businesses should realize that the blockchain system is not yet at an optimum maturity level (Wang, Chen, & Xu, 2016).

2.3 State of the Blockchain Technology

The ecosystem of blockchain applications, platforms and tools has been growing steadily. The overview of the discussed use cases is presented in the Appendix B. Blockchain venture capital funding reached 496 million in 2016 while ICOs totaled 236 million (Coindesk, 2016). Moreover, also governmental institutions have taken interest in the technology and its potential implication (e.g. UK Government, 2016). In comparison, academic research has shown little activity in the space of commercially oriented blockchain technology. Therefore, further aspects of coalition-specific and domain-specific blockchain technology should be addressed by the academic research (Lundbaek and Huth, 2017).

To understand the blockchain technology platforms space and different moving forces the following division can be made (Rodriguez, 2017):

- *Tier -1 Blockchain Platforms*: provision of fundamental building blocks of blockchain applications (e.g. Ethereum and Hyperledger)
- *Tier -2 Blockchain Platforms*: abstraction of the implementation of web or mobile apps (e.g. ErisTech)
- *Blockchain as a service*: native cloud services that enable the creation, scaling and management of blockchain applications (e.g. Azure, Bluemix Hyperledger)

It is important to distinguish between two main platforms enabling fundamental building blocks of blockchain technology: Ethereum and Hyperledger. Ethereum is an open source blockchain platform providing a platform for developers to build decentralized applications. It enables the realization of the smart contracts by offering decentralized virtual machine to handle the contracts (Buterin, 2014). The platform also enables the design and issue of the tradable digital token that can be used as a currency, a representation of an asset, a virtual share or proof of membership (Ethereum, 2017). Hyperledger is an open source blockchain platform, which was started by the Linux Foundation in December 2015 (Hyperledger, 2017). It is developing blockchain based distributed ledgers to support global business transactions with the goal of improving many aspects of performance and reliability.

The following trends describe the state of the market of blockchain technology in 2016 and beginning of 2017 (CoinDesk, 2017). First, enterprise incumbents have moved on the blockchain with the proof of concepts and vision definition (e.g. Microsoft, Deloitte, Accenture, IBM). Major IT companies offer experimental environments for blockchain technology as a service (e.g. IBM's hyperledger and Microsoft's Ethereum blockchain sevices) (Lundbaek and Huth, 2017). Moreover, many startup companies gained ground. Second, token sales as a new method of raising money through initial coin offering (ICOs) challenged traditional venture capital investments. Third, consortia gain steam (e.g. banking consortium startup R3 that leads the consortium of 70 biggest financial institution). Fourth, the privacy has become an important consideration in blockchain protocols.

Awareness of the state of the technology for the purpose of exploratory research is important since the state of the technology puts the limitations on the types of research that can be conducted. Blockchain technology is at the moment of this research at the peak of the Gartner Hype Cycle (Gartner, 2016). As recognized by O'Leary the overenthusiasm is typical for the technologies in that phase, which can also influence academic research (O'Leary, 2008). Those limitation will be further considered during research design phase.

2.4 Potential Societal and Business Impact of Blockchain Technology

Interest in the blockchain technology is constantly growing and various stakeholders from governments, professional service providers, incumbents and start-up companies in various industries have all taken interest in it. Mattila and Sepalla emphasized the following three reasons why blockchain is interesting subject of analysis from the view of social and industrial digitalization: high increase of venture capital with similar trend to the investments made on the internet, innovation projects launched by major technology companies and promising, unique technical features in terms of platforms (Mattila & Seppälä, 2015). Understanding the implication of technology on business can be explored at different levels of analysis. Giaglis & Kypriotaki suggest that information system research on digital currencies and bitcoin should make a clear distinction between: the micro level (end users/consumers), the meso level (corporations), and the macro level (society) (Giaglis & Kypriotaki, 2014). This division will also be used in this chapter to explain what has in the literature so far been discussed about the blockchain technology implications relevant for the business view.

From a macro level perspective, the influence of technology on the society at large can be studied in terms of direct economic consequences and indirect implication to life, consumption patterns, data privacy and similar. Regarding blockchain technology the macro level perspective was in academic literature so far mostly studied from the economic perspective (Catalini & Gans, 2016; Davidson, Filippi, & Potts, 2016; Kane, 2017; Meijer, 2016). Davidson et al. suggests two approaches to economics of blockchain: innovation-centred and governance-centred (Davidson et al., 2016). From the innovation-centred perspective blockchain technology can be seen as a general-purpose technology. This view is also supported by Kane, who confirms this statement by analysing contemporary data of 200 blockchain applications (Kane, 2017). Based on the analysis he argues that compared to other innovations blockchain technology displays the ability to improve, enable wide penetration of markets and further spawns' new innovations. In the view based on New Institutional Economics perspective blockchain technology can not only lower production costs, such as increasing efficiencies and decreasing risk, but also lower transaction costs. Therefore, Davidson et al. argue that the latter approach is recommended since the technology can be better understood as a revolutionary new institutional technology for economic coordination (Davidson et al., 2016). Meijer built on this perspective with the grounded theory research approach to understand the perceptions of different stakeholders on the technology from the institutional perspective and came up with the following conceptualization: re-intermediation of trust in environments with highly institutionalized values (Meijer, 2016). In the blockchain debate, trust takes a central position, which can be explained by the fact that the technology was designed with the assumption that trust is completely absent among users participating in the network (Nakamoto, 2008). However, Meijer based on the conceptualization of trust suggests that actors should also consider technology from control-perspective since it has the ability to increase control over counterparties in a transaction, but decreases control from a systems-perspective (Meijer, 2016).

At the meso level, the blockchain technology is interesting for businesses since it represents an opportunity to reinvent processes, operations, business models and strategies. Therefore, researchers can contribute to knowledge base by identifying opportunities and pitfalls for innovation (Giaglis & Kypriotaki, 2014). Glaser argues that digital innovation of blockchain technology with environmental developments holds opportunities to create and integrate new services and business models in the existing digital economy (Glaser, 2017). The opportunities for new types of digital platforms and services based on the blockchain technology have been the best recognized so far in the payment industry with examples such as peer-to-peer and direct transaction, cross-border and cross-currency transaction (Lindman, Tuunainen, & Rossi, 2017). Further, this change in services has a potential for new business models in the market and while some existing ones become obsolete, a strong impulse for new business model is given by new players like fintech companies in the case of payment industry who are able to leverage bigger potential of the technology (Holotiuk, Pisani, & Moormann, 2017).

Taking multi-user system perspective on the design of the technology valid use case for blockchain systems seem multi-sided, collaborative and P2P digital markets (Glaser, 2017). Furthermore, blockchain systems have the potential to leverage better interoperability in electronic markets due to its pervasive, decentralised and open design (Glaser, 2017). This reasoning can be linked to the claim that if the blockchain technology could overcome the digital trust and data-synchronization issues, this would evolve into the creation of multisided platforms with broader network effects (Mattila et al., 2016). Since the attributes as decentralization of the technology introduce new elements into the discussion on the platform economy the questions of platform ownerships and value capturing mechanisms are raised (Mattila et al., 2016). Nevertheless, blockchain technology characteristics recognized could potentially play the role in the transition from centrally controlled platforms to decentralized platform control, support return of data ownership to consumers and enhanced the trend of sharing economy (Tapscott & Tapscott, 2016a).

Blockchain technology could have different implications in various industries. Research exploring the role of digital trust on business model innovation by comparing financial and energy industry proposes that blockchain could result in disruption when trust is part of the value proposition (Seppälä, 2016). Potential other possible effects as a consequence of increased digital trust can be categorized under following three categories: disintermediation, data transparency and new model of partnership (Seppälä, 2016). Disintermediation, higher efficiency and consequently decreasing need for the centralized authorities are the concepts mentioned extensively in the context of the blockchain technology. This can be explained by the fact that the technology was initially designed as disintermediation tool (Morabito, 2017; Nakamoto, 2008). However, in the case of Bitcoin fully distributed application of blockchain a lot of third parties and money – making businesses contributing new types of intermediation services emerged due to the strong asymmetries of information between developers and end users (Kazan, Tan, & Lim, 2015; Morabito, 2017). Therefore, the concept of disintermediation can from the business model innovation perspective mean that there is opportunity for new entrants by providing different types of intermediary services.

Another perspective to analyse the potential implication of the blockchain technology in the enterprise setting is the value system, which can be defined as a coherent set of values adopted by an organization, or society as a standard to guide its behaviour in preferences in all situations (Morabito, 2017). The conclusion of the analysis conducted by Morabito is that blockchain adopters need to face several challenges such as the regulations that govern how it works, security and privacy issues, integration concerns and cultural acceptance to successfully match its potentials as a value system and capture the value of possible advantages (Morabito, 2017). Consequently, this means that adoption barriers could vary in different industry domains since the value systems differ. Moreover, based on the input from many blockchain practitioners Tapscott developed seven design principles that represent the vision of blockchain and should be in his view used for creating software, services, business models, markets, organizations, and even governments on the blockchain (Tapscott & Tapscott, 2016a). The design principles networked integrity, distributed power, value as incentive, security, privacy, inclusion and rights preserved stemming from bitcoin network design and its interconnected values are summarized in Table 2. This can be related to the concept of value sensitive design, a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process (Friedman, 1996).

Networked Integrity	**Trust is intrinsic, not extrinsic. Integrity is encoded in every step of the process and distributed, not vested in any single member.**
Distributed power	The system distributes power across a peer-to-peer network with no single point of control.
Value as incentive	The system aligns the incentives of all stakeholders.
Security	Safety measures are embedded in the network with no single point of failure, and they provide not only confidentiality, but also authenticity and nonrepudiation to all activity.
Rights preserved	Ownership rights are transparent and enforceable. Individual freedoms are recognized and respected.
Inclusion	The economy works best when it works for everyone. That means lowering the barriers to participation.
Privacy	People should control their own data. People ought to have the right to decide what, when, how, and how much about their identities to share with anybody else.

Table 2: Design principles of blockchain (Tapscott & Tapscott, 2016b)

Lastly, the final level of understanding and evaluating potential implication of the blockchain technology is micro level, where view is based on the end user perspectives. However, due to the early stage of the technology not more than importance of this view is emphasized in the literature up to now. In the grey literature, blockchain technology is presented as a solution to everything, not in details considering end user perception on the proposed use cases. Deeper understanding of what is acceptable for users and how they perceive trust and benefits of the potential blockchain technology enabled applications and services is needed in order to foster technology adoption in the future (Lindman et al., 2017).

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2.5 Conclusion

To conclude, this chapter starts with an overview of the technological concepts of blockchain, presents the current state of blockchain technology and then focuses on the reflection of current literature discussing potential societal and business implications of the technology from macro, meso and micro level. It provides answer to the first research sub question. The focus point of this research is the meso perspective considering potential business model innovation opportunities enabled by the technology from a company's perspective. The insights gained through literature review ascribe to the observation that technology shifts are not only a matter of technology innovation, but also have a close relation to the core of business models (Tongur and Engwall, 2014). The innovation opportunities identified are summarized in the Table 3.

Innovation Opportunities enabled by Blockchain Technology discussed in the Literature	Literature
General purpose technology	(Davidson et al., 2016; Kane, 2017)
Potential Disintermediation	(Morabito, 2017; Swan et al., n.d.; Tapscott & Tapscott, 2016a)
Digital Platforms with new features	(Glaser, 2017; Lindman et al., 2017; Mattila & Seppälä, 2015; Mattila et al., 2016)
New Services (e.g. asset digitalization)	(Glaser, 2017; Lindman et al., 2017; Seebacher & Schüritz, 2017)
Value Sensitive Design	(Morabito, 2017; Tapscott & Tapscott, 2016a)

Table 3: Innovation opportunities of blockchain technology discussed in the literature

The potential implications of blockchain technology that could have an impact on business model design relevant for this research are disintermediation, potential new services, redefinition of digital trust/control in the context of digital platforms and value sensitive design. The notion of general purpose technology is left out of the scope since its potential effects at the moment of the research cannot be observed due to the early stage of the technology. The next chapter provides an overview on the theoretical background of the research.

3 Theoretical background

Business model patterns are chosen as theoretical construct of this research due to their flexibility as a unit of analysis on different levels of granularity, its recognized potential to anticipate the new logics of technological innovation and usage as a tool for more systematic way to generate or adopt existing business models. This chapter provides theoretical insights on the construct gained through the literature review.

The chapter is divided into two parts. First, the concept of business model and business model innovation needs to be well understood. Therefore, the overview of the research studying both concepts is given with the focus on the studies in the field of innovation and technology management. Next, patterns emerged in the business model literature as a tool supporting practitioners in the business model analysis, design and innovation. Thus, scientific contribution supporting practitioners in business model research is discussed. Second part will provide an overview of the literature using business model patterns as a theoretical construct.

3.1 Business Model and Business Model Innovation Research

3.1.1 Emergence of Business Model concept

Business model concept is often associated to technology innovation. Based on the historical evidence that better business model can beat the technological idea scholars emphasize the importance of including business model perspective in the company's innovation process (Chesbrough, 2007). Business model relationship with technology can be formulated in a two-way manner. First, business models mediate the link between technology and firm performance. Secondly, developing the right technology is a matter of a business model decision regarding openness and user engagement (Baden-Fuller & Haefliger, 2013). The integration of new technologies into the existing product portfolio can open up new subspaces in terms of technical performance and functionalities, which consequently requires a new business model in order to capture the potential new value of the technology (Björkdahl, 2009). Moreover, business model can also be shaped by the technology network. Case studies showed that technological innovation network can with the provision of the necessary resources trigger changes in the company's activities (Calia, Guerrini, & Moura, 2007). Thus, the role of the business model could consist of unlocking the value potential embedded in new technologies.

The increasing role of the business model concept is especially significant in the context of information technology. There has been a progressive shift from a focus on the design of information system, to the design of IT enabled processes, and more recently to the design of business models for services provided through digital platforms (El Sawy & Pereira, 2013). This can be further explained with the observation that in the past commercial opportunities or technology problems called for technological solution in contrast to nowadays, when technological solutions are seeking commercial opportunities to trigger, or technological problems to solve (Gambardella & McGahan, 2010). The business model can be seen as an analytical tool for understanding the strategic challenges of firms facing technology shifts and explaining needed combination of service and technology innovation (Tongur & Engwall, 2014). Furthermore, the function of the business model concept can also be explained as interceding framework with mediating role between technological artefact and the fulfilment of strategic goals and objectives including the creation of the essential economic value (Al-Debei & Avison, 2010).

In the innovation and technology management literature, business model represents a new object of innovation, which complements the traditional subjects of process, product, and organizational innovation and involves new forms of cooperation and collaboration (Zott et al., 2011).
The business model innovation as additional dimension to innovation is a recent outgrowth of the business model literature (Bernd W. Wirtz, 2016; Foss & Saebi, 2016). The concept is in the literature studied from five different level of analysis: individual, team, firm, network (e.g. partnership and consortia) and the firm's institutional environment (e.g. industry, market, sector or society) (Andreini & Bettinelli, 2017). The majority of authors so far have taken a company as the unit of analysis. The main identified barriers that companies are facing in the process of business model innovation appear due to potential inertia of configuration of assets and processes, as well as cognitive inability of managers to understand the value potential of a new business model (Chesbrough, 2010). The role of technology is interestingly the central topic in the research from institutional level of analysis in the industry context. The technology can be characterized as external antecedents leading to business model innovation (Foss & Saebi, 2016). In this way, the technology push perspective on the innovation is adopted. The impact of technology evaluated from institutional level of analysis were discussed by Gambardella and McGahan, who have studied how business model innovation and industry structural changes are driven by general purpose technologies and have possible consequences at the firm and sector level (Gambardella & McGahan, 2010). Moreover, Hang and Christensen claim that the disruptive technological innovation has to be integrated in different business models in the health industry to create business model innovation (Hwang & Christensen, 2008).

As a construct business model innovation can be dimensionalized in terms of scope (as measured in terms of architectural and modular change) and novelty (new to firm and new to industry) (Foss & Saebi, 2016). Evolutionary BMI refers to changes in individual components of the business model, which are often occurring naturally over time. When company changes overall business model the adaptive BMI occurs, however, changes might be only new to the company. In contrast, focused and complex BMI can be defined as processes when the company actively engages in modular or architectural changes in the BMI to disrupt the industry.

Business model innovation has been in the literature widely studied in the context of recent emerging technology trends (El Sawy & Pereira, 2013; Huberty, 2015; Leminen, Rajahonka, & Westerlund, 2015). For instance, the research focusing on studying business model innovation emerging from the hype of the big data concluded that to date the technology has not achieved the distinction in value creation logic, instead successful big data business models largely use data to scale old modes of value creation (Huberty, 2015). Moreover, study conducted in the context of internet of things concluded that the concept should be from the business perspective viewed as a business ecosystem not as primarily only technology platform (Leminen et al., 2015). Following core shifts considering business ecosystem perspective that companies should consider in order to design more effective business models were identified (El Sawy & Pereira, 2013): digital platforms (e.g. internet of things, cloud computing, modular architecture), societal trends (e.g. sustainability, transparency, open source sharing) and value co-creation in the enterprises (e.g. open innovation, bottom of the pyramid).

Considering networks, societal values and interoganizational collaboration is becoming important in the context of business model innovation. However, the role of values in innovation management is often neglected. Building on this knowledge gap Breuer et al. argue that in order to better understand and design systemic innovation to address wicked problems (e.g. sustainable energy system) triad of business model innovation, collaboration in networks and values-based innovation need to be elaborated on (Breuer & Ludeke-Freund, 2017). Sustainability that can be characterized as a value is one of the topics widely discussed in the literature in the relation to business model design and innovation (Bocken, Short, Rana, & Evans, 2014; Breuer & Ludeke-Freund, 2017). Values-based business models can be defined as the way organisations create, deliver and capture value by pursuing values of their internal and external stakeholders (Breuer & Ludeke-Freund, 2017).

All in all, the literature reveals that business models and business model innovation perspective are intertwined with the technology innovation and should be taken into the account by the companies exploring emerging technologies. Moreover, companies should for effective business model design and innovation also take into consideration societal trends, values and co-creation in networks.

3.1.2 Tooling– Oriented Research for Business Model Design and Business Model Innovation

In line with the attempt to support practitioners' different tools, frameworks and methodologies to analyse, design or innovate the business model in systematic ways were developed by academic scholars. Taking into consideration the trade-off between the need for structured guidance on one hand and the need for creativity on the other, four types of general approaches for business model innovation that can be applicable also for the new business model design were identified (Bernd W. Wirtz, 2016):

1. Linear approaches that follow step-by-step procedure.
2. Semi structured approaches, which explicitly mention the need for inspiring, creative process steps.
3. Mixed approaches that combine liner and semi structured approaches.
4. Method oriented approaches that emphasize the methods and techniques applied instead of focusing on a process perspective.

Interesting idea proposed by Gunzel and Holm is to divide business model innovation in front end (externally oriented) and back end (internally oriented) innovation and suggest to use an experimental trial and error approach for front end innovation and a linear structured approach for back-end innovation (Gunzel & Holm, 2013).

Approach towards the concept of a business model design differs when comparing the work between American and European scholars (De Reuver, Bouyman, & Haaker, 2013). European scholars are more focused on casual modelling and design approaches in contracts to Americans who mainly focuses on classification in specific sector or its use in specific context. The biggest contribution in the development of the practical tooling originates from the information science research focusing on the design approaches and business model ontologies (e.g. Business Model Canvas, STOF, VISOR) (Bouwman et al., 2012). Moreover, following six general established approaches that could be used for business model design were identified in the literature reviewing work in scientific disciplines using business model concept (Eurich, Breitenmoser, & Boutellier, 2013).

Cases and lesson learned give focused insight into specific aspects and are useful for practitioners in similar situation, however they do not provide any structural guidance and they do not compare different options of business model design. Component – based approach on the other hand provides a very structural approach, yet the interrelations and dependencies are not made explicit. Those are taken into account in the addition to components in the conceptual models. Nevertheless, their strength and at the same time limitation is limited expressiveness and extension due to formal representation. Taxonomies develop typologies of business model by classifying them based on predefined criteria and can be used as a quick orientation and description of the business model; however, their practical use is limited since they are usually provided on a very abstract level. Casual loops centre on explaining the core logic of the business model; however, their user needs to identify key choices and their consequences. They are in some cases also used as visualization tool in business model design patterns (Eurich & Mettler, 2017; Sprenger & Mettler, 2016), the last of the six approaches. Business model design patterns offer proven structures and can be recombined and adopted flexible. The approach entails risk of missing organization specific, new options and situational dynamics and also lacks in the methodological support and guidance.

