The Impact of Blockchain Technology on Business Model Innovation

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Preface

This cumulative dissertation was prepared during my work as a research assistant at the Department of Account and Information Systems at the Institute of Information Management and Information Systems Engineering at Osnabrück University.

First of all, I would like to thank my supervisor, Prof. Dr. Frank Teuteberg, for his excellent guidance as well as continuous and constructive feedback. I appreciate that he has always supported me in writing this dissertation in my area of interest.

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I would also like to thank the co-authors of the contributions included in this cumulative dissertation, namely: Alina Behne, Christian Fitte, Duc Nguyen Ngoc, Pascal Meier, Julia Samuel, Jan Schulte to Brinke, Stefan Tönnissen.

And last but not least I have to thank my family and friends who have accompanied, encouraged and supported me over the past years. In particular, I would like to express my gratitude to my parents, Heike and Ralf Beinke, who have supported me at all times and in every way.

Osnabrück, July 2020

Jan Heinrich Beinke

Notes on the Structure of the Document

This cumulative dissertation is divided into two parts: Part A provides an overview of the included research contributions and positions them within the dissertation framework. In addition to the motivation of this research project, the applied methods are presented and the results of the individual contributions are summarized. Subsequently, the implications for science and practice are discussed, limitations are presented, avenues for future research are outlined and a summary conclusion is reached. Therefore, part A can be regarded as a stand-alone contribution with its own list of abbreviations, figures and tables in the beginning and references at the end. Part B contains the research contributions outlined in part A and their respective appendices. The formatting and citation methods of the original publication have been retained.

Contents

Part A: Introductory Overview

List of Abbreviations

AI	Artificial Intelligence
AML	Anti Money Laundering
BPMN	Business Process Model and Notation
CA	Conversational Agents
EHR	Electronic Health Records
GDPR	General Data Protection Regulation
ICO	Initial Coin Offering
KYC	Know Your Customer
PHR	Personal Health Records
RQ	Research Question
WHMS	Wearable Health Monitoring System

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1 Introduction

1.1 Motivation

Blockchain technology has gained increasing attention in recent years and has developed massive traction. This momentum continues and has led to blockchain being described as a potentially disruptive technology (Beck and Müller-Bloch 2017; Risius and Spohrer 2017). This assessment is shared by the scientific community and practitioners. In 2016, for example, the internationally leading consulting firm Gartner listed blockchain technology for the first time[1] in its *Hype Cycle for Emerging Technologies* published annually shortly before the "*peak of inflated illusions*". Gartner predicted that the plateau of productivity would be reached in about 5 to 10 years (Gartner 2016). In the following years, blockchain technology developed steadily and matured quickly so that in 2019 it was no longer listed in the *Hype Cycle for Emerging Technologies*. Instead, a separate *Hype Cycle for Blockchain Technologies* was created (Gartner 2019). In the accompanying report, Avivah Litant, Research Vice President at Gartner, states that blockchain technology has not yet enabled a "*digital business revolution across business ecosystems*" (Gartner 2019). In his opinion, this could even take until 2028, as Gartner currently still recognizes technical and operational obstacles to scalability. Several scientific studies also mention the challenges that the broad and timely diffusion of blockchain technology is facing, for example: hardware costs, relatively high power consumption, lack of necessary know-how or expert knowledge, process maturity and lack of identification of viable use cases (Chong et al. 2019; Grover et al. 2019; Post et al. 2018) Many of these challenges result from the high (technical) complexity of blockchain and smart contracts (Friedlmaier et al. 2018; Swan 2015; Woodside et al. 2017).

Blockchain in its generic form can be described as a decentralized database secured by cryptographic algorithms and consensus mechanisms (Meier and Stormer 2018; Risius and Spohrer 2017; Rossi et al. 2019; Swan 2015). Further, it can be defined "as a digital, decentralized and distributed ledger in which transactions are logged and added in chronological order with the goal of creating permanent and tamper-proof records" (Treiblmaier 2018). Blockchain technology owes its name to the way, in which transactions are stored – in blocks that are connected

(Gartner 2014, 2015)[1] In 2016, Blockchain was first included in the Gartner Hype Cycle for Emerging Technologies. However, it is worth pointing out that cryptocurrencies, which typically employ blockchain technology, were already listed in 2014 and 2015 (Gartner 2014, 2015).

to form a chain. Each individual block is chronologically attached to the previous block with a cryptographic signature (hash) (Meier and Stormer 2018; Swan 2015; Treiblmaier and Beck 2019; Walport 2015). Therefore, each block has exactly one predecessor and one successor. The chronological concatenation of the blocks, secured by cryptographic procedures, makes it almost impossible to subsequently change or even delete data from past transactions (Christian Hunziker 2017; Swan 2015; Weber et al. 2016). Validation, linking and storage of the blocks is usually performed by several independent parties in a peer-to-peer network (Schlatt et al. 2016).

In this peer-to-peer network, the blockchain protocol defines the technical framework guidelines. Table 1 shows the different approaches to designing access to transactions and access for validation of transactions (Peters et al. 2015; Rossi et al. 2019).

Access to Transaction Validation	Access to Transactions	
#	Public	Private
Permissionless	Public access: anyone can read, submit, and validate transactions. Example: Bitcoin (Nakamoto 2008), Ethereum (Buterin).	Not applicable.
Permissioned	Restricted public access: anyone can read and submit transactions, but only authorized agents can validate transactions. Example: EBSI.	Restricted access: Only authorized agents can read, submit, and validate transactions. Example: Hyperledger, R3 Corda.

Table 1: Dimensions of Blockchain Protocols (Rossi et al. 2019)

The access to transactions defines who is allowed to access the data in the blockchain. While in a public blockchain everyone can access it, in a private blockchain only a predefined group of participants can.

The validation authorization determines which participants may validate new transactions. In a permitted blockchain, only certain participants are allowed to validate new transactions. In contrast, the users of the permissionless blockchain are not defined beforehand, so that in principle any network participant may validate transactions (Böhme et al. 2015; Burgwinkel 2016; Peters et al. 2015; Rossi et al. 2019). To clarify the significance of these access rights, it is useful to look at cryptocurrencies in particular. Cryptocurrencies such as Ethereum meet the characteristics of public and permissionless blockchains. The Ethereum blockchain, with the corresponding cryptocurrency Ether[2], was initially introduced by Vitalik Buterin in 2013 and implemented and published in 2015 (Buterin 2013, 2014; Swan 2015). In principle, every person has the possibility to access this blockchain via the Internet and can participate in the validation of

[2] Ether is the largest currency unit at Ethereum. Other units are Finney, Szabo and Wei. 1 Ether is equivalent to 1,000 Finney, 1 Finney is equivalent to 1,000 Szabo and 1 Szabo is equivalent to 1,000,000,000,000 Wei.

transactions. With the launch of Ethereum, which has been designed from the beginning as a software development platform, so-called smart contracts[3] were implemented for the first time. These smart contracts allow the creation and programming of tokens that can be utilized by third parties (Buterin 2014). Thus, companies are able to offer blockchain-based products and services without setting up and operating a blockchain themselves (Buterin 2014; Swan 2015; Treiblmaier and Beck 2019). This massively reduced the barriers for companies, since significantly fewer financial and time resources have to be invested.

> "*I think the most interesting stuff that's going on are the beginning of execution on top of blockchain, the most obvious example being the capability of Ethereum. And if Ethereum can manage to figure out a way to do global synchronization of that activity, that's a pretty powerful platform. That's a really new invention.* "
>
> Eric Schmidt, former CEO and Executive Chairman of Google Inc (Mercatus Center 2018).