The view on the business model design or innovation through the process lenses from practitioners' perspective can be best summarized with the following four phases proposed by Franekenberger et al.:

initiation – analysis of the ecosystem; ideation – generation of new ideas; integration- building a new business model and actual realisation (Frankenberger et al., 2013). Expanding the view from the focus on business model design tooling towards the business model innovation process Tesch and Brillinge conduct a literature review on tools and methodologies supporting evaluation aspect in the process (Tesch and Brillinge, 2017). The reflection on dominant mode of evaluation within different stages of digital business model innovation process leads to proposed categorization of tools and methodologies concerning two major logics of evaluation: analytical/effectual and quantitative/qualitative (Tesch and Brillinge, 2017). Overview of the tools that is a result of extensive literature review is visualized in the Table 4. Effectual evaluation is used for an iterative exploration, whereas casual evaluation looks at the future as predictable.

	Qualitative	**Qualitative & Quantitative**	**Quantitative**
Effectual	• Ontologies and frameworks • Evaluation criteria • Learning from analogies through BM patterns • Roadmapping	• Experimentation • Trial and error • Minimum viable product approach	
Casual	• SWOT-analysis • PESTEL • Taxonomies and morphological boxes • Expert interviews • Levers for strategic business model innovation	• Analytic hierarchy process • Analytic network process • Balanced scorecards and metrics • Scenario planning • Decision support systems	• Market simulations, predictions and forecasting • Technology forecasting • Customer surveys • Financial spreadsheets

Table 4:Tools for Digital Business Model Innovation with the focus on Evaluation Aspects (Adopted by Tesch and Brillinge, 2017)

The focus and scope of practical tooling and methodologies developed in academic literature differs in support offered at different phases of the business model design or innovation process and also in contexts of use as technological innovation or incorporation of sustainability. To better support the practitioners in context of technological innovation Teece focuses on necessary steps of business model design in terms of technology innovation in the product and service design (Teece, 2010). When the impact of technology innovation is relevant, a scenario-based business methodology is proposed as efficient strategy in uncertain and complex business environments (Pateli & Giaglis, 2005). Recognizing the lack of the tools supporting the realisation phase of business model innovation, De Ruever et al. propose business model road-mapping as a tool that can support the transition to a new business model (De Reuver et al., 2013).

3.1.3 Conclusion

This chapter provides an overview of research in the field of business models and business model innovation. Focus is given to the stream of research in the field of innovation and technology management and scientific contribution supporting practitioners in business model design and innovation. Complete business models are often too complex and unwieldy to represent. Masanell and Ricart argue that analyst can in a way simplify their representation depending on the research question addressed and for that also just a part of business model might be appropriate (Casadesus-Masanell & Ricart, 2010). Since this research has the exploratory character aiming to better understand potential impact of recently emerged blockchain technology for business model innovation business model patterns were chosen as the main theoretical construct of this study. Detailed literature review on the construct follows.

3.2 Literature review on Business Model Patterns

This chapter will provide the findings of literature review on business model patterns, a construct chosen as theoretical base of this research. The chapter is structured as follows. First, the emergence of concept in the business model research is introduced and the general research scope of the scientific work using patterns as a theoretical construct is examined. Second, due to recognized confusing understandings of what a pattern is and lack of awareness on how the concept fits in the business model research, clarification of the construct multivalent character and linkage to the business model concept is provided. Third, since the patterns are one of the most popular practical tooling for business model innovation, patterns usage as a tool for systematic business model innovation, their optimal representation and their benefits and limitations from practical utility perspective are discussed.

3.2.1 Emergence of Business Model Patterns in the Literature

The start of the basic concept of patterns is in the literature designated to the work of the architectural theorist Christopher Alexander who described pattern as a proven solution to recurring problems in the context of design in architecture (Amshoff et al., 2015; Remane et al., 2016). Patterns have been later used as a concept in different domains, such as engineering, software design and human computer interaction as a way to improve efficiency in problem solving process (Amshoff et al., 2015). The idea to use patterns as a tool for business model innovation in the literature started in the books of Johnson and Osterwalder & Pigneur in 2010. Therefore, also this literature review is focused on the scientific work conducted after that year and discusses scientific work using business model patterns as a theoretical construct. Detailed overview of the literature on the business model patterns can be found in the Appendix C. However, it has to be acknowledged that authors as for instance Weill et al. studied and classified different business models to understand business model dynamics before that year (Weill, Malone, D 'urso, Herman, & Woerner, 2004). Identified archetypes that they developed are also presented as patterns, for example in the database developed by Remane et al. Thus, the question what exactly is the role of the business model patterns in the academic literature and how the concept relates to business model typologies, taxonomies and archetypes is raised.

The focus of the literature using business model patterns varies from general patterns applicable to all industries ((Gassmann et al., 2015; Johnson, 2010; Alexander; Osterwalder & Pigneur, 2010; Remane et al., 2016) to industry specific patterns (Abdelkafi et al., 2013; Laurischkat et al., 2016; Mettler & Eurich, 2012; Sprenger & Mettler, 2016; Mikusz, Schafer, Taraba & Jud, 2017) or technology specific patterns (Amshoff et al., 2015; Rudtsch et al., 2014). In the research of sustainable business model innovation a similar concept with similar objectives, named sustainable business model archetypes, is introduced (Bocken et al., 2014). The second distinction in the scope of literature work can be made based on the fact that some authors focus on patterns identification and documentation (Gassmann et al., 2015; Remane et al., 2016), others on the development of methodology for the pattern based business model design (Amshoff et al., 2015; Rudtsch et al., 2014) or on framework creation for the analysis of business model in specific context based on the relevant patterns identified (Abdelkafi et al., 2013; Eurich & Mettler, 2017; Mettler & Eurich, 2012).

Considering that the concept of patterns stems from the architecture and is used in the context of the design, it is not surprising that the role of the patterns is mostly recognized as a tool that can support creativity and support systematic business model innovation. Following authors made the most relevant contribution in using the patterns for that purpose. In the book about business model innovation for growth and renewal, Johnson created 19 business model archetypes with the aim to support initial stage of business model innovation (Johnson, 2010). Osterwalder & Pigneur present 5 business model patterns with similar characteristics, similar arrangements of business model building blocks that can serve to understand business model dynamics and as a source of inspiration for business model work (Alexander;

Osterwalder & Pigneur, 2010). The most extensive work of identifying 55 general business model patterns was done by Gassmann et al. with the claim that based on their research about 90 per cent of successful business model innovation is actually a recombination of existing business model elements (Gassmann et al., 2015). However, none of those authors give a clear explanation on how they derived those patterns. Lastly, Remane et al. have recognized the issues as incompleteness, overlapping and inconsistent structure of existing business model pattern collections and conducted extensive literature review, filtering for duplicates and structuring the patterns with application of rigours taxonomy building approach to assist with navigation through business model pattern landscape (Remane et al., 2016).

Due to difference in granularity of business model patterns in the literature Amshoff et al. suggest three categories that could be used to classify business model patterns (Amshoff et al., 2015):

- **Frameworks**: proven forms for the documentation and analysis of business model like Business Model Canvas
- **Prototypical business model:** industry holistic models, provide a quick orientation when entering a new market. They are derived from a taxonomy or cluster analysis and lead to homogenous groups of companies.
- **Solution patterns:** proven building blocks for designing business model

Moreover, Remane et al. take into account the distinction between prototypical and solution patterns and explain the difference according to hierarchical level of pattern impact on the business model (Remane et al., 2016). However, it is important to note that each category of patterns as suggested by Amshoff et al. is in the literature derived with different methodology, in different context and with different aim of use. The next chapter will further clarify the concept of business model patterns and link it to the multipurpose character of business models.

3.2.2 Linking the Concepts and Multipurpose Characters of Business Model Patterns and Business Models

To better understand the concept of business model patterns first the character of business model as a model needs to be understood. The business model concept has a multipurpose character in the scientific literature. The following three different roles of the concept use in the scientific literature can be distinguished (Baden-Fuller & Morgan, 2010):

Business model as a classifying device that provide valuable ways to expand our understanding of business phenomena.
Business model as instruments of scientific enquiry.
Business model as recipes – practical models that are ready for copying.

Classification-based business model research is prolific in industries that have been disrupted by technological changes such as information, media and telecommunication industry (Lambert & Davidson, 2013). This is not unanticipated since classification provides valuable ways to expand understanding on certain phenomena. Classification can be made based on a taxonomy or typology (Baden-Fuller & Morgan, 2010). However, both terms are in the literature many times used interchangeably (Lambert, 2006). In the business model research both notions come together and are also closely connected with the notion of ideal type. To differentiate between notions of taxonomies and typologies understanding differentiation between kinds and types is helpful (Baden-Fuller & Morgan, 2010). Taxonomy is derived with bottom-up empirical work and classifies firms based on the kinds of things observed in certain context. A typology is usually understood as delineating types of things derived from conceptual work by the scientists. Ideal types as a popular concept in the social science are a combination of both and are particular useful since they mediate between our ideas and theories on the one hand, and the things in the world we want to describe and explain in practical way on the other (Baden-Fuller & Morgan, 2010). Therefore, business models can be understood as idea types since they are based on the empirical and theoretical scientific work.

The second role of business models can be explained as a model of scientific inquiry. The investigation can be done in the form of experiments, simulations or manipulation with the model as in economics and is only possible when the model is simple enough to work through, but yet complicated enough to make the experiment meaningful (Baden-Fuller & Morgan, 2010). For instance, an interesting example is the study conducted by Weil et al. who first classified business models according to type of ownership of assets and type of assets. Next, he analysed the financial performance of each type and concluded that business models are a better predictor of financial performance than industry classification (Weil et al., 2004). Conceptual experimentation with the business models has also practical importance as part of the strategy process through thought experiments by managers in their own companies. Research aims to support this process with development of practical tooling.

The last role of the concept in the literature is business models as recipes, which comes from more practical and technological domain rather than scientific one (Baden-Fuller & Morgan, 2010). The primary role of this notion of model is to demonstrate and is interesting since it displays a matter of principle and also contains description of both organisation and integration of the main elements of the firm's activities. They lie between principles (general theory) and templates (exact and exhaustive rules) (Baden-Fuller & Morgan, 2010). Moreover, they provide managers and scholars a way to describe and distinguish types of behaviour that are found in the real world and can be explained with aforementioned notion of ideal types. As recipes, they describe what kind of outcome can be expected if the rules are followed and can also be copied with possible modifications.

Understanding this multipurpose character of business model as proposed by Baden-Fuller and Morgan can help better conceptualize the role of business model patterns as theoretical construct and link the concept of business model patterns to business model. Moreover, it can also partially explain the remarks that most researchers' have different understanding of the business model pattern concept (Remane et al., 2016). Alexander assert following definition of a pattern: "Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice" (Alexander et al., 1977, p. x). Scholars using business model patterns and referring to his work mostly adopt this definition (Abdelkafi et al., 2013; Amshoff et al., 2015; Eurich & Mettler,2017). The definitions inspired by Alexander refers to the role of patterns as recipes as discussed in explaining the role of business model. However, examining the role of business model patterns in the scientific literature it can be observed that the concept is used in the same three different ways as business models since busines models as recipies also enable classification and conceptual experimentation based on the behaviour observed in the real world. The overview of different definitions and role of patterns as a theoretical construct is presented in the Table 5.

Author	Article	Definition of a pattern	Role of patterns as a theoretical construct (classification device, instrument of scientific inquiry, recipes)
(Remane et al., 2016)	The business model pattern database – A tool for systematic business model innovation	Adapted by Abdelkafi et al., 2013	recipes
(Sprenger & Mettler, 2016)	On the utility of e-health business model design patterns	Adopted by Mettler and Eurich, 2012	recipes
(Amshoff et al., 2015)	Business model patterns for disruptive technologies	Proven business model elements, which reveal valuable insights about pursued business logics.	classification devices, recipes
(Gassmann et al., 2015)	Business Model Navigator – 55 Business Models That Will Revolutionise Your Business	A specific configuration of the business model dimensions that has proven to be successful.	classification device (Identification of patterns) and recipes (methodology on how to use it for business model innovation)
(Abdelkafi et al., 2013)	Business Model Innovations for Electric Mobility - What Can Be Learned from Existing Business Model Patterns?	Proven solutions to recurring problems during business model design. The relationship between a certain context or environment, recurring problem and core of its solution.	classification device, recipes
(Mettler & Eurich, 2012)	A ‘‘design-pattern’’-based approach for analysing e-health business models	Business model design patterns are archetypal design solutions of successful business models.	scientific inquiry, recipes
(Lüttgens & Diener, 2016)	Business Model Patterns as a Tool for Creating Innovative Business Models	Adopted by Gassmann	instrument of scientific inquiry, recipes
(Streuer, Tesch, Grammer, Lang, Kolbe, 2016)	Profit Driving Patterns for Digital Business Models	Viable approach of transferring analogies of past successful economic effects to new business endeavours.	classification device, instrument of scientific inquiry
(Mikusz, Schafer, Taraba & Jud, 2017)	Transforming the Connected Car into a Business Model Innovation	Adopted by Gassmann	classification device, instrument of scientific inquiry

Table 5: Examples of different definitions and roles of business model patterns in the literature

To sum up, based on the examination of the role of patterns as theoretical construct it was recognized that the construct has similar multivalent character as a business model and can be linked with the notion of ideal types. However, since the notion of concept doesn’t stem from scientific work but rather more practical its scientific relevance is questioned. Since scholars use the construct for multiple purposes, a different understanding of the construct multivalent character is adopted. Nevertheless, this research suggests that function of patterns in business model research could be interpreted as a granular unit of analysis explaining arrangements regularly found in comparable business models (e.g. business models of the companies utilizing the same technology) and needs to be derived from real world examples if one the objective of research is to support the practitioners.

3.2.3 Pattern based Systematic Business Model Innovation

Business model patterns are one of the most popular tools for business model innovation or development next to Business Model Canvas. There is an analogy between business model patterns and the principle of modularization proposed (Mikusz, Schafer, Taraba & Jud, 2017). In line with the analogy, business model patterns can be at the centre of experimentation and discovery driven business model innovation or can serve as a tool for updating the business model when for example technological innovations occurs. Latter requires that there is enough knowledge available on the transformation mechanism between technological innovation and innovation on the business level (Mikusz, Schafer, Taraba & Jud, 2017).

There are overall three general strategies how business model patterns can be used by companies to systematically generate business model innovation (Abdelkafi et al., 2013):

1. Identification of patterns in their industry and adaption of them to their specific context.
2. Adoption and transfer of business model patterns from outside their industry and fitting them to their context.
3. Combining different patterns – one from each value dimension – in order to assemble a complete business model.

The search for already recognized patterns as recipes can be conducted using sources such as literature, business model databases, and analysis of company's business models based on the information found on their websites, industry reports or expert interviews. Remane et al. argue that prior business model pattern literature has mainly applied the patterns for the first two phases of business model innovation to analyse existing business models and for generation of new business ideas (Remane et al., 2016). They suggest that the database they developed can also be used in the integration phase for the development of complete business model with combination of patterns and in implementation as a glossary linking to additional information (Remane et al., 2016).

Assessing the combination of patterns has the potential for more a radical business model innovation since more value dimensions are modified (Abdelkafi et al., 2013). This was also recognized while analysing potential business models for disruptive technologies since those require change in the nascent business model logic (Amshoff et al., 2015). There are two systematic approaches suggested in the literature how the patterns can be used for the design of business model for disruptive technologies. Rudtsch et al. after the identification of applicable existing patterns to the context of cyber physical system used interviews and workshop with experts to determine classification schemes of reasonable combination of different patterns for the technology business model design (Rudtsch et al., 2014). Furthermore, Amshoff et al. analysed the 20-business model of the companies already utilizing the disruptive technology and identify business model variables and their configuration options. In their work the business model patterns were defined as a combination of configuration option, which repeatedly occurs in successful business model and determined patterns with a similarity value of configuration options calculated based on the characteristics list (Amshoff et al., 2015). In both articles, the authors emphasize that feasible pattern combination must always be assessed from the specific market perspective. Rudtsch et al. further argue that potential configuration of future value creation networks requires qualified input from practitioners to be able to derive a valid statement (Rudtsch et al., 2014).

Last, there is limited knowledge on what are prerequisites, influencing factors and also on implementation guidelines for successful application of the patterns to turn in actual business model innovation. Osterwalder and Pigneur propose five patterns that they translate into the language of business model canvas to help achieve simplified application (Osterwalder and Pigneur, 2010). Next, Gassmann provide guidance on evaluating the application of pattern with few questions based on the objective of the

innovation (Gassmann et al., 2015) To help discover the way how to drive profit of a business model under development. Streuer et al. identify potentially profit driven patterns and derive practical guidelines on factors influencing successful application of patterns based on the multiple case studies, where patterns were applied (Streuer et al., 2016). Further research in this direction would be valuable.

Pattern Representation

There are some general guidelines about the representation of business model patterns found in the literature. The guidelines and elements used by different authors are represented in the Table 6.

	Generic principles of Design Pattern (Eurich & Mettler, 2017)	Business model Navigator (Gassmann et al., 2015)	Documentation of recognized patterns for disruptive technologies in the book (Amshoff et al., 2015)	Documentation of e-Health adopted patterns (Sprenger & Mettler, 2016)
Context when pattern is relevant or applicable (also interpreted as a problem to be addressed)	x	x	x	x (only problem)
Outcome to be expected (goal)		x		x
Basic solution towards the problem				x
Relevant actors	x			x
Visualization of logic behind the pattern	x			x
The origins of pattern		x		
Guidance how can pattern be applied		x (in book only)		
Example company	x	x	x	x

Table 6: Elements of business model pattern representation by different authors

After comparing pattern representation of different authors the following conclusion can be made. Gassmann et al. took detailed descriptive approach to present all of identified patterns in their book (Gassmann et al., 2015). In addition, they also provide criteria and relevant questions that companies should consider when determining the applicability of the pattern for their case. Patterns used in specific context as disruptive technologies and e-Health differ in some of the generic principles and elements. Patterns represented by Amshoff et al. do not especially address goal and relevant actors (Amshoff et al., 2015). The pattern representation focuses instead on the definition of problem in terms of drawbacks of prevailing technological solution and solution as different configuration options included in the pattern. Moreover, it also visualizes the relationship with other technology induced patterns in the pattern map. However, there is no visualization on how the value is created and what the relationship between different actors is. This can be explained by the focus solely on disruptive technology utilization and its complex characteristics. E-health patterns created by Sprenger & Mettler consist of clearly predefined goals and involved actors relevant for e-health domain (Sprenger & Mettler, 2016). Context is not separately presented, which can probably be explained by the fact that the patterns are aimed at e-Health professionals with the overview on relevance and context of each pattern.

Benefits and Limitations of Utility of Business Model Patterns as a Tool supporting Business Model Innovation

Choosing business model patterns as a theoretical construct or a tool supporting practitioners, one has to be aware of its benefits and limitations. Those are in the literature recognized from the practical utility perspective. Business model patterns and business model canvas are one of the most popular practical tooling for systematic business model innovation (Remane et al., 2016). The limitation of canvas as discussed by Eppler et al. in their experimental study about effectiveness of the business model canvas for idea generation and group interaction is the significant decrease of creativity (Eppler, Hoffmann, & Bresciani, 2011). In contrast, business model patterns beside supporting interactions also promote creativity by thinking in analogies (Johnson, 2010). The use of the patterns also addresses efficiency since they reflect solutions to already recurring problems.

Further on, the following practical benefits were recognized by scholars Sprenger and Mettler. By conducting focus groups to study the utility of e-Health business model patterns besides creativity, support in interaction and efficiency they also acknowledged the following benefits: enhanced understanding of interdependencies of involved actors and respective value flows, guidance as decision support tool in thinking about problems one can relate to and an overview of already instantiated business logic which serves as a mean to overcome the lack of experiences in business modelling (Sprenger & Mettler, 2016). Researchers recognized the benefits of patterns as a mean to analyse the logic of business model design and also as a mean of a clear communication for different archetypal design solutions (Mettler & Eurich, 2012). Moreover, employing business model patterns also offers flexible recombination (Eurich et al., 2013).