With his statement, Eric Schmidt highlights the potential of blockchain-based products and services. Currently, numerous possible applications of blockchain in many different sectors are being discussed: , finance (Beinke, Nguyen, et al. 2018; Collomb and Sok 2016; Gomber et al. 2017), supply chain management (Perboli et al. 2018; Queiroz and Wamba 2019; Treiblmaier 2018), health care (Beinke et al. 2019; Kuo et al. 2017; Swan 2015) as well as internet of things (Christidis and Devetsikiotis 2016; Lockl and Urbach 2020; Reyna et al. 2018). Thereby, according to Eric Schmidt (Mercartus Center 2018), it is striking that despite the different areas of application of blockchain technology, the effects on existing business models and the (further) development of innovative business models are always emphasized.

Due to increasing digitalization, companies are facing growing competitive pressure. Nowadays, customers can easily and quickly compare providers on comparison portals and price search engines prior to deciding on an offer. The example of the financial sector clearly demonstrates that innovative companies such as Bank N26 are challenging the incumbent companies (Gray 2019). In the respective business ecosystems of the companies, new opportunities and challenges arise. In order to take advantage of the opportunities and face the challenges, incumbent companies are forced to adapt. Although the terms "business model" and "business model innovation" are often used and discussed, no clear and uniform definition has emerged so far

[3] The concept of smart contracts was originated by Nick Szabo (1996) and describes the combination of "protocols with user interfaces to formalize and secure relationships over computer networks".

(Morris et al. 2005; Osterwalder and Pigneur 2010; Schallmo 2014; Zott et al. 2011). In this dissertation, the definition of business model innovation by Osterwalder and Pigneur (2010) is used:

> *"Business model innovation is not about looking back, because the past indicates little about what is possible in terms of future business models. Business model innovation is not about looking to competitors, since business model innovation is not about copying or benchmarking, but about creating new mechanisms to create value and derive revenues. Rather, business model innovation is about challenging orthodoxies to design original models that meet unsatisfied, new, or hidden customer needs. "*
>
> Osterwalder and Pigneur (2010, p. 136)

In addition to startups that successfully develop and market blockchain-based products and services (Beinke et al. 2018), it can also be observed that established companies and market leaders actively use this technology and recognize opportunities for themselves (Treiblmaier and Beck 2019). Since companies are in constant competition, the ability to identify and deploy (potentially disruptive) technologies at an early stage can be advantageous and enable them to secure or even expand their market position in the long term (Chesbrough 2006; Halecker 2016; Zott and Amit 2017).

1.2 Aim

As outlined in the introduction, blockchain certainly provides the potential to develop new business models and transform existing ones. Therefore, the overall goal of this cumulative dissertation is to investigate the impact of blockchain technology on business model innovation. Due to the tremendous dynamism of this field and the high practical relevance of business model innovation, this dissertation not only provides value for the scientific community, but also addresses companies and governmental institutions as well as the respective decision-makers. For instance, in the financial sector, health care and temporary employment, the storage and processing of personal and partly highly sensitive data is carried out (Kuo et al. 2017; Pinna and Ibba 2018; Rossi et al. 2019). In addition, each of these sectors generally involves a wide range of business process stakeholders, many of whom could benefit from increased process automation through smart contracts (Swan 2015).

In order to examine the high complexity and diversity of blockchain technology, its influence on business model innovation as well as its effects on existing business models, quantitative and qualitative methods in the sense of a mixed-method approach are applied (Recker 2013; Venkatesh et al. 2013, 2016). Within this cumulative dissertation, the following overarching research questions (RQs) will be investigated:

1. What are the characteristics of business models in token-based ecosystems?
2. How do companies benefit from the potential of blockchain technology in the financial sector?
3. What are the implications of using blockchain in the temporary employment, especially at the process level?
4. How can blockchain technology be leveraged in the health care sector and which innovative business models might be enabled?

To answer these research questions, models, methods, prototypical applications, recommendations for actions, key challenges, and key benefits as well as practical and theoretical implications are provided. Due to the dynamics in the blockchain sector and the fact that new business models can be developed at any time, this dissertation obviously cannot explain the full impact of blockchain technology on business models. Furthermore, the development of business models depends on numerous factors (e.g., the respective sector, the associated regulatory framework, competitive pressure). Moreover, it is very likely that blockchain will not be used alone, but in combination with other (emerging) technologies. Currently, the combination of Artificial Intelligence (AI) and blockchain is being discussed (Pandl et al. 2020). Therefore, it is not always possible to clearly define which technology has what relative share in a (new) business model. In this dissertation, the connection of blockchain-based personal health records (PHR) with a conversational agent (CA) can be considered as an example (see section 3.4).

1.3 Structure

The dissertation is structured as follows: Section 2 presents the selected contributions and outlines the research methods applied. Furthermore, selected contributions are illustrated in a framework and the connections between the individual contributions are elaborated. In the third section, the respective contributions are summarized. The presentation of the research contributions in section 3 is based on the framework in section 2. Consequently, in the first subsection the characteristics of business models in token-based ecosystems are examined. In the following subsection, the concrete influence of blockchain technology on business model innovation and the influence on existing business models will be examined on the basis of three industrial sectors: finance, temporary employment and health. In section 4, the gathered insights are synthesized, discussed, and critically reflected. Implications for science and practice are highlighted, and limitations and venues for further research are outlined. Finally, section 5 provides a conclusion.

2 Research Design

2.1 Selection of the Research Contributions

The contributions of this cumulative dissertation have been published in leading international conferences as well as prestigious and renowned journals (cf. Ranking in Table 2).

#	Title *(Translation)*	Medium	Ranking	Publication Sources
A	Understanding token-based ecosystems – a taxonomy of blockchain-based business models of startups	Journal	WKWI: A VHB: B JIF: 3.553	Tönnissen S., **Beinke, J.H.**, Teuteberg, F.: Understanding token-based ecosystems – a taxonomy of blockchain-based business models of startups, Electronic Markets, 2020.*[1]*[2]
B	Towards a Business Model Taxonomy of Startups in the Finance Sector using Blockchain	Conference	WKWI: A VHB: A JIF: -	**Beinke, J.H.**; Nguyen Ngoc, D.; Teuteberg, F.: Towards a Business Model Taxonomy of Startups in the Finance Sector using Blockchain; in: Proceedings of the 2018 International Conference on Information Systems (ICIS 2018), San Francisco, USA, 2018. *[1]*[3]
C	Diffusion der Blockchain-Technologie im Bankensektor Revolution oder Evolution? *(Diffusion of Blockchain Technology in the Banking Sector — Revolution or Evolution?)*	Journal	WKWI: B VHB: D	**Beinke, J. H.**; Samuel, J.; Teuteberg, F.: Diffusion der Blockchain-Technologie im Bankensektor - Revolution oder Evolution?, in: HMD Praxis der Wirtschaftsinformatik, 324, 2018.*[1] *[4]
D	Disruptionspotenzial und Implikationen der Blockchain-Technologie am Fallbeispiel der Zeitarbeit - Eine Prozess- und Schwachstellenanalyse *(Disruption Potential and Implications of Blockchain Technology at the Example of Temporary Work – A Process and Weak Point Analysis)*	Journal	WKWI: B VHB: D	**Beinke, J. H.**; Tönnissen, S.; Teuteberg, F.: Disruptionspotenzial und Implikationen der Blockchain-Technologie am Fallbeispiel der Zeitarbeit - Eine Prozess- und Schwachstellenanalyse, in: HMD – Praxis der Wirtschaftsinformatik, 2019, 56(3), pp. 660-676.*[1] *[5]
E	Towards a Stakeholder-Oriented Blockchain-Based Architecture for Electronic Health Records: Design Science Research Study	Journal	WKWI: - VHB: - JIF: 4.671	**Beinke, J. H.**; Fitte, C.; Teuteberg, F.: Towards a Stakeholder-Oriented Blockchain-Based Architecture for Electronic Health Records: Design Science Research Study, in: Journal of Medical Internet Research, Vol. 21, No. 10 (2019).*[1] *[6]
F	FeelFit – Design and Evaluation of a Conversational Agent to Enhance Health Awareness	Conference	WKWI: A VHB: A JIF: -	Meier, P.; **Beinke, J. H.**; Fitte, C.; Behne, A.; Teuteberg, F.: FeelFit – Design and Evaluation of a Conversational Agent to Enhance Health Awareness; in: Proceedings of the 2019 International Conference on Information Systems (ICIS 2019), Munich, 2019*[1] *[7]
G	Generating design knowledge for blockchain-based access control to personal health records	Journal	WKWI: A VHB: C JIF: 1.621	Meier, P.; **Beinke, J. H.**; Fitte, C.; Schulte to Brinke, J.; Teuteberg, F.: Generating design knowledge for blockchain-based access control to personal health records, Information Systems and e-Business Management, 2020. *[1] *[8]

Comments
*[1] Prof. Dr Frank Teuteberg is a co-author of each publication, he critically reflected on the content and the methodological orientation of each contribution.
*[2] Mr. Stefan Tönnissen worked in equal parts on this contribution.
*[3] Mr. Duc Nguyen Ngoc made a noteworthy contribution to this article, in particular in the operational execution of the cluster analysis, the literature search, and the initial interpretation of the acquired data.
*[4] Mrs. Julia Samuel made a noteworthy contribution to this article, in particular in the operational execution of the expert interviews and the initial interpretation of the acquired data.
*[5] Mr. Stefan Tönnissen worked in equal parts on this contribution.
*[6] Mr. Christian Fitte worked in equal parts on this contribution.
*[7] Mr. Pascal Meier and Mr. Christian Fitte worked in equal parts on this contribution. Mrs. Alina Behne made a noteworthy contribution to this article, in particular through her involvement in the evaluation.
*[8] Mr. Pascal Meier worked in equal parts on this contribution. Mr. Christian Fitte made a noteworthy contribution to this article, in particular to the theoretical foundation, best practice analysis and the elaboration of the implications. Mr. Jan Schulte to Brinke made a noteworthy contribution to this article, in particular to the development of the prototype and the evaluation.

Legend
VHB = Verband der Hochschullehrer für Betriebswirtschaftslehre (*Translation: German Academic Association for Business Research*) – Journal Quality Index 3 (VHB 2015)
WKWI = Wissenschaftliche Kommission Wirtschaftsinformatik – Orientierungsliste 2008 (*Translation: Scientific Commission Information Systems – Guidance List 2008*) (Heinzl et al. 2008)
JIF = Journal Impact Factor according to Journal Citation Reports

Table 2: Selected Research Contributions

Each contribution was critically examined by multiple reviewers in a double-blind peer review process. In addition to the bibliographic information of each research contribution, Table 2 lists the respective ranking of the publication outlet. The sources for the rankings are JOURQAL3 (VHB 2015) of the *Verband der Hochschullehrer für Betriebswirtschaft e.V.* (VHB), the *Journal Citation Reports*[4] and the orientation list of the *Wissenschaftliche Kommission für Wirtschaftsinformatik* (WKWI) (Heinzl et al. 2008). The Journal of Medical Internet Research is not listed in the VHB and WKWI ranking. However, the high quality is underpinned by a top placement for Management and clinical-centered eHealth Journals (one of only two A+ Journals)[5] and SIG IT in Healthcare Group as recommended publication organ of SIG (placed 4th)[6] as well as by the high JIF. Within the extended scope of this dissertation project, further articles were published. Although these are not listed in Table 2, because they are not the focal point of this dissertation, they have partly laid the foundation for the contributions.

2.2 Framework of the Research Contributions

The contributions of this cumulative dissertation can be integrated into a framework for business model innovation developed by Schallmo (2013) (cf. Figure 1). This framework lists four different types of innovation (service, process, market and social), each of which has relevant overlaps with business model innovation. Consequently, it can be stated that business innovation partly includes already existing types of innovation. Contributions A and B are located at the intersection of market innovation, service innovation and business model innovation. Both contributions analyze startups whose business models include blockchain technology as a core element. Contribution A examines sector-independent startups and their respective business ecosystems (Tönnissen et al. 2020), while contribution B analyzes startups in the financial sector (Beinke, Nguyen, et al. 2018), a sector which – as outlined in the introduction – offers significant potential for the application of blockchain technology.

Building on this, contribution C (Beinke, Samuel, et al. 2018) assesses the diffusion of blockchain in banking, a subcategory of the financial sector. This paper applies a macro perspective, identifying fundamental application areas of blockchain technology and the corresponding opportunities and challenges, without exploring individual issues. Further aspects considered in

[4] https://jcr.clarivate.com/JCRLandingPageAction.action , accessed 25th February, 2020.
[5] http://aserenko.com/papers/Serenko_Dohan_Tan_eHealth_Journal_Ranking.pdf , accessed 25th February, 2020.
[6] https://aisnet.org/page/SeniorScholarBasket , accessed 25th February, 2020.

this contribution are the market environment and changes in the organizational and legal environment (social innovation), particularly resulting from the use of smart contracts. In addition, practical recommendations for banks and their decision makers are provided. This practical orientation is pursued in contribution D. In this paper, the use of blockchain in the temporary employment sector and the associated implications are assessed (Beinke, Tönnissen, et al. 2018). The focus is on the effects on the process level, which are investigated by means of a case study. Furthermore, social, economic, legal, and ethical implications are discussed, which accompany the introduction of blockchain in the temporary employment sector.

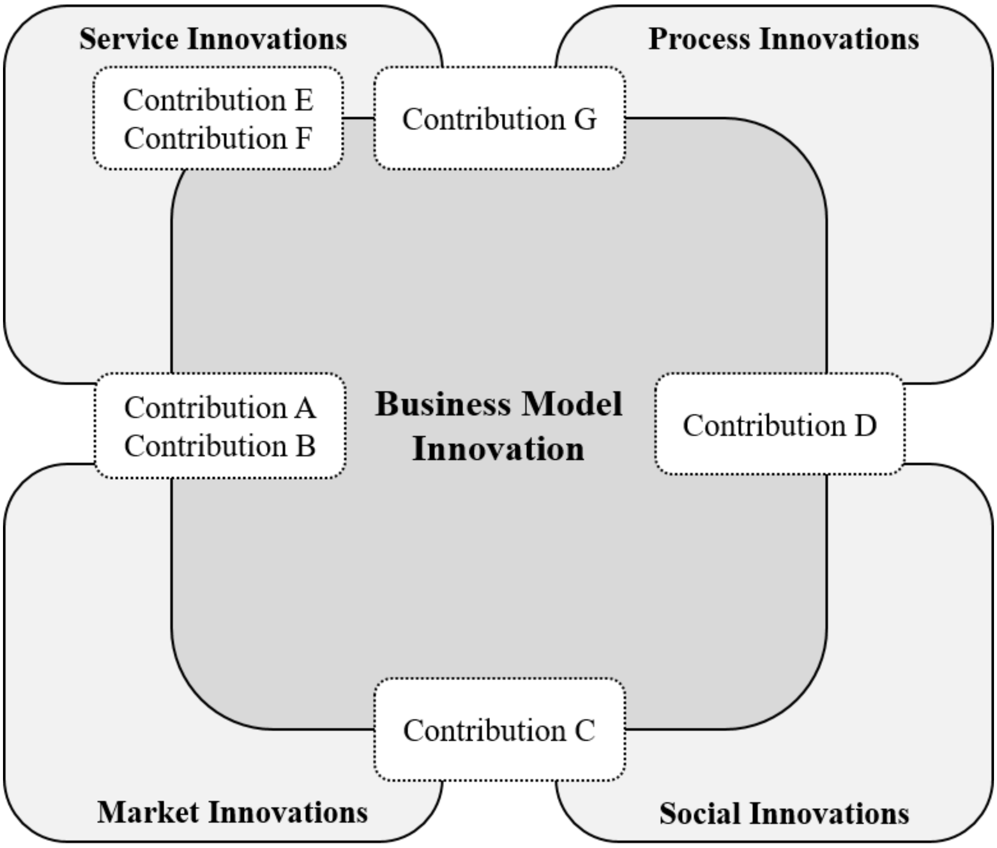

Figure 1: Framework of the Research Contributions based on Schallmo (2013)