In contrast, following limitations need to be considered. Patterns are abstract given by nature and explains particular business logic in isolation and therefore, its expressiveness is limited (Amshoff et al., 2015). General business model patterns do not account for the special characteristics of specific industry environment (Sprenger & Mettler, 2016). Last, scholars also warn that a practical application of business model design patterns is problematic and there is a need to find ways to improve the evaluation procedure of the patterns (Eurich & Mettler, 2017).

3.2.4 Conclusion

The research on the business model patterns used as a theoretical concept is scarce. This chapter provides an overview of the findings of scientific articles using the business model patterns as a theoretical construct. To explain its different interpretations by scholar multivalent character of pattern as a construct was adopted and its linkage to business model as a construct was emphasized. Moreover, the last part focused on discussing the ways that patterns can support a more systematic business model innovation. It is recognized that further research on practical guidelines and on influencing factors would be beneficial. The next part of the report builds upon the findings of the exploration phase and discusses research design.

RESEARCH DESIGN

4 Conceptual Framework

Conceptual framework is in the literature seen from a different perspective and is also often used interchangeably with the concepts such as theoretical framework and literature review (Antonenko, 2014; Rocco and Plakhotnik, 2009). This research adopts the instrumental view on the conceptual framework. In that perspective, conceptual framework can be defined as a theory-based and evidence-driven argument that is developed to justify the significance of the problem, define relevant concepts, establish theoretical and empirical rationale, guide selection of the appropriate methods, and scaffold data analysis and interpretation (Antonenko, 2014). The conceptual framework is custom-built, based on theories and empirical results of the exploration phase and is further used to explore the utility of business model patterns as a construct in the context of blockchain technology.

The chapter is structured as follows. First, as it was recognized there are different views on the concept of business model in the literature and scholars have developed several ontologies that can be used to describe a business model which differs in terms of scope, level of abstraction and number of business model components. To obtain unified view on what a business model is throughout the analysis, the most appropriate framework for construct conceptualization in regard to the research objective will be selected. Second, definition and purpose of use of business model patterns used in this research will be provided due to recognized limitations related to the construct in the literature. Lastly, the explanation and visual display of the main theoretical concepts and their relations is provided in the form of concept map.

4.1 Business Model Conceptualization

In order to select the most appropriate business model framework which will serve as a ground on what a business model is in this research, the selection criterium based on the research objectives was determined. Comparing various frameworks of business models is challenging because they include different components, they scope the business model differently and they are designed to collect and display business model information at different levels of abstraction (Lambert, 2010).

The Conceptual Model Analysis Framework suggests three elements of comparison that represent the various dimensions of the business model concept observations. The elements are represented and described in the Table 7.

Level of analysis	Level of abstraction at which a concept is portrayed.
The unit of analysis	The unit of analysis refers to the scope or boundaries of the concept. It can be the whole system, part of the system, a sub-part or component of the system. The business model unit of analysis can be the whole value network, the enterprise or part of the enterprise.
The conceptual focus	The conceptual focus refers to the filter through which the researcher views the business model.

Table 7:Elements of Conceptual Model Analysis Framework (CMAF) (Lambert, 2010)

Based on the proposed elements of the CMAF and research objectives the following criteria were derived. First, the level of the abstraction of the framework should be high since its role is to provide high level orientation to which parts of the business model individual pattern refers to. Second, due to openness and potential of the blockchain technology to influence digital ecosystem infrastructure on multiple vertical layers, the unit of analysis of the framework should be the whole value network. Third, since our basic assumption is that the technology is a driver for new innovative services and business models (technology push-model), the conceptual focus of the model should take this view into account. Based on the set criteria, STOF was chosen as the most suitable overall business model framework. The conceptual focus of the model is creating and capturing value from technological innovation, which fits well to the research objective. Moreover, the unit of analysis of the model is the entire value network and the abstraction level of components is high with dividing business model into four main domains. This provides the framework that is easy to use for the analysis. The STOF domains are visualized in the Figure 4.

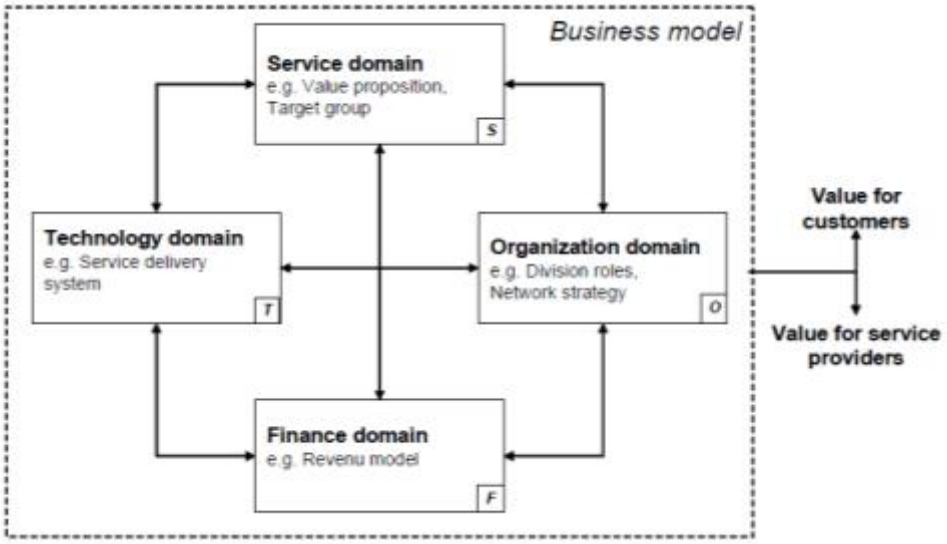

Figure 4: STOF model (Bouwman, Faber, Haaker, Kijl, & Reuver, 2003)

The focus of the STOF model is on the customer value, and on the organizational, technical and financial arrangements needed to provide a service that offers value to customers and allows the providers of the services to capture value as well (Bouwman et al., Faber, Haaker, Kijl,, 2003). The four domains are composed of individual elements, which can be interrogated in detail permitting granular analysis. Based on the conceptualization of STOF all four domains mutually influence each other. Hence, it is important to note that the exploratory focus of this research is to understand the potential impact of the blockchain technology on other business model domains and elements. Therefore, it is important to understand what could the potential impact of technology be on the business model. Based on the descriptive model of each domain developed by author of STOF model, the conceptual description on the potential technology influence on each domain is derived (Bouwman et al., 2003):

- ***Service domain***: Technology architecture delivers technology functionalities which co – determine delivered value.
- ***Organization domain***: Actors have strategies and goals to participate in the value network. Value network consists of actors which perform value activities. Those put requirements on the technical architecture.
- ***Finance domain***: Technical architecture generates costs, which are divided among actors according financial arrangements.

Lastly, the authors of STOF developed a practical tooling with questions addressing elements of the individual domain that can serve practitioners or researchers as a template and starting point for business model analysis.

4.2 Definition of Business Model Patterns as a Construct

Based on the literature review and proposed conceptualization and linkage of business model patterns to the concept of business model, the following definition of business model patterns is proposed. Business model patterns are a theoretical construct in management literature that offer granular unit of analysis in the context of business models with a multipurpose role, such as classification device, instrument of scientific inquiry or recipe and can be characterized with the notion of ideal types. When adopting the role of recipes business model patterns can serve in the similar role as defined in the architecture and engineering disciplines and can be described as a proven solution to recurring problems in the context of business model design and innovation (Christopher Alexander, 1999; Amshoff et al., 2015; Remane et al., 2016).

In the literature, a classification of business model patterns on prototypical business models and solution patterns is proposed (Amshoff et al., 2015; Remane et al., 2016). This research only considers solution patterns. Prototypical patterns are industry holistic models and are derived with the methods for taxonomies or typologies and cluster analysis.

4.3 Concept Map

4.3.1 Building Upon Components and Findings of Exploration Phase

Technology, Business Model and Business Model Innovation

As discussed in the theoretical background technological innovation and business model concept interaction can be described in a two-way manner (Baden-Fuller & Hae, 2013). First, technology can influence the business model possibilities. Technological development can facilitate new business models in order to appropriate novel technological features in business logic (Baden-Fuller & Haefliger, 2013; Björkdahl, 2009; Calia et al., 2007). However, in most cases technology does not change value creation logic completely, but just enhances or facilitates expansions of already existing business models. For instance, the internet did not invent two-sided platforms – they have existed since before the 18th century, but it did facilitate their expansion (Baden-fuller & Hae, 2013). Second, the choice of business model determines the nature of complementarity between business logics, technology and the paths to monetization (Baden-fuller & Hae, 2013). In this way business model choice determines in which way the technology will get developed.

In the context of business model innovation, technology is seen as one of the external antecedent that can lead to business model innovation (Foss & Saebi, 2016).The scope of business model innovation can be a matter of both architectural and modular changes. Further, the novelty can be assessed in terms of specific firm or industry (Foss & Saebi, 2016).The strength of the effect of antecedents is dependent on different moderating variables that can be distinguished on three different level of analysis (macro, firm and micro level).

Blockchain Technology as Emerging ICT Innovation

The starting point of the research is emerging ICT technology that is characterized as disruptive innovation. The distinction between a regular IT innovation and a disruptive innovation lies in the disruptive attributes, which are usually not so much connected to technological advancements but rather to their impact on the market position of existing innovations and its consequent displacement of an incumbent (Baiyere & Salmela, 2015). This can be further explained with a double-edged nature of IT innovation depending from which actor perspective the IT innovation is observed since its impact can be explained as sum function of the degree of empowerment and wickedness to the individual actor (Baiyere & Salmela, 2015). In this research, the perspective of a firm is taken into consideration with exploring potential impact of blockchain technology on its business model. Analysis of technologies through business model perspective has been recognized as one of solutions to cut through the hype and achieve more actionable conclusions about potential of the technology for specific institution (Kalman, 2016).

Multipurpose Role of Business Model Patterns as a Construct

Literature review revealed that the use of business model patterns as a construct differs in the work of academic scholars. The difference in perception on the construct is explained with a multipurpose role of business models as models in management literature that can be applied also for business model patterns as a construct. The fact that patterns can adopt the multipurpose role as classification device, instrument of scientific inquiry or recipe is made explicit in this research.

4.3.2 Visualization of the Concept Map

Exploratory phase of the research provided insights on the three main aforementioned components that are used to construct the conceptual model. Understanding of the relations between technology innovation, business model and business model innovation derived served as a basis for visualization of concept map, which consists of two separate parts due to the option of distinctive usage of business model patterns as a construct.

First, the patterns are used in the role of classification device that can enhance understanding of potential impact of the technology innovation on business model design logic with reducing complexity during business model analysis. The following assumptions are considered taking into account the two-way relationship between business model and technology. Technology can influence business model patterns possibilities since only certain business model patterns are appropriate and can therefore be used to utilize the technology. Furthermore, technology could enhance or facilitate expansion of specific existing business model patterns. However, due to characterization of the blockchain technology as disruptive the possibility that technology could enable new business model patterns is also taken into account.

Second, the interest of the research lays in the evaluation of the technology with the use of business model patterns as a construct in specific industry. Therefore, the role of business model patterns as an instrument of scientific inquiry is adopted to explore and evaluate the potential implication of the technology from business model innovation perspective in e-Health. According to the research model proposed by Foss and Saebi, technology is seen as one of the external antecedents that could potentially lead to business model innovation in terms of novelty and scope (Foss & Saebi, 2016). Industry specifics are seen as moderators that can be defined on macro, firm or micro level. Final conceptual map is visualized in the Figure 5.

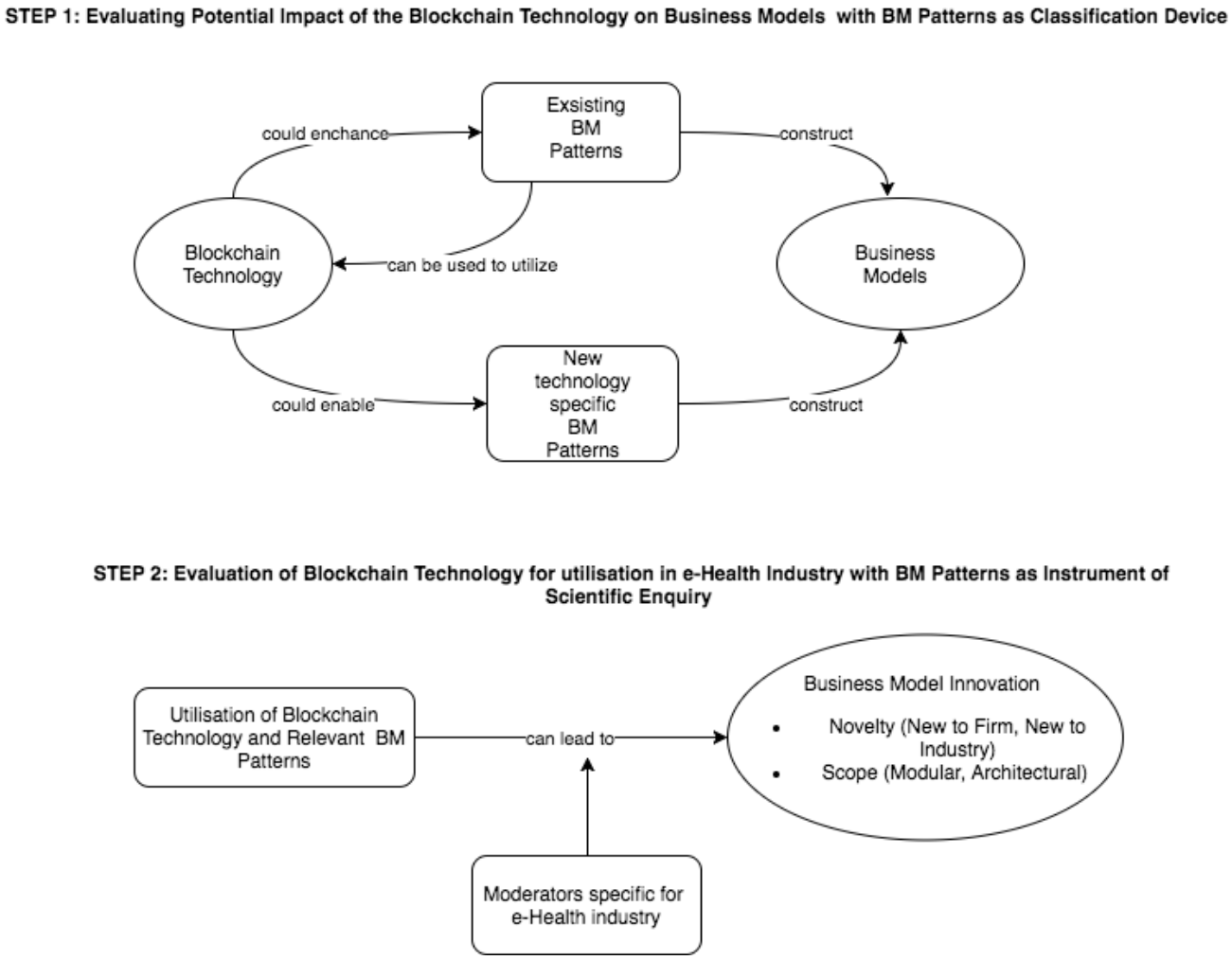

Figure 5: Research Concept Map

4.4 Conclusion

This chapter builds upon the exploration phase and provides the description of research conceptual framework. First, business model and business model patterns are due to recognisable inconsistencies in the literature defined for the purpose of further analysis. For understanding what a business model is the STOF model is adopted. Next, the concept map is visualised and described. The conceptual framework further serves as a base for building the research methodology and results interpretation.

5 Methodology

In the first part of the research the role of the business model patterns on the theoretical level is explored. Moreover, attention is given to the domain of blockchain technology and its current state. The utility of the business model patterns as a construct is further explored with empirical work in the context of technology evaluation from business model innovation perspective in e-Health industry. Therefore, this chapter addresses methodology constructed for empirical work. The construction process was guided by the conceptual framework and recognized limitations associated with the state of the blockchain technology.

The chapter is structured as follows. First, the philosophical perspective guiding qualitative research process is explained. Next, methodology of both two empirical steps is described. In the second part, the methodology for patterns identification is presented (business model patterns as a classification device). In the third part, the methodology for evaluation of the blockchain technology from business model innovation perspective in e-Health industry with the use of business model patterns is described (business model patterns as an instrument of scientific inquiry).

5.1 Philosophical Assumption: Interpretative Research

Qualitative research can be done with the positivist, interpretive or critical stance (Myers, 1997). The interpretative perspective to analysis was adopted in this research. IS research can be classified as interpretive if it is assumed that the knowledge of reality is gained only through the social construction such a language, consciousness, shared meanings, documents and tools and other artefacts (Walsham, 1995). However, interpretive IS research has been criticized for its failure to explain the unintended consequences of action and recognition of conflicts and contradictions in social relations, which cannot be explained by reference to participants and which are often significant force in shaping social reality (Doolin, 1998). To achieve more critical stance researchers, need to consciously adopt a critical and reflective stance in the role that the information technology can play in the social context. Another strategy is that the interpretation on how information technology is implicated can be made in a wider societal, historical, economical and ideological context (Doolin, 1998).

5.2 Part 1: Business Model Patterns Identification Methodology

This chapter addresses the identification of business model patterns. Due to unsuitability and limitations of existing patterns identification methods for the context of blockchain domain, first methodology for pattern identification needs to be developed. First, challenges in building methodology based on the literature findings are presented. In the second part the process of conducting pattern identification constituted of case study format definition, selection of cases for analysis, data collection and data analysis is described with providing the overview of steps that were taken.

5.2.1 Challenges in Building Methodology Based on the Literature Findings

There are not many guidelines provided in the literature about how business model patterns can be identified. Moreover, emerging stage of blockchain technology and the sociotechnical character of the phenomena surrounding the technology makes this task even more challenging. Examining the sources that were used to build the most extensive collection of business model patterns developed by Remanne et al., it can be observed that a lot of patterns are taken from the work where the development of typologies and taxonomies was the focus (Remanne et al., 2016). The research methodologies that authors used were conceptual (e.g. along the value chain, with Porters generic strategies) or empirical with the analysis of companies and business model innovation examples. In more than half of the cases methodology is not even addressed and also white papers are used as a source (e.g. Business Models and the Internet of Things –Fleisch et al.). This can be explained with the multivalent character of business models and business model patterns as discussed in the theoretical background.

Pattern identification methodology for disruptive technologies as suggested by Amshoff et al. with similar research objectives seemed the option that could also be applied in the case of this research. However, methodology is based on the assumption that data on successful business models of 20 companies that are already commercializing the technology in different industry is available. Methodology also requires that configuration options for all the elements of the business model framework used are described. This is not feasible for the current context of blockchain technology since most companies are still in the experimental stage of technology deployment and business model design. Moreover, also one of the objective as presented in the conceptual framework is to identify the existing relevant business model patterns for the context of blockchain technology.

The most extensive work on patterns in the context of business model innovation has been so far done by Gasssmann et al. Nevertheless, the research methodology of the patterns identification is only briefly described. The authors only note that the patterns were developed based on the empirical analysis of 250 business models in different industries. Further on, they emphasize that it is very important to understand what can be innovated by patterns. Therefore, they deploy conceptualization of business models that consists of four central dimensions: The Who, The What, the How, and the Value (Gassmann et al. 2013). This makes the concept easy to use and is exhaustive enough to provide a clear picture of the business model architecture. This conceptualization could be also used in our case, however, since our starting points are IT innovation-influenced business model patterns, this conceptualization does not provide clear enough understanding what the technology role in the concept of the business model is. Therefore, STOF model was chosen as a more appropriate framework for guiding the analysis of this research.

5.2.2 Overview of Business Model Patterns Identification Methodology

The patterns identification methodology was based on the analysis of multiple case studies. It is important to emphasize that the starting point of the patterns identification was not the development of typology (i.e. deductive approach) since there is not enough knowledge on the topic to make one and still a lot of ambiguity related to business model patterns as a construct. Instead the aim was the recognition of "ideal types", leading to the combination of inductive and deductive approach being adopted. Moreover, the focus of the research was not an exhaustive list of patterns, but the first exploration on how the patterns relevant for the emerging technology can be identified and their utility in terms of evaluation power of the potential implications of the emerging disruptive ICT technology. The overview of the methodology is visualized in the Table 8.