Another very promising area of application for blockchain is the health care sector, which is the primary focus of contributions E, F and G. In a first step, contribution E provides a multi-methodical elicitation of requirements for blockchain-based Electronic Health Records (EHR) (Beinke et al. 2019). These requirements are then integrated into a conceptual five-tier architecture, which can be used for prototypical implementations. Furthermore, the paper highlights the potential of blockchain as an enabler for business model innovation in the context of health data. In health research, the possibilities of Big Data Analytics, their opportunities and risks and the resulting business models have already been discussed for years (Belle et al. 2015;

Raghupathi and Raghupathi 2014; Wang et al. 2018). New business models could emerge, for instance, through data analysis via the ability to provide detailed adapted data access and tracing. For a fee, research institutes or companies could gain access to and use very large amounts of data via a blockchain-based health care infrastructure. The fee could in return be forwarded to the users. In contribution G the concept was implemented in the form of blockchain-based personal health records (PHR) (Meier et al. 2020). The core difference is that PHRs are patient-oriented, i.e., the patient is the owner of the data and decides who gets access to it. In addition to the systematic development of a prototype, meta-requirements and design principles were developed, which are of interest for future developments of blockchain-based applications. During the development, and especially during the evaluation, it was found that a decisive benefit of blockchain-based PHR is the high process integrity and the high reliability. Smart contracts offer the potential to automate and accelerate transactions (e.g., drug prescriptions and referrals to other physicians) and still guarantee persistent and permanently traceable records.

In addition to the common data (e.g., medication schedule and treatment history) stored in EHRs or PHRs, further data, such as about the general physical condition, offer interesting starting points for health care professionals. In contribution F, a conversational agent (CA) is developed for the tracking and output of vital parameters (Meier et al. 2019). The evaluation confirmed the assumption that a CA can contribute to improving personal health awareness. Furthermore, it emerged that the combination of CA with EHRs (or PHRs) can be especially useful as users can be provided with a holistic overview of their health status. Contributions E and F indicate that innovative health services in connection with innovative business models offer interesting perspectives for future providers and consumers as well as challenges for legal authorities.

2.3 Spectrum of Applied Methods

With regard to the information systems discipline, a distinction can be made between two basic paradigms: design science and behavioral science (Hevner et al. 2004; Österle et al. 2011; Wilde and Hess 2007). Design science research aims to develop new models, concepts and software artifacts through iterative development and evaluation cycles that address a given problem (Hevner 2004, Österle et al. 2011). The behavioral science paradigm, on the other hand, focuses on cause-and-effect relationships such as the acceptance of software products and the analysis of existing theories. Most of the contributions of this dissertation are clearly located in the design science-oriented spectrum. Only contributions F and G contain elements of behavioral science, but they primarily deal with the design and evaluation of IT artifacts.

In this dissertation, both qualitative and quantitative research methods were triangulated in the sense of a mixed method approach (Creswell and Creswell 2017; Recker 2013; Venkatesh et al. 2013, 2016) in order to answer the research questions. Blockchain technology, and especially its impact on business model innovation, is a less intensively investigated and still emerging research area. As a result, in particular, qualitative methods were increasingly used (Myers 2009; Myers and Avison 2002; Recker 2013).

	Research Method	Contribution A	B	C	D	E	F	G	References
Quanti-tative	Experiment						X	X	(Recker 2013; Wilde 2008)
	Survey				x		X	X	(Recker 2013) (Reips 2002)
Qualitative Methods	Case Study	X	X		X				(Benbasat et al. 1987; Bonoma 1985; Eisenhardt and Graebner 2007; Gable 1994) (Kaplan and Duchon 1988; Recker 2013; Yin 2017)
	Expert Interviews			X	X	X	X		(Gläser and Laudel 2010; Meuser and Nagel 2009; Myers and Newman 2007; Walsham 2006)
	Taxonomy Development	X	X						(Nickerson et al. 2013)
	Workshops / Focus Groups					X	X	X	(Morgan 1996; Myers and Newman 2007)Morgan (1996), Schwaber (1997), Myers and Newman (2007)
	Process Modelling and Analysis				X				Myers (2009)
	Other Qualitative Analyses (e.g., Content Anal-ysis, Description, Cluster Analysis, Observa-tion)			X	X	X	X	X	(Gable 1994; Myers 2009; Punj and Stewart 1983; Recker 2013; Sidorova et al. 2008; Wilde and Hess 2007)
	Prototyping						X	X	(Dey et al. 2001; Hevner et al. 2004; Schwaber 1997)
	Systematic Literature Review	X	X	X	X	X	X	X	(vom Brocke et al. 2009; Webster and Watson 2002)

Table 3: Applied Research Methods

Furthermore, quantitative research methods also yield benefits when different perspectives such as social, economic and political facets are examined (Recker 2013). Table 3 lists the research methods applied in the contributions. In addition, references to further information on the methods applied in the individual contributions are described. Details on the execution of the individual methods can be found in the respective contribution.

3 Summary of the Research Contributions

3.1 Token-based Ecosystems

As outlined in the introduction, blockchains such as Ethereum enable the issuance and distribution of digital tokens via smart contracts. In an initial coin offering (ICO), a company issues tokens and in return receives cryptocurrencies from the investors (Fisch 2019; Oliveira et al. 2018). These tokens can have different functionalities and purposes. So-called usage tokens (also known as utility tokens) enable the use of a blockchain-based service, while staking tokens (also known as security tokens) are more akin to shares in a company[7]. Together, the service provider, the underlying blockchain, the issued tokens and the users form an ecosystem. The tokens are of central importance here. They have several functions, including (a) transferring value between business partners, (b) encouraging (potential) users to use the offered service, (c) contributing to the financing of the company and (d) achieving network effects (Tönnissen et al. 2020).

Tokens and the associated token-based ecosystems therefore represent an interesting environment for companies. An indication of this is the relatively high number of ICOs carried out and the amount of capital invested. In 2018, for example, over 7.5 billion US dollars were invested in ICOs (ICO DATA 2018). Despite these high investment volumes and the resulting interest from practitioners and scientists, there is a lack of understanding of business models in these ecosystems. Consequently, in *contribution A*, titled *Understanding token-based ecosystems – a taxonomy of blockchain-based business models of startups*, the following research question is investigated:

(i) What are the characteristics of business models in token-based ecosystems?

To answer this research question a taxonomy according to (Nickerson et al. 2013) was developed. Taxonomies have proven successful in IS research to structure and classify business models (Beinke, Nguyen, et al. 2018; Labes et al. 2015; Remane et al. 2016). In a first step, the status quo of token-based business models and ecosystems was reviewed. Subsequently, a total of 195 startups were analyzed in detail with regard to their business model within the framework of taxonomy development. In order to ensure the highest possible data quality, a codebook

[7] The specific design of tokens can vary from company to company. For instance, the tZero distributes quarterly profits to the token shareholders. (Arnold et al. 2018).

(MacQueen et al. 1998) was initially created, in which criteria for the classification of the respective character-risks were recorded. In addition, the analysis of each company was carried out independently by two experienced researchers. Cases in which the opinions of the two researchers diverged were reviewed by both and a final decision was made[8]. In total, eleven dimensions with 45 characteristics were identified (cf. Figure 2).