Research Method	**Multiple Case Studies**
Collection of Data	Desk Research (White papers of the e-Health companies planning to utilize the Blockchain technology)
Starting point of Analysis	Conceptual Framework – Ch 4 & Understanding of Blockchain Phenomena (Ch2)
Approach to Analysis	Inductive-deductive approach (Identification of ideal types)
Business Model Patterns Identification Process through Analysis of Cases	• Open coding to recognize elements relevant for BM analysis • Identification of existing preselected business model patterns through the interpretation and identification of role of blockchain • Axial Coding combined with reflection on technology domain (Ch2) for construction of new patterns
Role of researcher	The researcher is active

Table 8: Overview of Business Model Pattern Identification Methodology

Multiple steps were taken to identify business model patterns relevant for the context of blockchain technology. First, the search was made on data sources of existing blockchain technology projects and related description on how the companies plan to create value with the proposing solutions. Second, based on the preliminary analysis of materials the final case study format was defined, final cases for analysis were selected and data was collected. Next, analysis was conducted with the coding of qualitative data collected. Two different strategies for business model patterns identification were adopted.

First, the identification of the existing business model patterns started with the choice of source where they are documented. The database constructed by Remane et al. was selected since it is the most recent collection of business model patterns created based on the exhaustive literature review of potential sources based on the exhaustive literature review and filtering for duplicates (Remane et al., 2016). Moreover, it was also double checked that all the important sources of business model patterns identified during the process of literature review are part of the database (e.g. Collection of 55 BM Patterns of Gassmann). Based on the analysis of the database and understanding of the characteristics of blockchain technology the preselection of existing BM Patterns was made to make identification of existing business model patterns more manageable. However, during the process of coding the database was checked multiple times for additional clarifications.

Second, the strategy for construction of new business model patterns was inspired by the combination of grounded theory approach and case studied suggested by Fernandez et al. as a solution on how to achieve synergy between research relevance and rigour in studying emerging ICT Innovation (Fernandez et al., 2002). More specifically, by Straussian Approach as a method to case study analysis, which is as argued by Halaweh et al. the only approach of analysis compatible within case study strategy (Halaweh, 2012). The key characteristic of Straussian approach is that the theory is forced through the structured question with structuring data through rigorous coding process defined by technique (three types of coding open, actual and selective coding) (Halaweh, 2012). Construction of the new business model patterns was also forced with structured questions as:

- How is the use of the technology associated with business model elements recognized?
- What are the main benefits and innovation opportunities of the technology emphasized?
- Which problems are being solved and what is the main value preposition?

The same as needed in the Straussian approach axial coding was used to reassemble the data in categories. Patterns were proposed based on the understanding of the technology (Chapter 2) and theory discussed (Chapter 3). However, third round of the coding meant for theory building was not needed since, as emphasized, the purpose was to identify the constructs in form of ideal types and describe them with the language used in practice.

The described steps taken are visualized in the Figure 6 and are further addressed in the following two chapters, where detailed choices made and analysis processes are described.

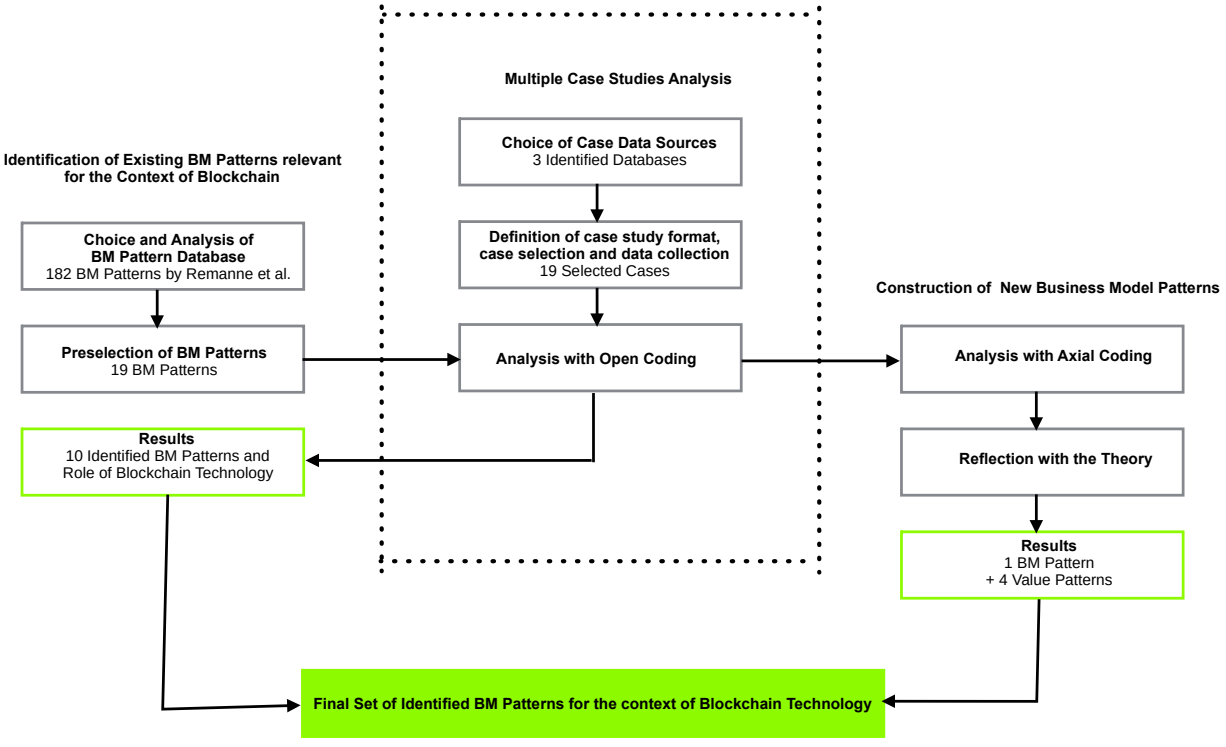

Figure 6: Scheme of Steps taken in Pattern Identification Process

5.2.3 Specification of Case Study Format and Data Collection

Case Study Format

Since the technology is in such an early stage and has many limitations at the moment of this research, most of the companies are still experimenting with technological proof of concepts and exploring how they could create distinctive business value in different industries outside the cryptocurrencies market and payments services with the technology utilization. More specifically, the establishment of the enterprise blockchain market is at the moment of the research just starting. For now, it has had two main participating groups - incumbent banks and financial firms, and startups, which gained the most ground in 2016 (Coindesk, 2017). Therefore, in line with the research objective the decision was made to focus analysis on business models of start-ups, which started exploring the blockchain technology in the context of existing industries.

First, initial desk research of blockchain projects and companies on the media portal CoinDesk, which is covering all the latest news and conducting analysis on the bitcoin and block chain tech, was made (Coindesk, 2017). It was observed that there is a lot of information available on the plans and vision of start-up companies in form of technical and business white papers. Especially start-up companies looking for public crowdfunding in form of Initial Coin Offering (ICO) explain their concept in that form.

Business model patterns are in the literature always derived from analysis of multiple case companies (e.g. Gassmann et al., Amshoff et al.). The same approach is adopted in this research; however, it has to be emphasized that due to such an early stage of the companies trying to utilize the technology for applications in traditional industries (e.g. supply chain, healthcare, insurance), mostly only the visions, plans and proofs of concepts of the companies can be taken as part of business model analysis. Consequently, also the decision was taken that only desk research as a strategy for data collection will be adopted. It would also be impossible to gain primary data of multiple cases in the form of interviews due to time constrains of this research. Moreover, business model patterns due to high level of abstraction only describe front end (externally-oriented) part of the business model. In the initial unstructured desk research of the case companies it was observed that this type of information is available in online sources.

Selection of Cases for Analysis

The next step, after determining the format of a case study for the analysis, was to choose the final set of cases for the analysis. Purposive sampling strategy was adopted. In purposive sampling, personal judgment of the researcher needs to be used to choose cases that help answer research questions or achieve set objective (Bhattacherjee, 2012).

Concerning the limitations on the available information due to only adopting desk research as a research strategy and overall perspective of the research, the following guidelines were followed:

- Business model is not solely based on the value of a cryptocurrencies, consultancy or development of blockchain technology stack, but is addressing the utilization of the blockchain technology in an established industry.
- There is information available on how blockchain technology is used.
- There is enough information available to be able to understand how the company plans to design at least some aspects of business model on their web page, in the form of white paper or case study describing the concept found in the literature.

Combination of databases was used for selection of cases and also later as a starting point of data collection. Based on the evaluation of available databases of companies, online decision was made to extract data of innovative start-up companies from three databases. First is the list of the projects and companies built on the Ethereum, open-source blockchain based distributed computing platform featuring smart contract (scripting) functionality. The platform is at the moment of the research most widely used blockchain based technology (dApps, 2017). The second database was the CrunchBase database, which gathers data on innovative companies using a crowdsourcing approach with a strong focus on start-ups as it maintains a large partnership program with more than 2,000 participants from the start-up community (e.g., accelerators, venture funds, and university programs) (CrunchBase, 2016). The third source was the initial coin offering (ICO) and crowd sales calendar of blockchain projects and companies, which in an organized way presents ongoing, upcoming and pasts ICOs. Additionally, case studies found during the process of literature review were taken into extra consideration and search on blockchain companies and initiatives in e-Health domain was conducted via Google (key words: blockchain in healthcare, use cases of blockchain in healthcare) on the projects and companies planning to utilize the technology for healthcare.

Since 17 cases identified addressed the use of technology in the field of healthcare, the decision was made to only include those cases as part of the analysis. However, in the future it would be interesting to analyse cases targeting different industries and compare the identified patterns to better understand potential impact of the technology. Short description of each case and material used for analysis can be found in the Appendix E.

Data collection

Data collection process started already at the same time as cases selection process since the information availability was one of the criteria for the selection. Nevertheless, after determining final selection of the company, an additional search for material and organization of previously saved material was conducted. Three main sources of data were used: white papers, web pages information and case studies description found in the literature.

5.2.4 Data analysis: Identification of Patterns

The goal of the analysis is to identify solution patterns, which refer to the sub-aspects of the business model. As defined in the conceptual model, the identification of pattern is divided into two types of patterns. First, identification of already existing patterns and the understanding of the logic why an individual pattern is relevant for the context of blockchain technology. Second, the assumption is made that potential new business model patterns may be found.

Before the start of analysis also two criteria on how the final set of patterns should be like were defined:

- The pattern description should provide the idea of underlying mechanism on how the blockchain technology impacts underlying business logic.
- The patterns should be suitable for intuitive further use in practice.
- The pattern is included in the result section if it is identified in at least two cases.

Analysis was conducted with the help of coding using qualitative content analysis software (Atlas.TI), which supports coding process and enables creation of memos, modelling and latter data analysis in systematic way. The rest of the chapter is divided into two parts each separately explaining the logic of analysis for both types of patterns.

Identification of the Existing Business Model Patterns

Based on the outcomes of literature review, as already mentioned in the overview of the methodology, the database created by Remane et al. was chosen as the source of existing business model patterns. The database consists of 182 patterns (Remane, et al. 2016). To make the number of patterns more manageable first the filtering of the database was made based on the facts that the focus of this study is only on solution patterns and that patterns need to be relevant for the domain of the research, which is blockchain as potentially disruptive ICT innovation. Filtered patterns from the database are presented in the Appendix D.

Since identification of business model patterns is based on the researcher interpretation of qualitative data it was important to get familiar with the relevant existing patterns. Moreover, also a good understanding of the domain (blockchain technology) was necessary to recognize the components of the technology that influenced business model design. The last important thing for interpretation was also the comparison of differences and similarities recognized across the cases. The iterative process of steps used during the process of interpretation is visualized in the Figure 7.

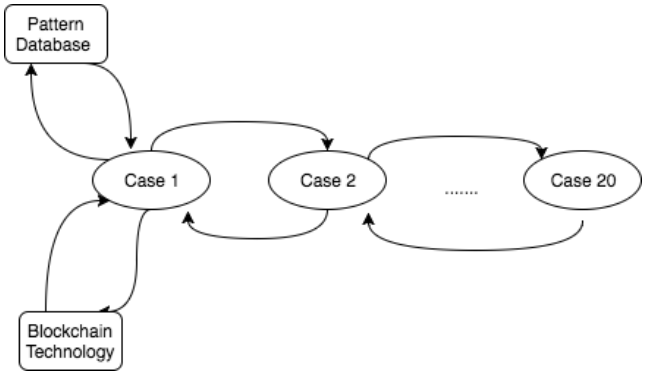

Figure 7: Visualized Iterative Process of Interpretation

The purpose of the open coding was to recognize the sections of the texts that explain the business model logics that the company plans to pursue and important concepts related to the utilization of blockchain technology.

Initial set of codes instituted of:

- STOF domain and elements
- Problem (current problems in the industry that the companies are addressing)
- Blockchain (to refer to specific characteristics and benefits of the technology)
- Preselected BM Patterns

Initial set of codes is presented in the Table 10.

service	**organization**	**blockchain**	**software provider**	**distributive network**
value preposition	actors' relationship	disintermediation	servitization	freemium
offering	finance	crowdsourcing	multisided platform	marketplace
actors	cost	cost reduction	P2P	shared infrastructure
technology	revenues	crowdfunding	collaboration platform	trust intermediary
architecture	financial arrangement	micro transactions	brokerage	open source
functionality	problem	revenue sharing	lock-in	

Table 9: Initial Set of Codes

The process and difficulty of identifying individual business model pattern varied, which can be explained with the following two reasons. First, business model patterns are ambiguous constructs. As discussed in the challenges of building the patterns identification methodology, there is clear lack of knowledge on how to derive the patterns from the case companies. Moreover, the names of some patterns are also widely used in practice, so in some cases the pattern name is directly found in the analysed data. Second, due to exploratory character of this research and current state of the technology the decision was made to analyse multiple cases but only with information collected via desk research and the ideas on the business model design that are not fully realised yet but in majority of cases only a future plan. Therefore, the data that was analysed does not offer complete view on the business model of all the case companies. In some cases, a key information was missing to make a final conclusion on the pattern.

The results in form of final set of identified patterns are presented in Chapter 6. To better understand the difference in the process of interpretation between the patterns, three examples of data segments and explanation of its interpretation are provided.

Examples:

Disintermediation

"This eliminates the need for middle person companies who provide clinical study leads, often times handling sensitive patient data." (Bowhead White Paper)

Disintermediation pattern (deliver a product or service that has traditionally gone through intermediary directly to the customer) is strongly associated to the context of blockchain technology and is therefore very easily recognisable since the companies emphasize the trusted parties that their service is eliminating.

Multisided Platform vs. Software (platform) as a Service

To distinguish between platform business model and software as a service pattern of the company, the understanding of revenue creation logic is needed and recognition on who the end customers are.

PokitDok presents their product as a platform API, however, the revenue logic that they sell their product as a service represents that they only design the product in mind for three main customers: consumer, provider, and payer. The pattern recognized for their case was software as a service.

"PokitDok is a leading offering which healthcare organizations depend on to build applications that securely store, process, and transmit personal health information. Customers from industry vertical markets, such as Healthcare, want access to software like PokitDok that is available for immediate purchase and deployment from Amazon web Service Marketplace." (Bowhead Web Site)

Digital Lock-In

"Creation of a closed ecosystem- real money in closed circle" (DentaCoin White Paper)

"We firmly believe that using a token is the best payment system to support this infrastructure for the foreseeable future. The future is a vibrant ecosystem of many tokens, for which healthcare will need a closed loop payment system in place. The result will be an efficient care cycle management positive feed-back loop with significant decreases in billions of dollars currently attributed to healthcare payment fraud. (Patientory, White Paper)"

From this two segments of text Digital Lock-In pattern was identified. The pattern is by definition associated with a strategy to lock in the customer to the closed ecosystem with increasing the switching costs through high hurdles using digital technology, which is in this case blockchain based infrastructure and its digital token. As mentioned in the second quote the future with different tokens is imagined, however, to achieve the efficiency in the healthcare system the closed loop system is proposed as the only solution. Consequently, the closed system design with having only certain token recognized as a value could led to hurdles for the customers with many additional actions required in the changing process to similar ecosystem.

New Business Model Patterns Construction

To construct new business model patterns the codes of open coding that were not relevant for the identification of already existing business model patterns were used as a starting point for analysis and further axial coding. Based on the analysis of codes central themes were identified. Those were token and values incorporated in the design (security, privacy, transparency and patient empowerment). Based on the 'paradigm model', which enables the researcher to think systematically those themes were seen as phenomena, which represents the central idea or event and indicate about which set of actions/interactions are directed at its meaning (Halaweh, 2012). The interactions between main themes and associated codes with the STOF elements were visualized with the use of network maps in Atlas.TI.

As a result of the analysis it is proposed that tokenization is a new blockchain specific enabled pattern. Moreover, also four value patterns are proposed that seem to be relevant for the context of blockchain technology and business model innovation since they have an impact on different parts of the business model. The logic of each pattern construction is further presented in the form of examples of network maps derived from the individual cases.

Tokenization

In analysing individual cases it was recognized that the use of token is associated with many different functions not only as a tool that simplifies crowdfunding. It can also be used as a payment method as a part of service offering or used for platform governance as a tool to design incentive mechanism. This lead to further reasoning that using a token (tokenization) is seen as a new blockchain specific business model pattern that can be implemented with the utilization the technology (in most cases Ethereum blockchain). The construction of tokenization pattern from the case of Dentacoin is visualized in the Figure 8.
STOF domains and elements are coloured in green. Token and crowdfunding as associated patterns are coloured in purple.

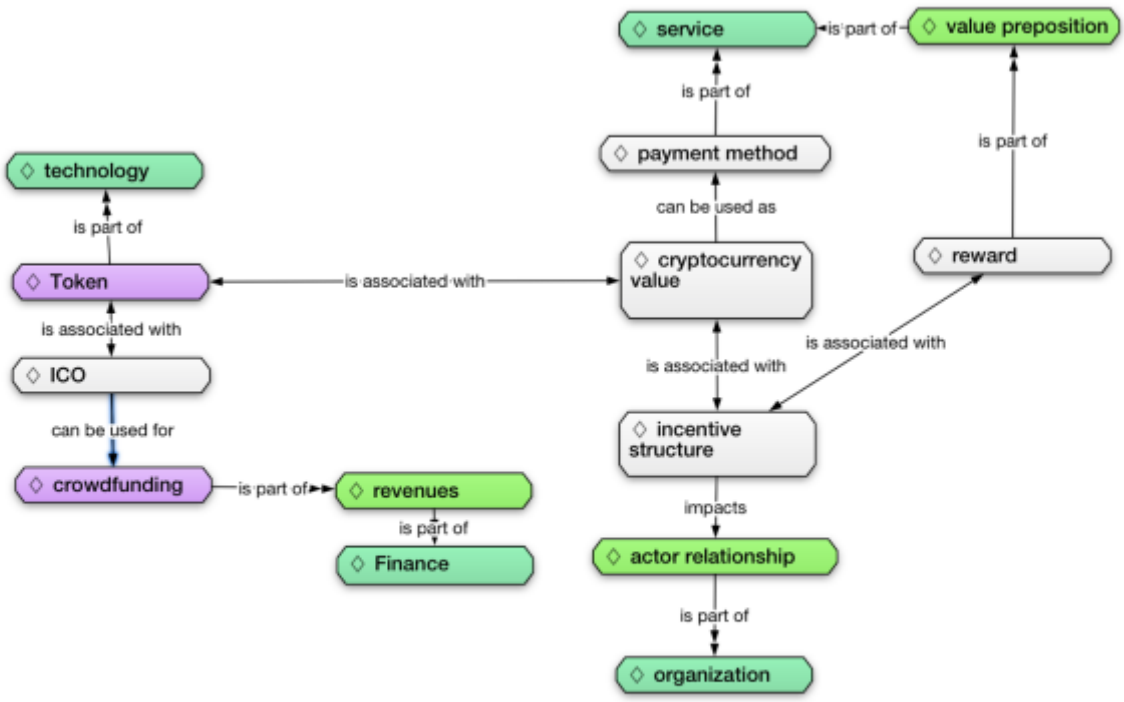

Figure 8: Construction of Tokenization Pattern (Dentacoin)

Value patterns

The second phenomenon observed based on the open codes were values. Those are usually not treated as business model patterns; however, it was observed that they are presented as important part of the value preposition of the service with addressing values in the design of current ICT solution. Moreover, the values also influence the design of business models in different domains.

Transparency by Design

Transparency is associated with the blockchain property that no manipulations are possible due to immutability of the record once a transaction is recorded and saved in the blockchain. Moreover, it is also associated with the transparent agreements between stakeholders that need to be determined before the smart contract can be programmed. Examples of transparency networks map that are complementary from the cases of Dentacoin and Patientory are visualized in the Figure 9.

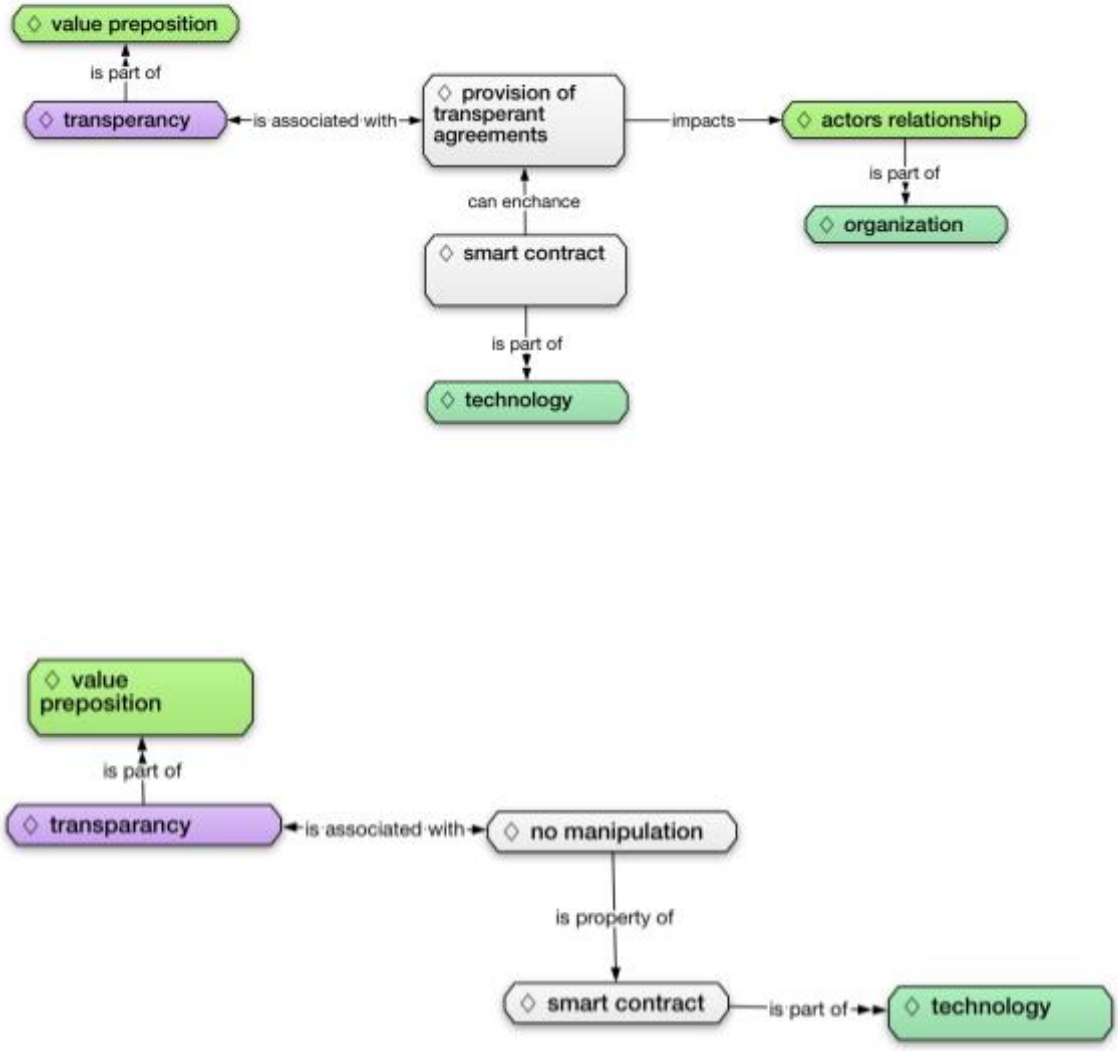

Figure 9:Construction of Transparency by Design Pattern (Patientory, Dentacoin)

Security by Design

Next value pattern is related to security by design. Example of security in the context of data sharing is visualized in the Figure 10 and was derived based on Patientory example.

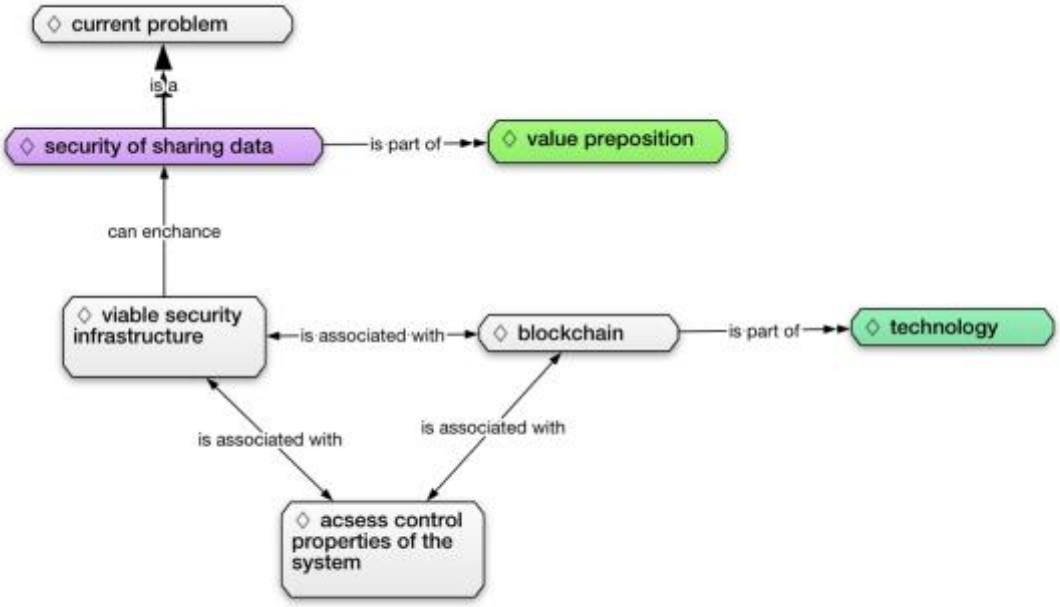

Figure 10: Construction of Security by Design Pattern (Patientory)

Privacy by Design

Third value pattern that was recognized is privacy by design. Interestingly it is mentioned that due to privacy matter only private blockchain implementation is viable. They argue that this limitation may be overcome with additional encryption, but if decryption key is ever leaked the sensitive data cannot be removed from the blockchain. Figure 11 presents construction of the privacy by design pattern.

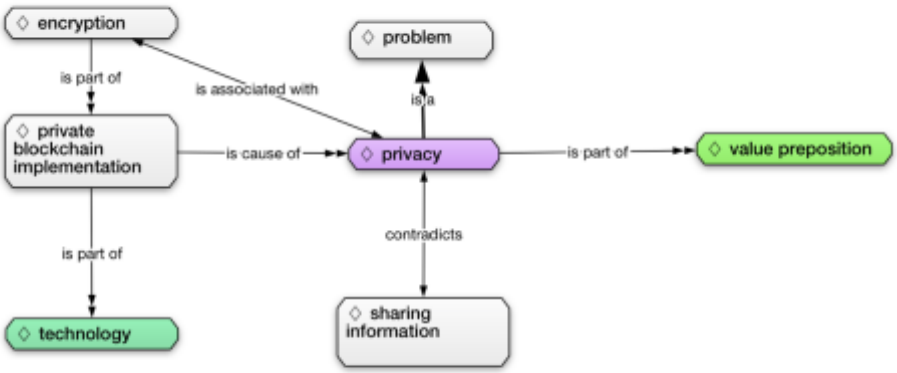

Figure 11: Construction of Privacy by Design Pattern (Patientory)

Patient empowerment

The last value pattern that this research purposes is patient (or user) empowerment. Startup companies want to empower patient with providing them access and higher control over their information. This is in the example of Patientory visualized in Figure 11 also related with proposed reorganization of data sharing to P2P architecture that is associated with the blockchain technology.

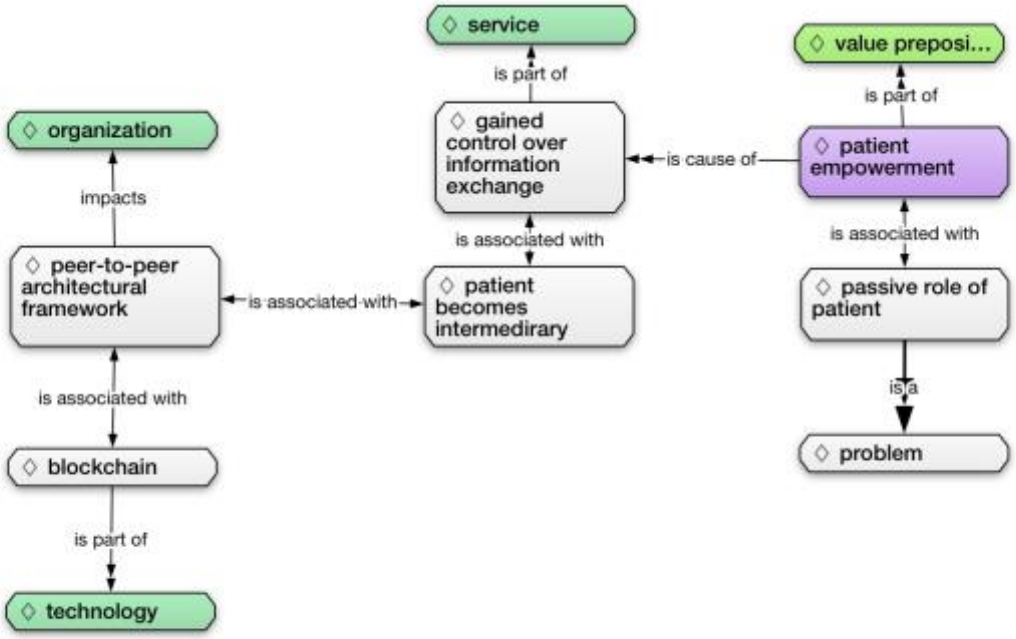

Figure 12: Construction of Privacy by Design Pattern (Patientory)

To conclude, it is important to note that similar relations as presented in the examples above were recognized across cases. Differences recognized were in most cases complementary (e.g. additional use or function of token, transparency by design due to immutability and need for predefined requirements between stakeholders in automation with smart contract). The differences and variations are with examples discussed in the result chapter that follows.

5.3 Step 2: Semi Structured Expert Interviews – Exploration on Blockchain Potential as a Catalyst for Business Model Innovation in e-Health

After the identification of business model patterns in the first step of the research, a better understanding of associated business logics relevant for the context of blockchain technology was gained. However, to understand the extent of applicability of pattern in certain industry, moderators' specific for the industry needs to be considered. Therefore, in the second step of the research identified patterns will be used as a basis to further explore and evaluate the potential of technology to trigger business model innovation in e-Health industry.

For exploration identified patterns will be used in a role of instruments of scientific inquiry as a part of semi structured interviews with professionals working in e-Health domain. Due to very recent interest in the technology in e-Health industry and almost no knowledge about its potential due to current technical uncertainties and limitations, high level and open reflection on the patterns was made. Moreover, the participants were asked to discuss the patterns in terms of healthcare in general. However, the focus of each interview was related to their background.

The requirement for the interviewee selection was that the interviewees are knowledgeable about e-Health industry and also familiar with the basic principles of the blockchain technology. Interview protocol was in each interview adopted based on a background of each participant. Due to the time limitations and different backgrounds of the participants, a different number of patterns was discussed in every interview. Priority was given to tokenization and value patterns that were identified as the patterns triggered by the blockchain technology. The two interviews with blockchain entrepreneurs were aiming at understanding how they plan to implement identified patterns in their work. With other interviewees patterns were evaluated in the healthcare context in general. Since the privacy by design and the new General Data Protection Regulation from European Commission emerged as an interesting topic in the context of blockchain applications dealing with personal data, an additional interview with the researcher specializing in data privacy and EU law was conducted.

Seven semi structured interviews were conducted via Skype. Each interview was 30 to 60 minutes long. Each interview was transcribed and fed back to participants for validation before the analysis. Table 11 presents the final list of interviewees, organization in which they work, their function, base country of work and the main topics of each interview.

First step in the analysis was highlighting the segments of the text referring to individual pattern. Afterwards, the opinions related to individual pattern were compared across all conducted interviews with taking into account the background of each interviewee. The results are presented in the form of discussion, where interesting conflicts and differences in opinions are emphasized. It is important to note that the aim of the discussion is to only introduce the potential opportunities and technology implications for healthcare and at the same time discuss the barriers for adoption through the evaluation of applicability of business model pattern. The analysis was concluded with the researcher reflection on the interviews outcome based on the knowledge gained in the research process and reflection on the utility of business model patterns as a construct in evaluating emerging ICT technology from business model innovation perspective. Results are presented in form of discussion in Chapter 7.

Category	Interviewee	Organization	Function (Country of work)	Main topics
Blockchain Entreprenur	David Manset	My Health My Data (EU research project exploring the potential of blockchain technology) / Gnubila (data privacy solution designer and independent software vendor)	Responsible for Blockchain Platform Development/ CEO and Entrepreneur (France)	-Related to the project: patient empowerment, implementation of incentive mechanism (tokenization), disintermediation, privacy and security - Future vision on the technology - Insurance industry perspective
Blockchain Entrepreneur	Donika Kraeva	Dentacoin, an industrial blockchain concept invented by Dentacoin Foundation.	Strategic communication manager (EU/NL)	-Usage of token in the concept - Vision of the future of the foundation
e-Health SME	Guido van 't Noordende	Whitebox Systems/University of Amsterdam	Founder/Researcher in the System and Network Engineering (NL)	-Whitebox system as a privacy oriented solution for healthcare data exchange - Privacy risks in current national system -Technical use cases of blockchain and technology limitations - Patient empowerment (drawbacks)
e-Health consultant	Jaco van Duivenboden	Nictiz, the national competence center for standardization and e-Health in the Netherlands	Senior Adviser (NL)	-Patterns evaluation in the context of Dutch healthcare system
Insurance and Business Background	Hamza Jap - Tjong	CED Group (European Claim Expert) /Insur-Tech Holland	Corporate Strategist and Business Development/Co-Founder (NL)	-Patterns evaluation in the context of Dutch healthcare system -Potential Use Cases from Insurance Industry perspective
Business Models & e-Health	Timber Haaker	Innolavor (Research based consultancy about ICT driven innovation) / TU Delft	Senior Adviser/ Senior researcher on business models, business model tooling and innovation management (NL)	-Evaluation of BM Patterns as a construct -ICT BM patterns in healthcare (SaaS vs. Platforms), focus on NL -Disintermediation -Patient empowerment
Additional interview: Blockchain and Privacy	Helena Uršič	Center for Law and Digital Technologies	Researcher and PhD Candidate (Specialty: Data Privacy Laws, Law & Technology, EU law and policy) (NL)	-Conflicts in the idea of technology from Data Privacy Law perspective -GDPR

Table 10: Overview of Conducted Experts Interviews

RESEARCH RESULTS

6 Identified Business Model Patterns

Identified patterns that present the outcome of the analysis are described in the following three sub chapters. First, new patterns that are specific for blockchain technology: tokenization and value patterns (e.g. user empowerment, transparency by design) are discussed. Second, patterns that could be potentially enhanced by the technology are presented. Last, overview of generally applicable ICT patterns is presented. Overview of analysed companies and identified patterns by case are presented in the Appendix E. Majority of cases were associated with the applications related to medical data. Based on their communication o their service offering cases were grouped into six general categories and are visualized in the Figure 13.

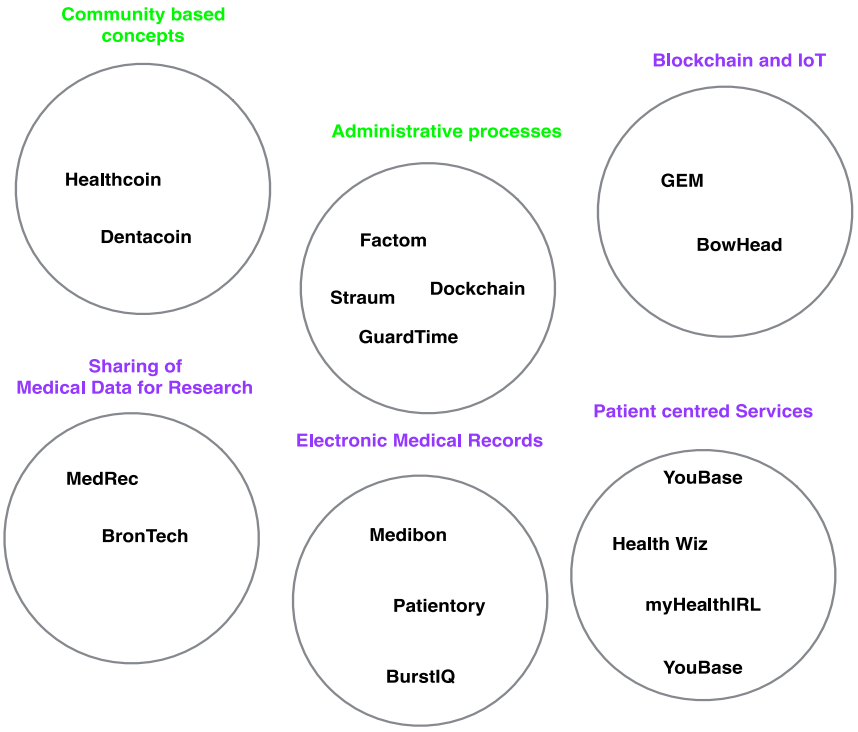

Figure 13:Overview of Analysed Cases

6.1 Blockchain Specific Business Model Patterns

The logic behind the construction of the tokenization pattern and value patterns is presented in the analysis section of the report. In this chapter only the overview of the main principle of the pattern is summarized and generalized along the cases. Blockchain technology role is emphasized for each of the pattern and short discussion on the pattern is provided.

Tokenization

Pattern Name	Description (principle)	Blockchain Technology Role	Example
Tokenization	Create a token as a part of your system and link it to economic value. Possible usage: -crowdfunding -economic initiative (governance of the platform) -establishment of the network -payments	**Related Technology Feature**: Solving of double spending problem with Bitcoin protocol Ethereum enables creation of the tradable digital token.	Dentacoin is creating the universal cryptocurrency for dental community that is incentivizing patients and doctors to improve dental healthcare services.

Table 11: Tokenization as a Business Model Pattern

It was discovered that creation of the token in the design of the system and linking it to the economic value in form of cryptocurrency can have an impact on all of the STOF domains. Moreover, STOF model does not assume that technology can be used as mechanism that affects revenue element. The trend of Initial Coin Offering is also growing on the market. However, there are many uncertainties regarding its regulation. The pattern is also associated with already existing business model patterns, which will be discussed in the next chapter.

Value patterns

Value patterns are usually not the topic of business model research in the context of technology innovation. However, in this research we identified values by design connected to blockchain technology implementation as important business model patterns that explains how companies in the industries as e-Health are claiming to differentiate themselves. The overview of the value patterns is given in the Table 12.

Pattern Name	Description (principle)	Blockchain Technology Role	Implications
User empowerment	Enabling user (patient) more control over their own data.	(1) P2P network as a component of blockchain systems	Patient becomes the primary intermediary in sending and receiving health information in EHR. (Patientory)
Transparency by Design	Important value in blockchain discussion	(1) Immutability (2) Concept of the smart contract	(1) Transactions of the ledger cannot be tampered (2) Agreements between stakeholders need to be achieved before programmable in the system.
Security by Design	Important value in blockchain discussion	(1) Safety measures are embedded in the network with no single point of failure (only public, decentralized system) (2) Access control	Security is increased due to the inherent access control properties of Patientory.
Privacy by Design	Important value in blockchain discussion	-Encryption - Access control properties	Access and control over personal data increases privacy.

Table 12: Blockchain Specific Business Model Patterns

6.2 Blockchain enhanced Business Model Patterns

Four business model patterns were identified relevant for the context of the technology that could potentially be enhanced by the use the technology. First is crowdfunding business model pattern, which is observed to be enhanced due to digital token creation. Next is digital lock-in pattern that could potentially be enhanced due to the decisions for implementation of close systems related to efficiency reasons. Third pattern, the automatization is directly linked to the concept of the smart contracts. Last is disintermediation of the parties, which is often discussed topic in the context of blockchain technology. Overview of the blockchain technology enhanced business model patterns is presented in the Figure 13.