Perspective	Dimension	Characteristics						E/N[1]	It.[2]
Community of different actors (P01)	Customer segment	B2B (1, 2, 4, 5 -14)			B2C (3)			N	1
	Types of decentralized business models	no/low dependence on 3rd parties			some dependence on trusted 3rd parties			E	1
	Associate	Stakeholder			Partner			N	1
	Market types	one-sided		two-sided		multisided		E	2
Defined time (P02)	Stage of Business Ecosystem	birth	expansion	leadership	self-renewal	death		E	1
Common goal (P03)	Level of Control	Price		Other key contractual terms		Ownership of key		N	1
Acting shaping of relationships (P04)	Collaboration	Collaborative Information Systems		Collaborative Business	Collaborative Incentive	Collaborative Performance Systems		N	1
Common value for all actors (P05)	Increase network effects	Personalization of service offerings	Recommendation systems	Trust mechanisms	Simplification of transactions	Initial Coin Offerings		N	1
	Network effect	indirect			direct		none	E	2
Usage of tokens (P06)	Token incentive	active work			passive work		none	N	3
	Token purpose/type	usage	work		funding	staking		E	1

Figure 2: Business Models in Token based Ecosystems (Tönnissen et al. 2020)

In a further step, a cluster analysis was carried out and the clusters obtained were interpreted[9]. It was discovered that the three identified clusters can be classified according to Moore's lifecycle of business ecosystems (Moore 2016). The three clusters – pioneering (vision) model, expansion model and authority model – show differences in the intensity of use, the (primary) purpose of the tokens and the interaction with other actors.

3.2 Finance Sector

Taking a closer look at the startups analyzed in contribution A, it is worth noting that many of them belong to the financial or related sectors. In previous publications on the disruption potential and areas of application of blockchain, the financial sector has also often been given special emphasis (Collomb and Sok 2016; Gomber et al. 2017; Parra Moyano and Ross 2017; Swan 2015). This sector is explicitly examined in contribution B, entitled "*Towards a Business*

[8] The inter-rate agreement of 0.87, can be evaluated as reliable (>.8) according to (Krippendorff 2004).
[9] All analyses were carried out in SPSS (version 24).

Model Taxonomy of Startups in the Finance Sector using Blockchain", which investigates the following research questions:

(i) *What are the elements of business models of startups using blockchain in the financial sector?*

(ii) *What business model archetypes can be identified by empirically examining these elements?*

For this research project, 63 startups were analyzed that use blockchain as a key component of their business model[10]. Based on this data, a taxonomy according to Nickerson et al. (2013) was developed and seven archetypes were derived on the basis of the cluster analysis. The characteristics of the business models are listed in the second column in Figure 3, while the clusters represent the corresponding archetypes. Trading platforms were identified as the first archetype. These companies provide platforms for the trading of various cryptocurrencies and aim exclusively at private customers. In addition to trading as a core activity, these platforms usually provide (sometimes at extra cost) further information, e.g., chart analyses. The second cluster comprises providers for payment applications. It is noticeable that companies in this cluster do not address business customers but are only active in the business-to-customer segment, and their revenue stream results exclusively from fees.

Compared to the previous companies, the companies in the third cluster, which can be grouped together as software solution providers, are much more broadly diversified. These exclusively target business customers (most of them in the financial sector). In return for their services (e.g., provision or development of software), they take license fees or individually agreed prices.

Looking at the companies in the next cluster (credit card providers), it is striking that all companies offer a physical product in addition to a service. These are credit cards, which can be used in any retail store that accepts credit cards to pay with cryptocurrencies (e.g., Bitcoin, Ethereum) rather than with fiat currencies (e.g., Euro, US Dollar). Wallet providers are grouped in the fifth archetype and offer the purchase and sale of cryptocurrencies. Unlike trading platforms, they do not offer a professional trading option (e.g., margin trading).

[10] It is noteworthy that the overlap of the investigated start-ups in *contribution A* and *contribution B* is relatively small. Due to the high dynamics of startups, those that are present in both data sets were analyzed again and adjusted.

	Number of companies per Cluster	Cluster 1 14	Cluster 2 10	Cluster 3 11	Cluster 4 6	Cluster 5 9	Cluster 6 7	Cluster 7 6
Dimensions	Characteristics							
Value Proposition	Cooperation	0,0%	0,0%	54,5%	0,0%	0,0%	0,0%	100,0%
	Platform	100,0%	0,0%	0,0%	0,0%	100,0%	14,3%	0,0%
	Customization	0,0%	0,0%	45,5%	0,0%	0,0%	0,0%	0,0%
	Insight	0,0%	0,0%	0,0%	0,0%	0,0%	14,3%	0,0%
	Convenience/ Usability	0,0%	100,0%	0,0%	100,0%	0,0%	71,4%	0,0%
Delivery Channel	API	7,1%	10,0%	100,0%	0,0%	0,0%	43,0%	100,0%
	App	14,3%	50,0%	0,0%	0,0%	0,0%	0,0%	0,0%
	API, App	78,6%	30,0%	0,0%	0,0%	100,0%	57,0%	0,0%
	API, App, Physical	0,0%	10,0%	0,0%	100,0%	0,0%	0,0%	0,0%
Market Segment	B2B	0,0%	0,0%	100,0%	0,0%	0,0%	0,0%	100,0%
	B2C	100,0%	100,0%	0,0%	83,3%	100,0%	0,0%	0,0%
	B2B & B2C	0,0%	0,0%	0,0%	16,7%	0,0%	100,0%	0,0%
Revenue Stream	Fees	92,9%	100,0%	0,0%	0,0%	100,0%	57,1%	67,0%
	Sales, Fees	0,0%	0,0%	0,0%	100,0%	0,0%	0,0%	0,0%
	Membership	7,1%	0,0%	0,0%	0,0%	0,0%	14,3%	33,0%
	Unknown	0,0%	0,0%	45,5%	0,0%	0,0%	28,6%	0,0%
	Licensing	0,0%	0,0%	54,5%	0,0%	0,0%	0,0%	0,0%
Product Offering	Exchange	0,0%	30,0%	27,3%	16,7%	88,9%	28,6%	0,0%
	Solution Provider	0,0%	0,0%	72,7%	0,0%	0,0%	0,0%	0,0%
	Investing	0,0%	0,0%	0,0%	0,0%	11,1%	0,0%	0,0%
	Trading	100,0%	0,0%	0,0%	0,0%	0,0%	14,3%	0,0%
	Payment Service	0,0%	70,0%	0,0%	83,3%	0,0%	28,6%	100,0%
	Financing	0,0%	0,0%	0,0%	0,0%	0,0%	14,3%	0,0%
	Supply Chain	0,0%	0,0%	0,0%	0,0%	0,0%	14,3%	0,0%

Figure 3: Archetypes of Blockchain-based Business Models in the Finance Sector (Beinke, Nguyen, et al. 2018)

The next cluster unites various application providers for business and private customers. This distinguishes the companies in this cluster quite significantly from those in clusters 3 and 7, which only address business customers. The last cluster contains companies that conduct payment transactions for business customers. They enable and accelerate the processing of cross-border payments by using cryptocurrencies. Overall, the broad spectrum of startups in the financial sector using blockchain technology is illustrated, and the areas in which the startups are active are shown. On the one hand, this provides an overview of the status quo, and on the other hand, it presents "economic niches" that can be filled by (future) entrepreneurs, for example.

After contribution B revealed that numerous startups have already implemented successful blockchain-based business models in the financial sector, contribution C, entitled "*Diffusion of Blockchain Technology in the Banking Sector – Revolution or evolution?*" (original title: "Diffusion der Blockchain Technologie im Bankensektor – Revolution or Evolution?") focused on the banking sector and conducted a macro-perspective analysis of the potential for deployment (Beinke, Samuel, et al. 2018).

The corresponding research questions are as follows:

(i) What are the potential applications of blockchain technology in the banking sector and what are the opportunities and challenges?