Pattern Name	Description (principle)	Blockchain Technology Role	Example
Crowdfunding	Finance a product, project, or company by a group of private investors often including a non-monetary compensation in exchange.	Company can make their own token on Ethereum and do the crowd sale to finance their project.	Deltacoin is doing the crowdsale to establish the value of currency to be used as a main payment method in the dental community.
Digital Lock-in	Use digital technologies to limit the compatibility of physical products and thus lock customers to your ecosystem.	Internal token is used in platforms using blockchain technology, which enable users to perform tasks as payments or purchasing.	Patientory designed closed loop payment system in their platform to enable automatic billing between health institutions and individuals as token based debt.
Automatization	Use smart contracts to automate execution of predefined agreements.	Smart contracts	Automatization of billing services between insurance, hospitals and bank.
Disintermediation	Deliver a product or service that has traditionally gone through an intermediary directly to the customer.	Governance can be built in the network with the consensus mechanism (no need for a central party).	(Bitcoin was design with the aim to disintermediate bank as a central player in the money transaction.) Potential elimination of clinical study leads.

Table 13: Blockchain technology enhanced business model patterns

6.3 Applicable ICT Patterns

Last, collaboration and multisided platform business model patterns were identified besides software as a service business model pattern. Blockchain technology is by design technology aimed at coordination of the transaction between different parties that do not trust each other. This is also aligned with the conceptualization of the technology as proposed by Glaser and its linkage to collaboration, multisided and P2P market models (Glaser, 2017). Moreover, distributive network pattern was identified since the companies aim to provide a blockchain infrastructure.

Pattern name	Description of the pattern principle (adopted by Remanne et al. 2016)	Role of Blockchain Technology	Example
Distributive network	Provide an infrastructure to connect other actors of the economy such as logistics, energy, mobility or communication.	Blockchain technology can be utilized as infrastructure for transactions (e.g. data exchange)	Peer to peer Electronic medical record storage network.
Collaboration platform	Provide a set of tools and an information environment for collaboration between enterprises.	Blockchain is by design technology for transaction between multiple parties. Coordinated information exchange needs to be designed in a system.	GEM is designing platform with partners to enable collaboration of different healthcare stakeholders into sharing and transferring healthcare data.
Multisided platform	Bring together two or more distinct but interdependent groups of customers, where the presence of each group creates value for the other groups.	General ICT pattern (multiple parties setting)	GEM wants to create scalable and flexible platform that will enable developers to build distributed applications for healthcare.
Software as a service	Sell the service that the products perform rather than product.	General ICT pattern	Patientiory charges to medical institution SaaS based fee after they decide to participate in the network.

Table 14:Overview of Applicable ICT Patterns

6.4 Conclusion

This chapter provides an overview of the identified business model patterns relevant for the context of the blockchain technology. The role of the technology is explained and examples are added. Business model patterns associated business value logics with blockchain based technology components.

7 Exploration of the Blockchain Tecnology Potential as a Catalyst for Business Model Innovation in e-Health

This chapter discusses the results of the second step of the empirical part of the research based on the exploration with the use of semi structured interviews as a method. Chapter is structured as follows. First, introduction into e-Health and business modelling is provided based on the literature. Motivation on using business modelling as a tool for technology implementation strategy in healthcare is emphasized. Second, the discussion of the findings based on the interviews conducted is provided. The chapter concludes with the reflection on the utility of business model patterns as a construct.

7.1 Introduction into e-Health and Business Modelling

Innovation in healthcare through the use of IS/IT is seen as a 'land of opportunities', promising a wide range of improvement potential with respect to quality, cost, and efficiency (Parante, 2000). The term e-health can be explained in the following way: (1) e-health involves health activities as well as technology, (2) technology is both the enabling tool and the embodiment of e-health, and (3) e-health often involves a variety of stakeholders (Oh, Rizo, Enkin, & Jadad, 2005). In this sense, e-health can be understood as both, a specific area of application of IS/IT as well as a particular paradigm of how health services are delivered. The term is used to cover a wide range of system used in healthcare such as telemedicine, electronic health records, health information systems, m-Health and certain aspects of telework.

Mettler and Raptis outlined a possible technology enabled scenario of future healthcare based on the following three areas of research: clinical systems, personal health and independent living and connection of trans-sectional system (Mettler and Raptis, 2011). The scenario is visualized in the Figure 13.

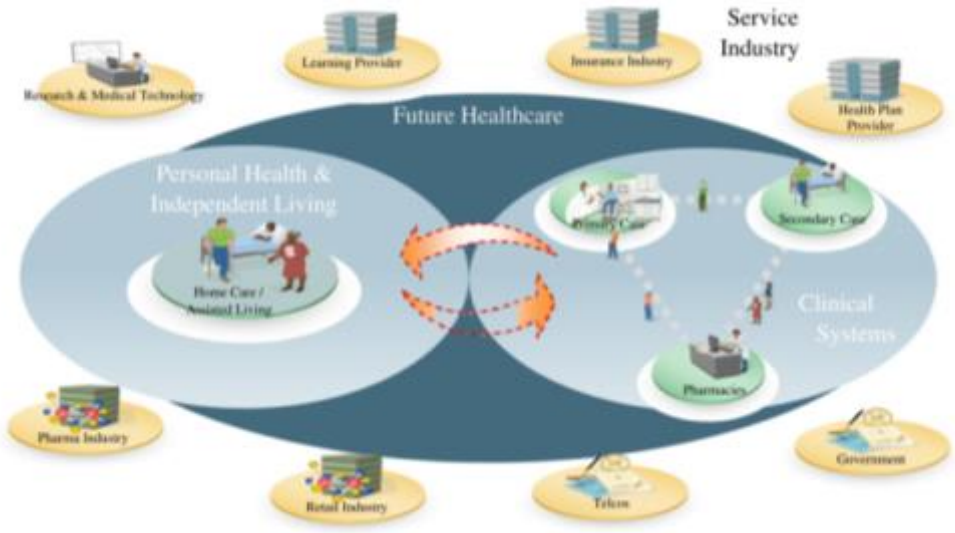

Figure 14: Scenario of technology enabled future healthcare (Mettler and Raptis, 2011)

Developments in e-Health market are promising in terms of benefits as lowering of costs and patients' empowerment (Gorp, 2016). However, healthcare system is very fragmented and differently organized in different countries and regions. This also reflects to the state of the e-Health. For example, in the Netherlands in 2015 less than 1 per cent of patients were having access to medical information (Gorp, 2016).

A business modelling was recognized as potential tool to help healthcare to determine technology implementation strategy by involving all important stakeholders in a value-driven dialogue about the way in which the technology should be utilized. However, it has not gained much attention in academic studies (Gorp, 2016). Lehoux et al. (2014), who study the mutual influence of business model and health technology design, found synergistic readjustments, drastic reconfiguration and mismatch between business model and technology design occur in their case studies, resulting in a change of the initial value proposition. Due to identified challenging gap between a successful pilot and the first stage of a commercial service of an e-health solution the use of business model design patterns was proposed as solution (Mettler and Eurich, 2012). It was recognised that a more profound understanding of the value-creation mechanisms behind the technology might help in various ways when designing e-health services or defining a business case since the can serve as a basis for the specification of simulation models in order to analyse market dynamics (Limburg et al., 2011). Although healthcare has its specialities and is heavily regulated industry, it is always possible to learn from and adapt business models from other industries. This research explored to what extent can the use of business model patterns help explain and evaluate potential implication of the emerging ICT technology.

7.2 Discussion based on the Interviews Findings

Due to many uncertainties about the fit of blockchain technology in healthcare context, the interviewees reflection on the individual pattern mostly from the system perspective on Dutch Healthcare was automatically adopted. However, two interviews with blockchain entrepreneurs were mostly focused on the patterns that they envision to use to better understand the logic behind. Discussion summarizing the conducted interviews is focusing on the new proposed patterns relevant for the context of blockchain technology and e-Health. Moreover, evaluation on platform business model patterns, disintermediation and automatization due to smart contracts are additionally provided since important points to consider relevant for blockchain technology context were discovered.

General View on the State of Blockchain Technology and its Innovation Potential

When the interviewees were asked to reflect on the current state of the technology they have emphasized that technology is at the peak of the Hype Cycle and currently in majority of cases seen more as a goal rather than mean. However, they foresee that technology could potentially be the solution for some of the problems, when it becomes more established and technical limitations are overcome.

"I have been noticing that a couple of parties or in fact many parties probably from a year ago are claiming all sorts of great things coming from the blockchain that would solve many healthcare problems such as privacy blindly. And of course, that is not true because blockchain is a technology that could be used for a couple of things but not for everything."

"It is the hype cycle. Now we are going to go down until the death of the idea. And this will bounce back and come to a more reasonable level, where we can witness the first real working applications based on the blockchain technology in the systems that are scalable and put into the production. "

"Also, the consultancy firms are talking about it, but if you really try to understand why are they using blockchain the answers they give are dissatisfying. It is a hyped technology at the moment."

When asked on the future vision on the technology some of the answers had a strong ideological connotation.

"Blockchain technology is a key to a new society and this is clear to me. It is a society where you have less monopolies, less big businesses. You have a more fragmented value chain, so everyone can find a place as a node in this new society. And blockchain is really helping at tying all these nodes from the little to the biggest together

An interesting perspective also comes from the view that the real innovative opportunity of the technology could be process innovation.

"They see putting blockchain technology not only as a technical solution but something that enables totally different kind of processes. They strongly believe that the real innovation is process innovation with different kind of people and parties involved and also a lot less parties involved so things can be cheaper."

Disintermediation

How could technology trigger disintermediation in healthcare is not as clear as in financial industry. Interviewees usually started to think about who could represent a trusted third party in healthcare context. Insurance companies were in most cases mentioned as an example. However, it was acknowledged that the importance of the role of intermediaries goes beyond only handling the transactions.

"For example, if you look at insurance companies they have a specific role in the healthcare system not only handling transactions. They have a much bigger role."

One of the interviewee emphasized that insurance companies are interested in the technology (this is also shown with the recent establishment of consortium B3i project) since they see themselves as a trusted third party, which represents paradigm shift for them. Moreover, since they in a way see the threat in the technology, the question arises what it means for them to be a trusted third party or to be a node of the new network in the future.

It was also emphasized that disintermediation, if you look on it from technology implementation perspective, often adds extra intermediary from the system perspective. As an example of new intermediary potential new party providing transparency service towards patients was pointed out.

"However, maybe you need a new independent party to provide this information and improve transparency in the healthcare system, which is contrary to disintermediation."

Last, when thinking about the disintermediation in healthcare it has to be noted that currently most of the healthcare systems still base on hierarchical trust mode.

"Whatever comes from the top is by definition trusted, because the payment comes from there, all the rules and regulations come from there. I don't think that is easy to change. I am not really seeing how except in entire portal where the patient itself is in the centre."

Value patterns

Privacy by design was emphasized and the most discussed value pattern in the healthcare context during the interviews since the discussion about the potential applications using blockchain technology in healthcare is often associated with sensitive personal data. It is important to note that when we look at the conceptual idea behind the blockchain conflicting points in terms of data privacy arise.

"On one hand the technology is bringing trust in every transaction since it is enabling immutable record of the transaction, which is timestamped. If it is also possible to come to identity of people participating in the transaction, every transaction is in a sense very protected from a legal point of view and simplified counterfeit over fraud is possible. On the other hand, the possibility to identify the person who made the transaction raises privacy related issues. Law protecting personal data states that your personal data can only be visible and accessible to parties to who individual provides consent. Moreover, each individual also has a right to delete the personal data and if that data is on the immutable ledger and therefore cannot be erasable again a conflict arises. Another important right is to have access to your personal data, which is what some blockchain applications proposed on the market are offering as part of their service, which is again a positive side to the protection of privacy. The important difference arises between private and public blockchain design. Private blockchain solutions seem less problematic from protection of personal data. Furthermore, another open issue is related to the responsibility of protection of personal data in blockchain governed systems. For protection of personal data, the party processing the data is held responsible. It is not very clear who is responsible for that in different designs of blockchain systems."

It is important to raise the privacy issue, which is in the context of the blockchain technology since with the new regulation of European Union starting from May 2018 all the companies dealing with processing of personal data will have to prove privacy by design component in their technology solution.

The conflicts related to the idea behind the blockchain technology on the privacy issue were also observed during the interviews. Both of the interviewees with background on privacy design strictly emphasized that blockchain technology is not a privacy solution and that additional measures need to be taken to achieve privacy in the systems where the technology is used. The association of blockchain with privacy can be explained with the fact that privacy is connected with providing access control of data to the users. However, this is only one of the issues related to the topic and is not providing the solution to the whole privacy matter.

The importance of privacy in the systems providing healthcare data exchange was by the three of the interviewees demonstrated with example of mandatory information exchange system in the Netherlands proposed by the Dutch Government a few years ago, which was criticized and shot down due to privacy matter.

Transparency by design was the second pointed out pattern during the interviews. In My health my data research project, which is exploring the idea of creating data science market the blockchain platform, presents the core of their solution providing transparent and full traceability of data transaction between different stakeholders. It's the solution that could realize the vision of establishing a market place of sensitive information making transactions between different types of stakeholders transparent and traceable.

Moreover, one of the interviewees emphasize that there is a lack of transparency in healthcare in terms of availability of information on the quality of medical services. This could be potential opportunity for new entrants on the market providing the service. Similar vision has the concept of Dentacoin.

The **user empowerment pattern** was recognized as part of natural development in e-Health industry worldwide and also in the Netherlands. Blockchain, was recognized as technology that could potentially be relevant as one of the tools enabling patients to give consent on the use of specific kinds of data or to provide the data that GPs, doctors and the specialists need from the patient at the moment he or she is visiting the clinic or pharmacy. Moreover, user empowerment in terms of personal data in opinion of one of the interviewee will also be enhanced by the GDPR regulation, which is emphasizing that consumers should have rights on their data. This could potentially lead to more incentive based business logics where you are asked if you want to benefit from the service to take control.

However, important discussion arises on the topic of putting the patients in the center of data exchange and providing him or her with higher control over his or her personal data.

"In healthcare context if the patients will be willing to take the responsibility on control of their medical data is a completely different discussion and has basically nothing to do with the technology. This is the matter of ethics and even the politics."

It was emphasized that of course it is important to empower patients who are willing to do this, but it cannot be expected that everyone is capable of taking this responsibility. One of the alternatives mentioned was that the personal GPs should be ones authorizing the access to the patient data since the data is potentially safer with someone having enough knowledge and professional secrecy to keeping data safe.

Tokenization

Use of Ethereum blockchain is enabling adding a cryptocurrency as a part of the technology utilization. In My Health My Data project they see the possibility for using the token in their solution as a mean to establish socio-economic model. With the model, they want to create incentives for the participating stakeholders. Moreover, they also want to demonstrate a second value in terms of societal impact of shared data.

"However, the midterm objective of the research project is to have a socio-economic model, which is more than a business model, where we have economical and societal valuations."

Dentacoin sees the opportunity in creating their own currency as a tool to create strong community. Ownership of tokens also represents the vote on the future direction of the community. Lastly, the importance of token and related economic model was also discussed as a mechanism, which enables public blockchain network to grow.

Automatization (due to smart contracts)

Automatization and improvement of processes due to smart contract was only recognized outside the primary care. For example, there is a lot of processes between healthcare professional, insurance companies, municipalities and citizens. Moreover, different health insurance models could be created.

‘‘Blockchain could help in creation of different kind of products: P2P insurance, physical therapy (from smart contract concepts). If you look at healthy people they never pay a deductible, while chronically sick people always pay a deductible. You can use blockchain to leverage that. “

SaaS and Platform Business Model

Last, interesting conclusion was observed regarding comparison of SaaS and platform business model pattern.

Platforms as a business model are not so common in healthcare, especially in the Netherlands. Most of software in healthcare sector (public sector in general) is only licensed from software providers. Nevertheless, SaaS model is increasing (patient systems in hospitals or at GPs). Companies with the platform business models are emerging, but they have issues with finding effective monetization mechanism. “

Interesting examples mentioned was Patients like me, community for people with the same kind of condition the same disease. The community turned to platform in business model sense when they started selling data generated on the portal to third parties. Another example is concept of platform aiming at personalized treatment with collecting data on patient side and then connecting different care providers. There are also some P2P pilots on the edge of the healthcare and well-being emerging (e.g. connecting volunteers with elderly patients).

The privacy issue and commercial interest related to medical data also emerged in the context of platforms.

“The important thing in platforms is that no commercial companies are involved and that privacy is the number one issue that is being guaranteed.”

It was recognized that establishment of platform business model is very challenging in the healthcare context, especially in the context of medical data, therefore the link with using this pattern for utilization of blockchain technology seem far fetching taking into account current situation. However, the trust notion of blockchain could potentially enhance emergence of multisided platform.

"Strong point in the blockchain context could be linking entities that not necessary trust each other (e.g. patients – insurance companies – healthcare providers), which could lead to emergence of multisided platform. Moreover, also more collaborative platforms in terms of consortiums could emerge (e.g. between insurance companies). "

7.3 Conclusion

Overview of identified implications and uncertainties related to individual pattern from the business model innovation perspective identified are summarized in the Table 14.

Disintermediation	- Strong role of intermediaries in healthcare - Parties
Transparency by design	- Potential opportunity for new entrants in terms of providing quality of information (e.g. Dentacoin Review System) - Potential key to realization of sensitive medical data marketplace
User Empowerment	- Conflicting views on patient centric medical data solution (opposite opinion: GP should be ones authorizing the access) - political and ethical discussion - Current trend in the industry
Privacy by design	- Confliction characteristics of the technology in terms of data privacy (especially public blockchain) - Blockchain system will need to show that they comply to GDPR - Data sharing with access control does not solve whole privacy issues
Tokenization	- Community creating mechanism (due to incentives) - Idea of establishment of socio economic model
Automatization (smart contracts)	- Can trigger new health insurance models (due to automatic payments) - Potential Optimization of administrative process outside the primary care
Platform Business Model	- Currently not widely represented pattern in the context of e-Health (difficulties in monetization, ethical issues regarding commercial interest in data) - The trust notion of blockchain technology could enhance emergence of multisided platforms.

Table 15: Overview of the identified technology implications per pattern

Patterns as a construct were guiding a high-level reflection on potential implications of blockchain technology adoption in healthcare. Regarding the utility of the patterns as a construct following benefits in using business model patterns for evaluation of emerging technology were recognized. First, patterns as a classification device provide a good overview of business logics associated with the technology currently discussed and proposed on the market. Second, business model patterns help to think in analogies. It was recognized that patterns also offer a good starting point for benchmarking the current situation of the market and overlook the hype. Due to so many uncertainties, only a reflection on the system level was credible. It was also showed that some of the patterns do not fit fully in current structure of e-Health market due to the hierarchical organized system ethical issues related to medical data (e.g. platform business models). The importance of including values in evaluation of business model innovation perspective in the context of emerging ICT innovation was displayed. Moreover, we argue that the values and ethical

Due to many ethical issues that arise in the context of IT systems in general (not even related to blockchain characteristics), the utility of the business model patterns (as recipes) as a tool for supporting practitioners is doubted in the e-Health context.

CONCLUSIONS & REFLECTION

8 Conclusions and Reflection

The final chapter discusses the main findings and contribution of this research. Moreover, reflection on the research limitations is made and recommendations for further research are built. The conclusion and recommendation are in line with the previously formulated research question:

How can identification of business model patterns relevant for the context of blockchain technology support the process of technology evaluation from business model innovation perspective in e-Health domain

Hence, the research outcomes can be broken down into three important parts: (1) the reflection on the use of business model pattern as theoretical construct in the context of exploring potential impact of emerging ICT technologies from business model innovation perspective, (2) development of methodology for patterns identification and identification of relevant business model pattern for the context of blockchain technology and (3) the reflection of the applicability of patterns for e-Health.

Based on those three outcomes the research question is answered. Due to exploratory character of the research the outcomes also give orientation for future research on both prime topics: blockchain technology as complex socio technical phenomena and its implication on business modelling and the use of business model patterns in IS management literature. The chapter is structured as follows. First, main findings are discussed with answering individual research sub-questions. Second, research contribution is emphasized and discussed based on the knowledge gaps that were identified. Third, research limitations are discussed. Lastly, recommendations for further research are developed.

8.1 Research Findings and Discussion

The main research question was answered with the help of four research sub questions.

SQ1: ***What is the current state of the blockchain technology and what are related innovation opportunities that could have implication on the business models discussed in the literature?***

To be able to evaluate the potential implications that the utilization of blockchain technology could have on business logics, first a good understanding of the blockchain technology was needed. The literature review and desk research were adopted as main two research strategies to answer this question and to gain good understanding of the domain. It was recognized that the technology is at the peak of hype cycle and that critical stance towards the analysis is needed. Furthermore, it was also acknowledged that market applications for e-Health industry just started to appear in the market.

Blockchain technology is based on the pervasive, decentralized and open design and could impact different layers of digital ecosystem. The main characteristics of the technology

(immutability, non-repudiation, integrity, transparency and equal rights) are dependent on the design decision and in some implementations, require trade-offs.
Four main innovation opportunities were identified in the literature that are closely related to business model innovation perspective. First, technology behind bitcoin was designed with the aim to remove the central party. Therefore, the potential disintermediation in different industry is a generally discussed topic in the context of technology. Second, the attributes of the technology as decentralization and trust introduce questions as the ownership and value capturing mechanisms in the context of platform economy. Third, the characteristics of the technology could enable new services. Lastly, values as distributed power, value as incentive, inclusion, security, privacy and others surrounding the blockchain technology and discussion are important to be considered and could shape also future business model design of the companies utilizing the technology.

SQ2: How can business model patterns as a construct support evaluation of the blockchain technology from business model innovation perspective for e-Health industry?

Business model patterns were chosen as a theoretical construct of the research due to following reasons. First, they provide the flexibility in analysing potential impact of the technology on the business model at different level of granularity. Second, they were already recognized as a construct that can help to reveal valuable insights about business logics of disruptive technologies. Third, they can be used as a tooling for more systematic business model innovation. However, patterns are relatively new construct that stem from the architecture. There was a lot of inconsistency and different understanding of patterns recognized after conducting literature review. Therefore, the conceptual linkage to the concept and multi-purpose character to the business model as a construct was made. Business model patterns similar to business models can serve as a classification device to expand the knowledge about business phenomena, instrument of scientific inquiry that can be used to conceptually experiment or recipes displaying the successful principle from practice that can be reused. In literature, the use of patterns in all three roles can be observed. Taking into account their multipurpose character their different use in literature can be explained. Based on the literature study on the relation of technology innovation, business models and business model innovation concept map that constitutes two steps was developed. First, business model patterns can be used in the role of classification devices in order to gain understanding of the business logics associated to the context of the blockchain technology. Second, to explore the potential impact of the individual patterns from the business model innovation perspective, industry specific moderators need to be taken into an account. Therefore, the role of the business model patterns as an instrument of scientific inquiry is proposed. Use of the business model patterns as recipes is not a viable option due to such an early stage of the technology and related uncertainties. Moreover, only reflection on the business model patterns from the system level was a credible option.

SQ3: ***Which are the relevant business model patterns in the context of blockchain technology that can be identified?***

Due to very limited knowledge on how business model patterns can be identified and ambiguity of the construct, a methodology for patterns identification needed to be developed. The methodology was constituted from two separate strategies. Seventeen cases and their visions on how the blockchain technology can be utilized in the context of e-Health were analysed. First, existing business model patterns relevant for the context of the blockchain technology were identified based on the reference to the collection of patterns. Second, new technology specific patterns were constructed inspired by the combination of case studies and Straussian grounded theory approach as suggested solution on how to achieve the balance between rigour and relevance in studying emerging ICT innovations. However, the grounded theory was not fully adopted since the starting point of the patterns identification is the development of the "ideal types" that can be communicated with the language and concepts used in practice. The conceptual framework developed was used as a starting point for analysis in combination with theory and domain knowledge. The result of this phase was construction of tokenization as a new business model pattern and four value patters (patient empowerment, privacy by design, transparency by design and security by design). With the analysis assisted by coding process, it was demonstrated how do those patterns as a central concept relate to and impact different elements of the business model STOF. Moreover, also eight existing business model patterns relevant in the context of blockhain technology were identified and are presented in the results section. It has to be acknowledged that collection of the patterns is not exhaustive list, but first attempt based on the chosen cases analysis.

SQ4: ***To what extent can the usage of business model patterns help understand potential implications of blockchain technology for e-Health industry from business model innovation perspective?***

Patterns help thinking in analogies. During the interviews, business model patterns served as a guidance for high level reflection on the potential implications of the blockchain technology. The importance of consideration of value patterns in business model innovation perspective for emerging ICT technology was demonstrated. Many ethical, legal and cultural barriers were mentioned that need to be addressed if technology would be implemented in e-Health. Also, it is not clear what kind of transaction could be facilitated by the technology (e.g. medical data, meta data, transaction outside of the primary processes, …) and if there exist any transaction intermediary that could be at least partly disrupted. The identification of patterns served as a classification of relevant business logics associated with the blockchain technology. The use of the patterns also displayed, which patterns are difficult to utilize reflecting on the current e-Health market situation.

Main research question: How can identification of business model patterns relevant for the context of blockchain technology support process of technology evaluation from business model innovation perspective in e-Health?

To conclude, after answering individual research questions main research question can be answered. In brief, business model patterns can have multipurpose role as a construct. Used as a classification tool, they can help understand business logics associated with the

technology or logics suitable for the technology utilization. The business model patterns identified in this research reflect on how the components of technology are associated with business logic presented in the patterns. Furthermore, in such a such an early stage of the technology they can be used for conceptual experimentation and as a benchmark to the current market situation to evaluate the potential implications of the technology from business model perspective. Moreover, using the patterns for technology evaluation and applying it to specific industry as healthcare, raises important questions regarding, legal, social and cultural barriers that are important to consider in the context of emerging technology with potential socio technical implications. Therefore, they can be used as a starting point of a value-driven dialogue about the ways in which technology should be utilized.

8.2 Research Contribution

Based on the identified research gaps, the research contribution can be emphasized. The major emphasis of the research due to exploratory character was a generation of new ideas and assumptions, which can help determine the direction for future research and refine the issues for more systematic investigation. In line with this objective first, scientific contribution will be discussed in the context of business model patterns. Next, contribution from practical perspective will be explained.

8.2.1 Scientific Contribution

Business model patterns are recently introduced concept in the business model research. However, they are often considered less scientific since they stem from more practical and technological domain rather than scientific one. Therefore, the linkage of business model patterns to the business model concept as a multipurpose model was introduced. With review of the current literature it was showed and explained how different scholars use the concept in one or more different roles, which can explain different understanding of the concept. Moreover, with reflection on the business model and business model innovation literature business model patterns role in comparison to other concepts (e.g. taxonomies, typologies, conceptual model ...) used in the literature was displayed.

Complex socio technical character of blockchain technology and its uncertain implications on business models on different levels of granularity made the technology a relevant practical setting for studying scientific knowledge gaps. Research introduced a methodology for business model patterns identification based on two separate strategies. Identification of existing business model patterns was conducted in the context of emerging technology inspired by the combination of multiple case studies and grounded theory method of analysis, which was developed as a solution for balancing between relevance and rigour in the research of emerging IT phenomena. With referring to existing business model patterns, two-way relationship between technology and business model was taken into consideration. Conceptual framework connecting concepts of technological innovation, business model, business model innovation and multipurpose role of business model patterns were

developed. Lastly, importance of including values concept in the business model innovation and design in the context of emerging technologies as blockchain was displayed.

8.2.2 Practical Contribution

This research was one of the first ones evaluating blockchain technology from business model perspective. First, the research provides a good starting point for the socio technical analysis of the blockchain technology as it critically presents the current state of the technology and emphasizing the main uncertainties that could lead to wrong or limited assumptions in the analysis from the socio technical view. Second, the research discusses potential innovation opportunities of the technology already discussed by authors and links it to the business model view with business model patterns identification. Identified set of patterns offers practitioners and researchers a starting point and orientation for further investigation. Moreover, by evaluating the applicability of the patterns in the context of healthcare, high level reflection on the technology from the industry perspective was made. Insights in barriers and potential implications of the technology that need to be addressed by the companies if they are considering utilization of the technology were shown.

8.3 Research Limitations

Research limitations will be addressed from two different perspectives. First, limitation regarding studying emerging IT technology innovation as blockchain and using business model theory will be addressed. Second, reflection will be made narrowing focus to research strategy and methodology used in this research.

Blockchain technology was at the peak of the Gartner's Hype Cycpe at the time of the research. At this stage, there is still limited information about the technology, and how the technology will be applied or impact organizations. Moreover, most of the information is presented in the positive way. Blockchain technology was especially challenging to study due to following two reasons. First, there is no clear agreement on innovative features of the technology since the technology is a combination of already established technologies. Second, the technology is closely intervened with strong social values and ideology. Using business models in practice is complex and needs an acceptable simplification. Moreover, the use of business models and business model patterns is always abstract given by nature. In this research, only the view on the business model through the lens of STOF model was adopted. Moreover, the expressiveness of a single pattern is limited. An overall business model logic can become evident only when precise information about the interaction of patterns is understood.

Due to exploratory character of the research there is a lot limitations connected to the empirical part of this research that need to be noted. The attention was paid to obtaining unbiased outcomes and providing a clear chain of reasoning in the pattern identification. However, the subjectivity of the researcher is involved in the conceptual interpretative research. Moreover, the interpretation part was highly dependent on the researcher's understanding of the blockchain domain. The identification of patterns was only based on the secondary data sources as white papers and web pages. Including primary data could

increase the analysis validity, however this was not possible in this research due to the time constrains. The credibility of method for the patterns identification should be further evaluated. In this research, it was only conceptually evaluated in form of discussions with the experienced researchers in the business mode domain. Lastly, it was very challenging to reflect on the interview results with the industry experts, since they had a very diverse background and point of view on the technology.

8.4 Future Research

Based on the findings of this research and on its limitation, new directions for future research are proposed.

First, the credibility of proposed methodology should be further tested. For example, the similar analysis could be done by another researcher and results could be compared. Furthermore, the similar exploratory approach with business model patterns identifications as a construct in different industry with the interest of the technology could be conducted and technology implications across industries could be compared. In this way, better understanding of the business logics associated with the technology could be achieved in a context not related to specific industry. Potential for business model innovation could be discussed in the form of a Delphi method an alternative to expert interviews if the objective would be to achieve consensus among participant about potential implications of the technology.

Second, role of the tokenization and its impact on the business model design should be further investigated. Design research methodology could be adopted as a suitable approach.

Third, implications and consequences of value patterns associated with the technology should be further investigated. Perspective of different stakeholders in relation to the values could be analysed from a specific system perspective. Also, the impact of the strong ideology surrounding the technology should be further evaluated and explained.

Fourth, impact of the blockchain technology on the future platform business models could be evaluated. The context of multisided platforms emerged as an interesting example.

Fifth, utility of the business model patterns as a construct should be further explored and evaluated. Especially the role of construct as classification device and instrument of scientific inquiry in different contexts of management research as also explored in this research.

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Appendices

Appendix A: Definitions and visual representation of the Blockchain technology related concepts

Distributed ledger - A consensus of replicated, shared, and synchronized digital data geographically spread across multiple sites, countries, or institutions. There is no central administrator or centralised data storage. A Blockchain is only one type of data structure considered to be a distributed ledger.

The Bitcoin Blockchain - A shared digital ledger, or continually updated list of transactions used in realization of Bitcoin.

Double spending - a failure mode of digital cash schemes, when it is possible to spend a single digital token twice. Since, unlike physical token money such as coins, electronic files can be duplicated, and hence the act of spending a digital coin does not remove its data from the ownership of the original holder.

The Ethereum Blockchain is an open-source, public, blockchain-based distributed computing platform featuring smart contract (scripting) functionality. It provides a decentralized Turing-complete virtual machine, the Ethereum Virtual Machine (EVM), which can execute scripts using an international network of public nodes.

Transaction - Meaning of the word transaction can be ambiguous in the context of a blockchain. On the one hand, a blockchain is a database and in this traditional context it can simply mean the update of data in the database. On the other hand, a blockchain often facilitates the transfer of tokens, where a transaction then refers to the transfer of tokens from one user to another user. Tokens are either inherent to the system or implemented in higher layer scripting or programming languages (Glaser, 2017).

Smart contract - Blockchains can automate messages by the addition of code snippets. These code snippets are referred to as 'smart contracts'. These smart contracts employ the use of the 'if-this-then-that' logic (Morabito, 2017).

DApps - Services based on one or more smart contracts are commonly called Decentralised Applications (Glaser, 2017).

Decentralized autonomous systems/services -This could be the most prominent role of blockchain, which is about establishing trust mechanisms between the human and the computer. This is also called Decentralized Autonomous Organizations (DAO) and it can autonomously hire agents on the Internet to perform specialized tasks.

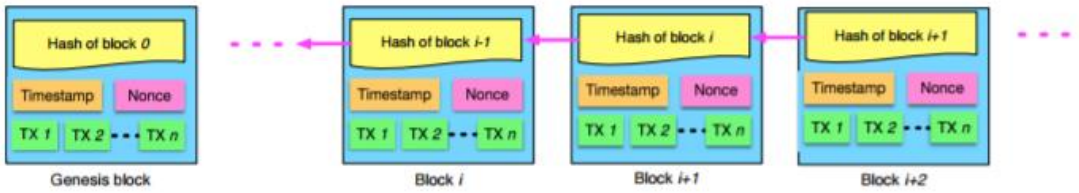
Type of users in blockchain system – adapted from Meijer, 2017

User that read data	User that write data	User that validate data
Access to view blockchain data	User that send and receive transactions via blockchain (transaction user)	Users that validate the transactions that are send onto the blockchain (miners/ validators)

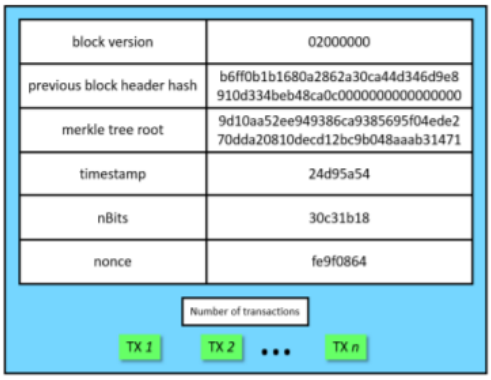
Blockchain architecture (Adapted from Zheng, 2016)

A Blockchain is essentially a public ledger, in which all committed transactions are stored in a list (or a chain).

Figure 1 An example of blockchain, in which a sequence of blocks are backwardly ordered via the hash values of the previous blocks with the exception of the first block (called the genesis block).



1. Block Structure



A block consists of the block header and the block body as shown in figure above.

2. *Digital signatures*

Figure 3 Digital Signature used in blockchain

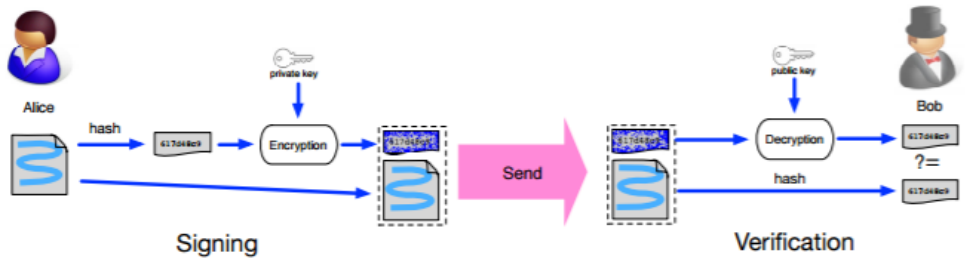
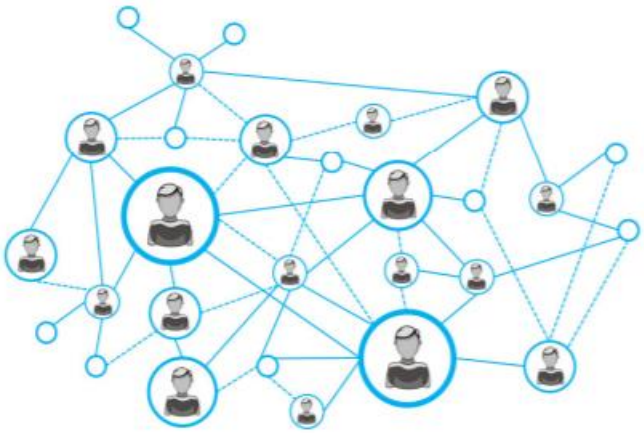


Figure shows an example of digital signature used in blockchain. The typical digital signature is involved with two phases: the signing phase and the verification phase. Each user owns a pair of private key and public key. The private key that shall be kept in confidentiality is used to sign the transactions. The digital signed transactions are spread throughout the whole network and then are accessed by public keys, which are visible to everyone in the network. (Bitcoin Blockchain)

3. *Decentralized Network*

Each user interacts with the blockchain network via a dedicated node in which a blockchain client is installed. A large number of nodes across the whole network form a decentralized network.

Decentralized network



4. Consensus algorithms

Once the transactions have been created, they need to be verified by the network. There are four representatives of the modern consensus algorithms. Proof of work and Proof of Stake are commonly mentioned in the context of the blockchain technology.

POW (Proof of work) is a consensus strategy used in Bitcoin network (Nakamoto 2008). POW requires a complicated computational process in the authentication. In POW, each node of the network is calculating a hash value of the constantly changing block header.

POS (Proof of stake) is an energy-saving alternative to POW. Instead of demanding users to find a nonce in an unlimited space, POS requires people to prove the ownership of the amount of currency because it is believed that people with more currencies would be less likely to attack the network. The idea of POS originated from (Szabo 2004), which essentially discusses alternative proof systems.

Understanding of process that runs on blockchain network – adapted from (Christidis & Devetsikiotis, 2016)

A node can generally act as an entry point for several different blockchain users into the network, but for simplicity we assume that each user transacts on the peer- to peer network via their own node.

Users interact with the blockchain via a pair of private/public keys. They use their private key to sign their own transactions, and they are addressable on the network via their public key. The use of asymmetric cryptography brings authentication, integrity, and no repudiation into the network. Every signed transactionis broadcasted by a user's node to its one-hop peers.
The neighbouring peers make sure this incoming transaction is valid before relaying it any further; invalid transactions are discarded. Eventually this transactionis spread across the entire network.
The transactions that have been collected and validated by the network using the process above during an agreed-upon time interval are ordered and packaged into a timestamped candidate block. This is a process called mining. The mining node broadcasts this block back to the network. The choice of the mining node and the contents of the block depend on the consensus mechanism that the network employs.
The nodes verify that the suggested block (a) contains valid transactions, and (b) references via hash the correct previous block on their chain. If that is the case, they add the block to their chain, and apply the transactions it contains to update their world view. If that is not the case, the proposed block is discarded. This marks the end of a round.

Blockchain System Concepts and Relationships - adopted from (Glaser, 2017)

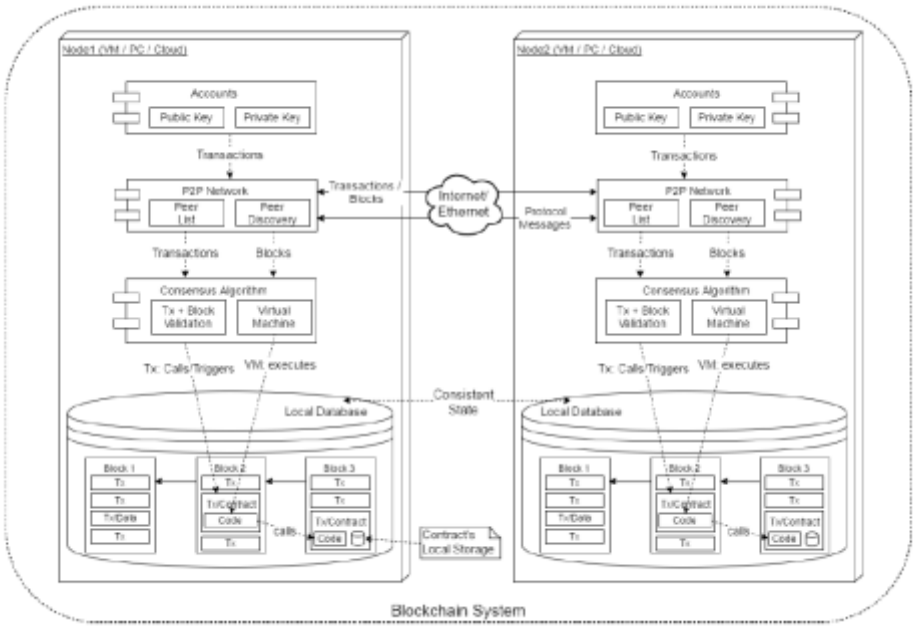
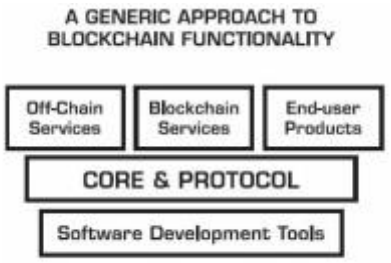
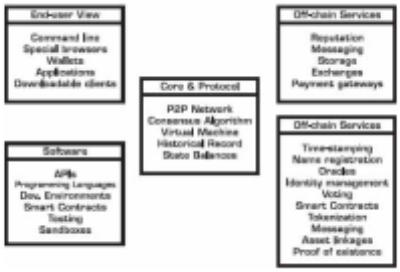


Figure represents conceptual descriptions of generic blockchain system components and relationships.