(ii) *Which concrete implications and recommendations for action can be derived from this for practice?*

Since the instantiation of Bitcoin as a decentralized peer-to-peer payment system, based on the concept by Nakamoto (2008), various other use cases for blockchain technology have been identified and implemented. When comparing use cases, it is remarkable that there are especially common factors such as the need for increased transparency and availability, high security and the desire for disintermediation as well as efficiency increases through improved automation (Buhl et al. 2017; Treiblmaier and Beck 2019). These factors apply in particular to the banking sector, where there is a high degree of homogeneity of the product and service portfolio (e.g., accounts, management of shares and funds) and a high regulatory framework (Alt and Puschmann 2016; Schönfeld 2017). In addition, there is a possibility of arbitrage transactions through increased transparency and automation through smart contracts. Furthermore, transaction costs can be reduced, for example in international payment transactions. The success of startups that have successfully established services in the area of cross-border payments confirms this assumption (see contribution B). Other highly promising applications for blockchain are asset management and portfolio and risk management. The increased and legally compliant automation through smart contracts is also of particular importance and offers interesting potential for companies in the banking sector. Nevertheless, the use of blockchain technology in the banking sector is also facing several challenges.

A consolidated overview of the opportunities and challenges is presented in Table 4.

Opportunities	Challenges
• Elimination of central clearing houses (disintermediation) • Simplification of "know-your-customer"-processes • Improving anti-money laundering measures • Increased transparency and traceability of transactions as well as reduction of manipulation risks • Increased transaction speed • Automation through smart contracts • High process integrity • Improvement of the system availability • Efficacy through decentralized management • High data integrity • Reduction of necessary trust between business partners • Long-term decreasing costs for the IT infrastructure due to decentralization • Detailed access control and assignment of rights for various stakeholders	• Lack of standardization • Lack of a regulatory framework • High diversity of affected stakeholders • Design of sustainable (digital) business models • Customer communication – reputation systems to increase trust in the technology • Correction of erroneous transactions • Secure storage of private keys • Scaling, especially regarding limited storage capacity • High energy consumption for proof-of-work, therefore consensus mechanisms such as proof-of-stake must be further developed • Potential attack vectors due to the early stage of development and low level of maturity • Usability both within the bank and in B2B and C2C segment

Table 4: Opportunities and Challenges of Blockchain Technology in the Banking Sector (Beinke, Samuel, et al. 2018)

In sections 3.1 and 3.2, the potential of blockchain for the financial sector and in particular for banks was explored and illustrated. From this, recommendations for banks and their decision-makers can be derived (Beinke, Samuel, et al. 2018). First, it is recommended to deal intensively with blockchain technology on all corporate levels. Subsequently, concrete cross-departmental use cases should be developed and a selection of them implemented as prototypes. It may be advisable to involve in-house innovation labs or to initiate cooperation with, for example, FinTechs. Furthermore, participation in industry associations is recommended in order to be able to participate directly in current developments and to help shape the regulatory framework. Finally, proactive customer communication is recommended to reduce acceptance barriers and to portray the company as innovative, which may give the company a competitive edge.

3.3 Temporary Employment

Temporary employment enables companies to react flexibly to changing economic circumstances (Pfeifer 2005). This allows capacity fluctuations in operational processes to be managed flexibly, for example in the case of strong demand for certain products. In 2017, an average of more than 800.000 employees in Germany were in temporary employment (Bundesagentur für Arbeit 2020). Due to its nature as a workload-balancing mechanism and due to high government regulation, for example by setting the maximum length of employment in a relationship, temporary work is subject to relatively high fluctuation of the workforce (Bundesagentur für Arbeit 2020; Pfeifer 2005).

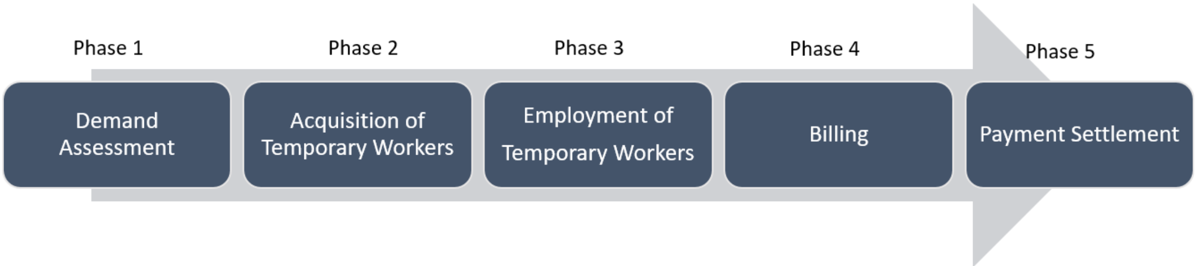

Figure 4: Phases of Employee Leasing (Beinke, Tönnissen, et al. 2018)

The complete process of employee leasing (cf. Figure 4[11]), from the assessment of demand to the payment settlement, is characterized by numerous media breaks, a wide range of actors involved and long and often inefficient communication (Beinke, Tönnissen, et al. 2018). Therefore, this case study represents a potential area of application for the use of blockchain technology and is examined in contribution D, entitled "*Disruption Potential and Implications of*

[11] A BPMN model of the entire process is available via the following link: https://tinyurl.com/HMD-Uebersicht

Blockchain Technology at the Example of Temporary Work – A Process and Weak Point Analysis" (original title: Disruptionspotenzial und Implikationen der Blockchain-Technologie am Fallbeispiel der Zeitarbeit – Eine Prozess- und Schwachstellenanalyse) based on the following research question:

(i) What effects does the introduction of a blockchain-based system have on the business model of the temporary employment industry and what are the advantages and disadvantages at process level?

The analysis reveals that a blockchain-based system in temporary employment certainly offers advantages for the stakeholders involved in the temporary employment industry. At present, a great amount of work is being done by the hiring temporary employment company, which acts as an intermediary between the borrowing company and the employee. In addition to advantages in the central storage and administration of relevant data (e.g., concerning the employee) and access via a central platform, the greatest advantages arise particularly in phases four and five, billing and payment settlement. A prerequisite to fully realize the benefits is the connection of the central blockchain via an interface with the working time recording system of the borrowing company and the accounting system of the lending company. Interviews with experts reveal that there are often tensions between the involved companies because data on working time recording is sometimes transmitted too late and/or incomplete. In addition, some of the companies would not adhere to agreements on deadlines regarding the payment run and some would independently reduce the amount to be paid. A blockchain with transparent data storage, in which the data is stored persistently and tamper-proof, since transactions cannot be reversed or manipulated, could represent at least a partial solution. Smart contracts, which transparently explain how the amounts to be paid are calculated at and how the working time was recorded, could also improve the relationship between the involved actors.

These main advantages, however, may conflict with the GDPR (General Data Protection Regulation) regarding the lack of the possibility of deleting the data in a blockchain (Marnau 2017). One way out of this problem is the use of reference databases. Another interesting starting point is DIN SPEC 4997, which presents a model for processing personal data using blockchain technology (DIN 2020[12]).

[12] DIN SPEC 4997 was published after our article was published and was therefore not considered.

3.4 Health Care Sector

In the health sector, a vast amount of sensitive patient data is stored and managed. Nevertheless, the potential that such data holds is not yet fully exploited (Kuo et al. 2017; Raghupathi and Raghupathi 2014; Wang and Hajli 2017). Digitization projects in the health care sector (such as digital patient records) are progressing only very slowly in many countries, as is the case in Germany (Amelung et al. 2016). The different, sometimes competing, requirements of the various stakeholders involved are often quoted as the reason for this sluggish process. In addition, health data are generally subject to high standards of data protection and data security. The management of patient data is a particularly striking example of this. These data are currently only available in fragmented form to the various doctors, pharmacists, health insurance companies and other players in the health care sector. A consolidated view of all relevant patient data is only possible in a few countries, e.g., Estonia (Meier et al. 2020). Due to its technology-immanent high security, high transparency, and availability, blockchain presents an interesting starting point for the administration of patient data in the form of electronic health records (EHR) or patient health records (PHR)[13]. This potential is investigated in contribution E, entitled "*Towards a Stakeholder-oriented Blockchain-based Architecture for Electronic Health Records: Design Science Research Study*" with the following research questions:

(i) Which stakeholders have an interest in EHR and what are their specific requirements for an EHR?

(ii) How can these requirements be implemented in a blockchain-based architecture?

(iii) Which key benefits and key challenges does the proposed blockchain- based EHR architecture provide?

In general, the stakeholders involved in an EHR can be divided into three major groups (cf. Figure 5) (Beinke et al. 2019). The primary stakeholders have direct access to the patient and are directly involved in health care. Secondary stakeholders, on the other hand, still have direct contact with the patient but are not directly involved in health care (e.g., insurance brokers), while tertiary stakeholders have an indirect interest or view the patient from a macro perspective (e.g., public authorities).

[13] The key difference between EHR and PHR is that EHR are administered by institutions (e.g., insurance brokers) and in the case of PHR by the patients themselves.

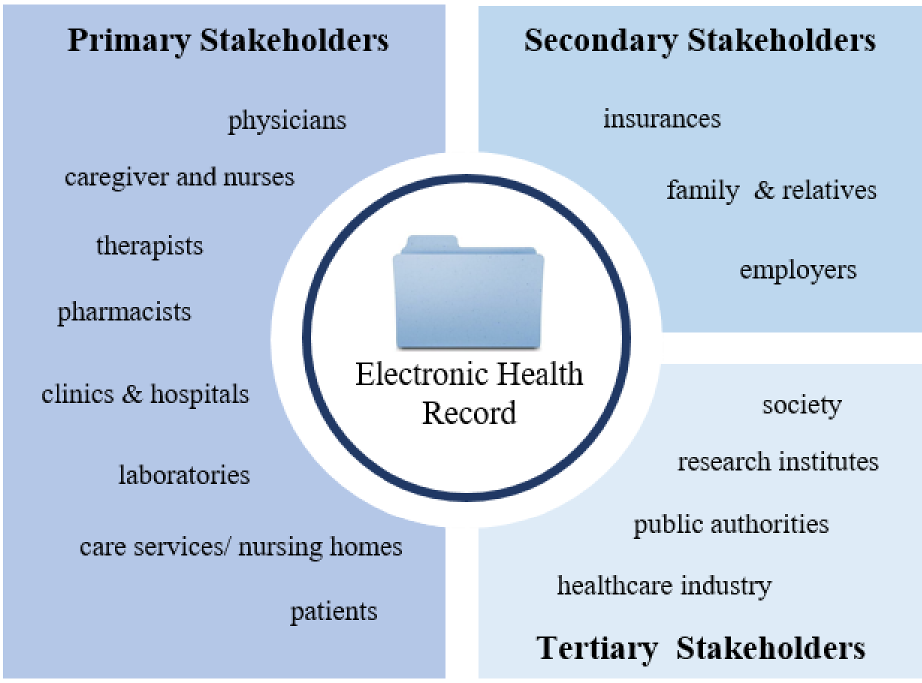

Figure 5: Overview of Stakeholder Groups (Beinke et al. 2019)

Based on the identified stakeholders, we gathered a total of 34 requirements and developed a blockchain-based architecture for EHR (cf. Figure 6) (Beinke et al. 2019). The development was carried out iteratively with several evaluation cycles and thus follows the design science research paradigm of Hevner et al. (2004).

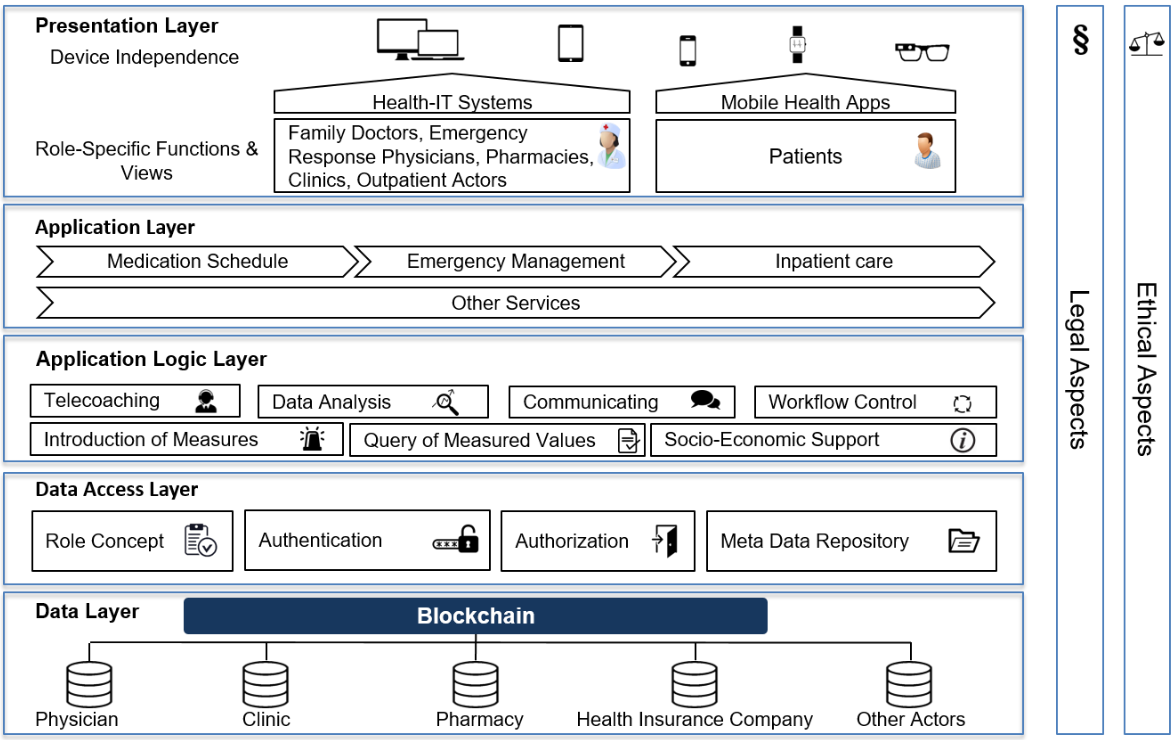

Figure 6: Five-Tier Architecture (Beinke et al. 2019)

The architecture is structured in five layers. The basis is the data layer, in which the different data sources are located. Furthermore, blockchain, which serves as an interface as well as the administration of the access rights, is placed there. Standards such as FHIR, openEHR and the profiles of the IHE and xDT family are considered for the interfaces. Within the data access layer, the role assignment, the authentication, and the authorization are carried out. This reduces the risk of possible data manipulation. The three components are supplemented by a so-called Meta Data Repository, in which relevant meta data are stored, which can be used for data organization as well as administration and also support data analysis. The following application logic layer illustrates the workflow of various applications. Depending on the application, different data from the various data sources are required. The application layer starts above the application logic layer. This layer contains the concrete applications, some of which are shown as examples. These can be defined individually by the respective user, provided that the rights release allows it. The presentation layer contains the requirements for the frontend, which should be device-independent and adapted to the respective terminal device used. It should also be considered that different players may require different data. In addition to the numerous advantages, the implementation of the concept also poses challenges that should be considered (cf. Table 5). However, as these challenges are basically manageable and technical in nature, they are likely to be solved as standardization matures.

Key Challenges	Key Benefits
High energy consumption	Decentralization
High and unpredictable transactions costs	No single point of failure/ vulnerability
Requires high storage, bandwidth and computational power, low scalability	Tamper-proof
Access and authorization issues	Data Security
Accountability for development and administration	Traceability of entries
Public availability of transactions	Overview of all health related data
51% Attacks	Automation by smart contracts
Slow processing speed	Data sovereignty for patient
Data imports needs verification	Improved intersectoral collaboration through file and data sharing
Technical skills of patient and health care professional	Integrated payment application
Incentives for provision of computational resources	New Mining Business Models for Data analysis
Standardization	Patient-oriented treatment

Table 5: Key Challenges and Key Benefits (Beinke et. al 2019)

These challenges and benefits of the architecture can also give rise to numerous new business models. As an example, anonymized data could be sold to pharmaceutical companies for the purpose of drug development. Furthermore, parameters such as treatment compliance could be measured, or long-term studies could be conducted with diverse information on different players.