A generic approach to Blockchain Functionality (Mougayar, 2016)

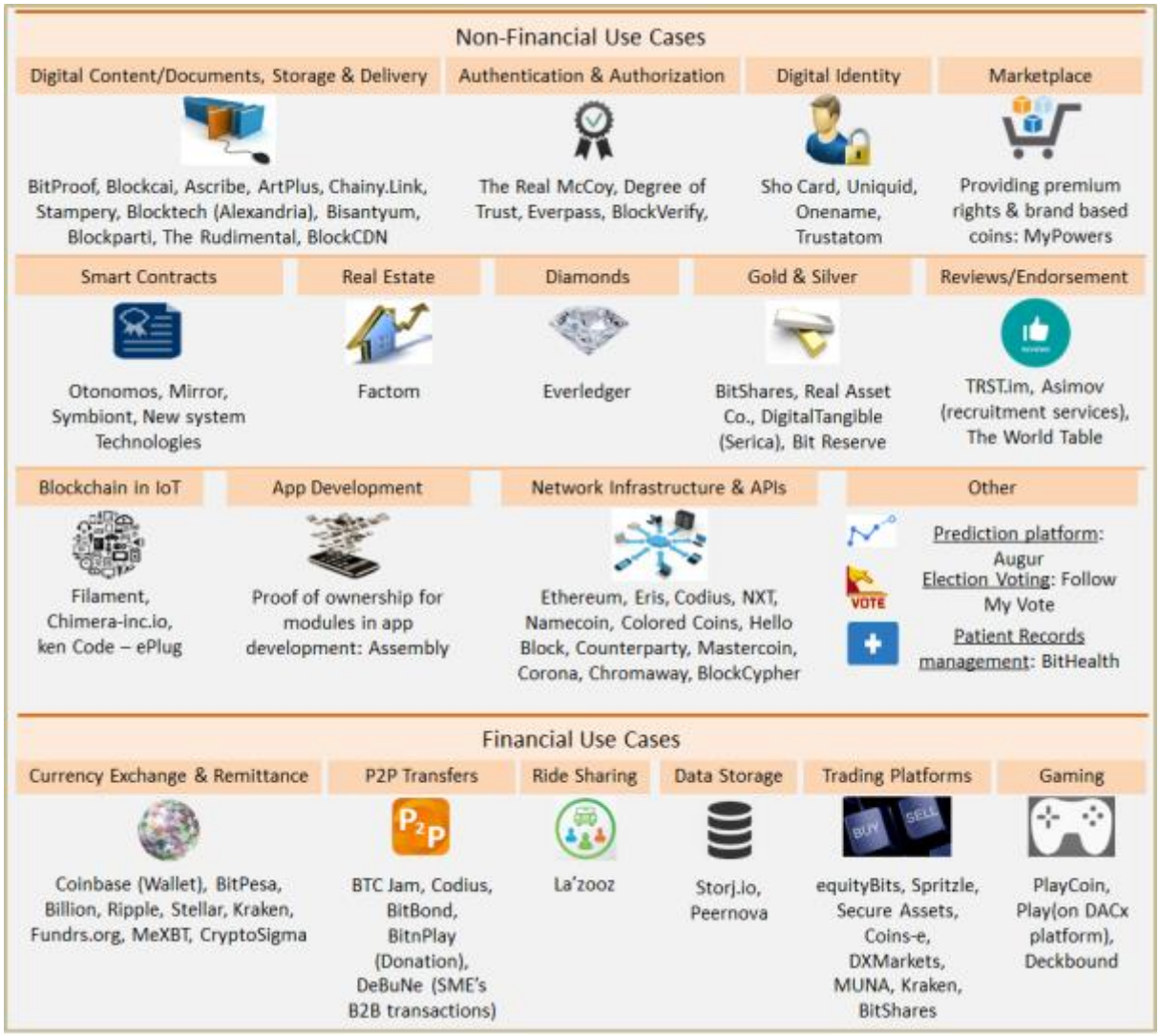




Blockchain use case feasibility study (Wang et al., 2016)

1) Multiple parties share data: multiple participants need views of common information
2) Multiple parties update data: multiple participants take actions that need to be recorded and change the data
3) Requirement for verification: participants need to trust the validity of the actions that are recorded
4) Intermediaries add cost and complexity: removal of 'central authority' record keeper intermediaries has the potential to reduce cost (e.g., fees) and complexity (e.g., multiple reconciliations)
5) Interactions are time-sensitive: reducing delays has business benefits (e.g., reduced settlement risk and enhanced liquidity)
6) Transaction interaction: transactions created by different participants depend on each other.

Appendix B: Overview of the Blockchain Technology Use Cases



Appendix C: Overview of Scientific Literature using Business Model Patterns as a Theoretical Concept

Author	Article	Theoretical Outcome	Key Findings related to BM patterns concepts
(Mikusz, Schafer, Taraba & Jud, 2017)	Transforming the Connected Car into a Business Model Innovation	Adaption of business model patterns from previous work to connected car domain.	(1) Adopted analogy between business model patterns and the principle of modularization. (2) The tolerance of uncertainty of a set of business model patterns allows to seamlessly update the business model when technological innovation occurs (if enough knowledge on transformation mechanism in place between technical innovation and business innovation is available).
(Eurich & Mettler, 2017)	Explaining Healthcare as a Two-Sided Market Using Design Patterns for IT Business Models	Application of the concept of design patterns to the domain of business model innovation with explaining the case of two-sided market pattern in healthcare.	(1) Introduction of a generic template to systematically document business model design patterns: purpose and scope, the core entities involved, the functioning and blueprint of the business model, and examples of businesses that adopted this pattern in practice. (2) The practical application of BMDP is problematic. There is a need to find ways to improve the evaluation procedure of BMDP.
(Streuer, Tesch, Grammer, Lang, Kolbe, 2016)	Profit Driving Patterns for Digital Business Models	Identification of potentially profit driven patterns and practical guidelines on factors influencing successful application of patterns.	(1) Concrete guidance in terms of identifying and applying patterns that drive profit for a business model under development.
(Remane et al., 2016)	The business model pattern database – A tool for systematic business model innovation	Database with a meta – perspective as a navigator through the business model pattern landscape.	(1) The concept of business model patterns is in the literature is often confusing and differently understood. (2) Only one original source of business model patterns comes from within the last three years. (3) Business model patterns primarily serve as tools for designing the front-end of a business model, i.e. defining the necessary changes.
(Sprenger & Mettler, 2016)	On the utility of e-health business model design patterns	Transformation of insights from extant design pattern areas to the field of e-health, proposal of a	(1) General business model patterns do not account for the special characteristics of the e-health environment. (2) E-health design patterns are useful as they provide insights into business model

		template for the documentation of e-health business model design patterns, and evaluation of the utility of a pattern-based business model design approach for e-health services.	logics, enhance the understanding regarding relevant actors and the respective value flows, foster discussions, support creativity in the design itself, and offer guidance in design decisions.
(Laurischkat et al., 2016)	Business Models for Electric Mobility	A framework for the analysis of e-mobility business models by defining central business model patterns, customer segments and essential key values of electric mobility.	(1) A framework for e-mobility business model potentials builds a basic work for the first phase of a systematic development process for innovative business models.
(Amshoff et al., 2015)	Business model patterns for disruptive technologies	Methodology for pattern-based business model design simplifying development and analysis of business model for disruptive technologies.	(1) BM patterns are a valuable approach to understand logic of new, unknown markets. (2) Commercial exploitation of disruptive technologies establishes new business logics and therefore new business model patterns. These patterns are applicable across industries. (3) New business model of disruptive technologies is often based upon an unconventional recombination of proven solution elements. (4) Three different categories can be used to classify business model patterns: frameworks, prototypical business models and solution patterns.
(Gassmann et al., 2015)	Business Model Navigator – 55 Business Models That Will Revolutionise Your Business	Systematic methodology Pattern Adoption for Ideation	(1) There are 55 business models in all and innovation is the matter of recombination 90 per cent of time
(Rudtsch et al., 2014)	Pattern-based Business Model Development for Cyber-Physical Production Systems	Methodology for the pattern-based development and realization of business models in the context of Cyber-Physical Production.	(1) Potential configurations of future value creation networks require qualified input from practitioners to be able to derive valid statements. The success of proposed methodology relies on the experience and intuition of experts with knowledge of business domain.
(Abdelkafi et al., 2013)	Business Model Innovations for Electric Mobility -What Can Be Learned from Existing Business Model Patterns?	Generation of systematically business model innovations in the field of electric mobility with introducing a framework that enables the classification of business model patterns, identified in the literature, according to five categories.	(1) Business models developed and implemented successfully in various industries can actually represent business model innovations in the industry under investigation. (2) The business models transferred from other industries should be carefully examined with respect to their suitability in the new context. (3) The analysis of the business model patterns, identified in the literature, shows that most patterns are related to a single value dimension.
(Mettler & Eurich, 2012)	A ‘‘design-pattern’’-based approach for analyzing	Provision of appropriate means to analyze and	(1) Explanations of the different, isolated business logics can help to increase the understanding of value creation and revenue mechanisms.

	e-health business models	explain business logics of e-health service provisions with respect to business model innovation.	(2) Business model design patterns provide a useful basis to start the business model design process by helping to not only better understand the logic behind a business model, but also to figure out the contextual conditions under which a business model might be implementable or not.
(Alexander; Osterwalder & Pigneur, 2010)	Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers	Defining and describing five business model patterns to recast well-known business concepts in a standardized format with business model canvas.	
(Johnson, 2010)	Seizing the White Space: Business Model Innovation for Growth and Renewal.	Presentation of 19 archetypal business models that can be used as a tool for business model innovation.	(1) Certain archetypal business models lend themselves well to problems that lie at different points on the problem-solving continuum.
(Lüttgens & Diener, 2016)	Business Model Patterns as a Tool for Creating Innovative Business Models	Evaluation of business model patterns according their impact on each of Porter's forces.	(1) Identification of clear trends in the performance of patterns against Porter's forces. (2) Confirmation that if business model patterns have a similar impact on value dimensions, it is possible to systematically innovate business models by combining different patterns from different value dimensions.

Appendix D: Preselected Business Model Patterns

Selection of applicable Patterns after first Filtering (adapted from Remanne et al.)			
Disintermediation (manufacturer direct model, direct selling, multi-level marketing, direct to customer)	Deliver a product or service that has traditionally gone through an intermediary directly to the customer	Dell, Nespresso, WebMD	Gassmann et al. (2014), Johnson (2009), Johnson (2010), Rappa (2001), Strauss and Frost (2014), Weill and Vitale (2001)
Crowdsourcing	Solve a problem by outsourcing it to the crowd (e.g., an internet community)	Cisco, Procter & Gamble, InnoCentive	Gassmann et al. (2014), Johnson (2010)
Cost reduction [through the internet]	Use the Internet to reduce costs and thus increase efficiency	Cisco	Hanson (2000)
Crowdfunding	Finance a product, project, or company by a group of private investors often including a non-monetary compensation in exchange	Marillion, Pebble Technology, Brainpool	Gassmann et al. (2014)
Micro transactions	Sell many items for as little as a dollar – or even only one cent – to drive impulse purchases	Kartrider	Tuff and Wunker (2010)
Revenue sharing (retail alliances)	Share the revenues with other companies in order to create a symbiotic relationship	Cdnow, Apple AppStore, Groupon	Gassmann et al. (2014), Hanson (2000), Rappa (2001)
Software firm/provider	Create software and license/sell it	Microsoft, Oracle, Siebel	Applegate (2001)
Blockchain as a service -> Servitization of products (product to-service)	Sell ongoing services in addition to the product or even sell the service the product performs rather than the product	IBM, Hilti, Zipcar	Johnson (2009), Johnson (2010)

Multi-sided platforms (two-sided market)	Bring together two or more distinct but interdependent groups of customers, where the presence of each group creates value for the other groups	Visa, Microsoft Windows, Metro Newspaper	Gassmann et al. (2014), Osterwalder and Pigneur (2010)
Peer-to-peer (Person-to-person networking services)	Facilitates a transaction among peers, i.e., two or more consumers, through provision of a platform	ebay, Napster, Airbnb	Gassmann et al. (2014), Rappa (2001)
Collaboration platforms	Provide a set of tools and an information environment for collaboration between enterprises	Deutsche Telekom/Globana's ICS, ESPRIT GENIAL	Timmers (1998)
Open source (alliance)	Develop a product not by a company, but by a public community with all information being available publicly	Mozilla, Linux, Wikipedia	Gassmann et al. (2014),Rappa (2001), Tapscott et al. (2000)
Brokerage (switchboard, network, efficency, open market-making)	Bring together and facilitate transactions between buyers and seller, charging a fee for each sucessful transaction.	NASDAQ, Century 21	Chatterjee (2013), Linder and Cantrell (2000), Johnson (2010), Tuff and Wunker (2010)
Lock-in	Lock the customers to your ecosystem by strongly increasing the switching costs through high hurdles	Lego, HP	Fleisch et al. (2014), Gassmann et al. (2014)
Distributive network	Provide infrastructure to conncet other actors of the economy such as logistics, energy, mobility, or communication	Enron, UPS, AT&T	Tapscott et al. (2000)
Freemium (free trial)	Offer basic services for free, while charging a premium for advanced or special features	Skype, Dropbox, LinkedIn	Gassmann et al. (2014)
Marketplace exchange	Build a specific form of broker also offering a full range of services covering the transaction process, from market assessment to negotiation and fulfilment for an industry consortium	Orbitz, Chem Connect	Rappa (2001)
Shared infrastructure	Share a common infrastructure among several competitors	ABACUS	Weil and Vitale (2001)

Trust intermediary (transaction broker)	Provide a third party payment mechanism for buyers and sellers to settle transaction	Paypal	Hartman et al. (2000), Rappa (2001)

Appendix E: Overview of Case Studies

Name of the company	Short description	Business Model Patterns Identified	Material for Analysis Used
Patientory	A Healthcare Peer to Peer EMR Storage Network	Software as a service, Tokenization, Distributive network, User empowerment, Security by design, Transparancy by design, Lock-in	White Paper, Website (https://patientory.com/)
Dentacoin	Dentacoin is an industrial blockchain concept invented by Dentacoin Foundation in the Netherlands	Tokenization, User empowerment, Multisided platform, Lock-in	White Paper, Website (https://dentacoin.com/)
Healthcoin	A global, blockchain-enabled rewards platform designed to change people's behaviors and prevent diabetes.	User empowerment, Tokenization, Collaboration Platform	Website (https://www.healthcoin.com/)
BurstIQ	The BurstIQ platform leverages blockchain and machine intelligence to enable data from disparate sources to be brought together in a single, unified data repository, and to be shared quickly and easily while still maintaining HIPAA compliance.	Multisided Platform, Tokenization, Marketplace, User Empowerment	White paper, Token Momerandom, Website (http://www.burstiq.com/big-token-crowdsale/)
BowHead	Blockchain and IoT	Disintermediation, Security by design, Tokenization, Software (blockchain part) as an Add-on, Crowdfounding	White paper
Health Wizz	Health Wizz is a mobile device application with focus on the individual user or the patient	User empowerment	Website (https://www.healthwizz.net/)

Medibon	Advancing and Enchancing healthcare with blockchain technology (verification system, medical record management, artifical inteligence)	Security by design, Privacy by design, multisided platform	Website, white paper (https://medibond.io/#documents)
MedRec	As a key feature of our work, we engage the medical research community with an integral role in the protocol. Medical researchers provide the "mining" necessary to secure and sustain the authentication log on a private, Ethereum network, in return for privacy-preserving, medical metadata in the form of "transaction fees."	Multisded platform, Tokenization	https://www.pubpub.org/pub/medrec
BronTech	Mainstreaming of the new data backed digital currency- The Bron. We empower our users to monetize the value of their data	User empowerment, Tokenization, Privacy by Design	https://bron.tech/
myHealthIRL	At the core of the myHealthIRL framework is a health wallet. This is the place where an individual can maintain ownership of their health records and keep them safe.	User empowerment, Marketplace	Website (http://www.myhealthirl.com/)
GEM	Blockchain network for the global community of companies that take part in the continuum of healthcare.	Distributive network, Multisided Platform	Morabito Case Study,
YouBase	Youbase.io decentralizes sensitive consumer and personal information, while creating a single source of anonymous population data.	User empowerment	White paper, Website (https://www.youbase.io/)
Dockchain	**PokitDok** is a cloud-based API platform designed to make healthcare transactions more efficient and streamline the business of health.	Software as a service, Security by design, User empowerment	Blog, Website (https://pokitdok.com/)

GoClinic	GoClinic is proposing the development of a decentralized platform with guaranteed privacy in which healthcare providers and patients can develop mutually bene cial relationships.	Multisided Platform, Security by design, Privacy by design	White paper (https://goclinic.io/)
GuardTime	Guardtime offers a host of KSI-based solutions that help insurance companies to better run their business and offer various cyber-related services, from supporting reinsurance standards, insurance policies and claims, new cyber liability policies, subrogation, regulatory compliance, to connected vehicle and health-care sectors.	Blockchain as a Service, Security by Design	https://guardtime.com/industries/insurance
Blockchain Health	Blockchain technology revolutionizes the relationship between medical researchers and users. Users share their health data with researchers while maintaining control.	User empowerment, Transparany by Design	https://blockchainhealth.co/
Straumn	Proof of Process Technology helps companies and organizations trust the millions of processes that connect our world.	Collaboration Platform, Privacy by Design, Security by Design, Software as a Service	https://stratumn.com/
Factom	Factom stores the world's data on a decentralized system. Using blockchain technology for smart contracts, digital assets and database integrity.	Software as a Service, Asset digitalization	https://www.factom.com/

Appendix F: Interview Protocol

Application of Pattern Based Analysis of Blockchain Technology in e-Health domain with the expert interviews

Introduction: The interview is divided into two parts and will take from 30 – 45 min. In the first part I will present you with the outcome of my research and ask you to reflect on its applicability for e-Health. The second part of the interview will conclude with the reflection on the entire discussion and opportunities of blockchain technology.

Intro in the thesis objective:
Lately, there has been a huge hype around the potential of the blockchain technology. It has been recognized as disruptive technology that will enable business model innovation with increased transparency, new models of partnerships and possible disintermediation. In my master thesis project I am evaluating the potential of blockchain technology for business model innovation for e-Health companies with the use of business model patterns and business model theory. I identified the business model patterns based on the conceptualization of the technology and empirical analysis of the case companies that are already using the technology. I would like to ask you if you can reflect on them in the context of e-Health market.

Part 1: Evaluation of applicability of patterns in e-Health

Points of the discussion per pattern:
- Do you currently recognize this business model pattern in the e-Health companies?
- Do you think this type could be used by companies in e-Health domain with the use of blockchain technology?
- Which restrictions do you see in the applicability of a pattern in terms of external environmental (market environment, regulatory environment, investment environment, technological environment – current systems)?

Part 2: Reflection on the Blockchain Technology

Goal of the part: Overall reflection on the discussion

- What is your overall impression on the potential of the technology? Which characteristics are in your opinion attractive for the use in e-Health sector? Which problems could they address?

- Do you think the blockchain technology has potential to bring new types of business models in e-Health? Which?