Based on contribution E and the qualitatively predominant advantages of the presented architecture, the idea of blockchain-based storing and administration of patient data is further pursued. In the prototypical implementation, however, the patient is to be placed in the foreground so that the architecture is implemented in terms of a PHR and not EHR as conceived in contribution E. This concept is implemented in contribution G, entitled "A German Perspective on the Design and Evaluation of a Blockchain-based Personal Health Record". The following research question is addressed:

(i) *How can a patient-centered blockchain-based PHR be designed and evaluated ensuring users' acceptance and the specifics of the German health care system?*

In addition to the requirements of contribution E (Beinke et al. 2019), also the legal framework conditions in Germany are included in the development. In order to evaluate the acceptance of such a system under the most realistic conditions possible, the prototype is developed as realistically as possible, taking into account in particular the high German requirements for data protection and data security (Amelung et al. 2016; Dehling and Sunyaev 2014).

In this research endeavour, existing issues among current PHR providers in Germany are systematically identified. On the basis of the results, meta-requirements are derived that are similar to the requirements identified in Contribution E (Beinke et al. 2019). Based on the meta-requirements, design principles are formulated. Issues, meta-requirements, and design principles are depicted in Figure 7 and serve as guidelines for the development of the system architecture (Figure 8).

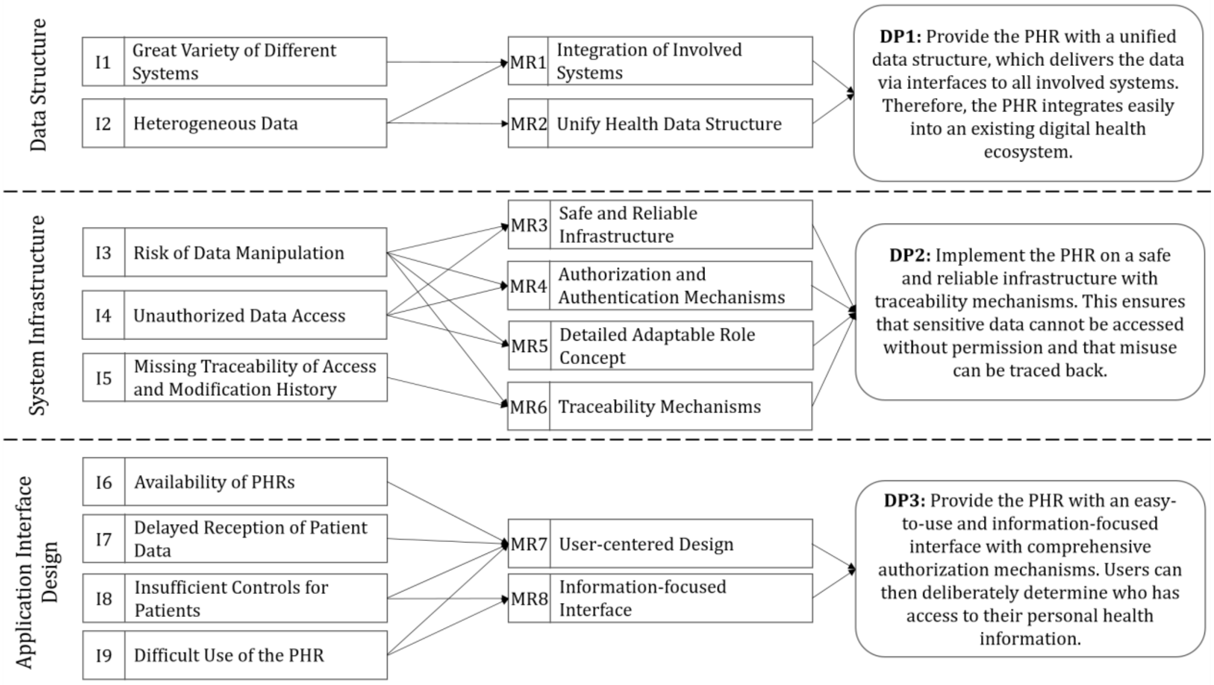

Figure 7: Issues, Meta-requirements and Design Principles for Blockchain-based PHRs (Meier et al. 2020)

Hyperledger Fabric is used as the underlying technology because this blockchain features a particularly wide range of functionalities, support and above all extensive interfaces. Within the prototype, the blockchain, in conjunction with an external service provider (e.g., github), handles the authorization to access certain data. General information about patients and healthcare professionals (e.g., doctors) are directly stored in Hyperledger Fabric, while documents (e.g., X-ray scans) are stored on a separate document server. A stand-alone document server is a suitable and efficient solution because managing a large number of different document types via Hyperledger Fabric can be technically problematic and lead to delayed retrieval times.

To visualize the retrieval and storage process, red circled numbers are depicted in Figure 8. In a first step, a query for a document is made using the web application (1) and the Hyperledger API (2). Third, the Hyperledger Fabric application checks the transaction authorization and executes it (3). Next, the corresponding access path is passed (4) and with this information, the requested document is retrieved from the document server (5, 6).

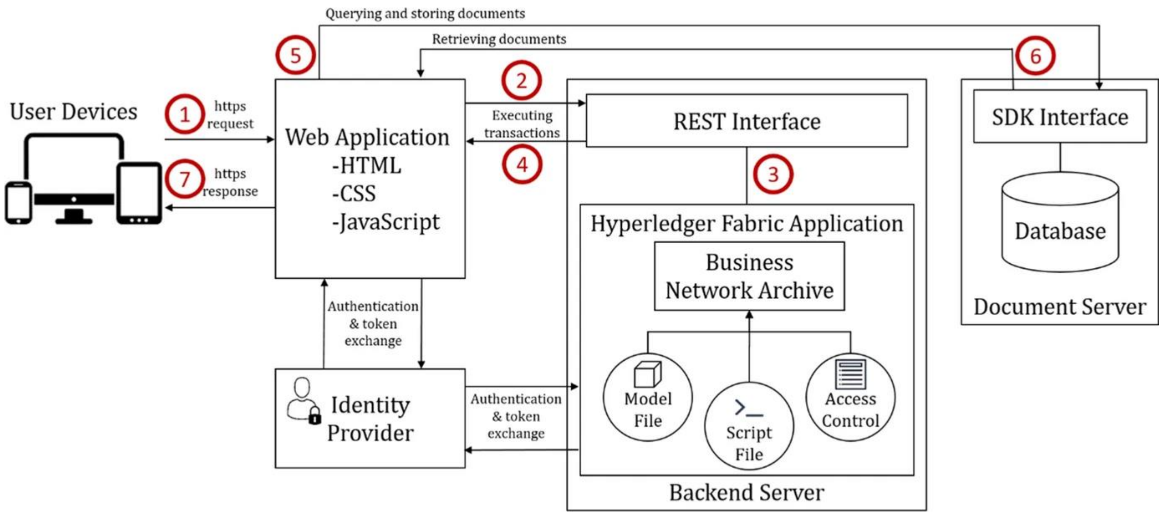

Figure 8: System Architecture of the Prototype (Meier et al. 2020)

Afterwards, the document is displayed in the web application (7). Based on the feedback from several evaluation cycles, it is evident that blockchain-based PHRs offer promising potential and can be implemented under consideration of strict data protection requirements. In addition, the results of an evaluation round indicate that blockchain and its technology-immanent characteristics positively influence the acceptance of PHRs.

As outlined in the introduction, the use of blockchain technology is often discussed in connection with other technologies, such as AI, to enable new business models. This idea is further pursued in Contributions E and G. In the feedback sessions and evaluation rounds with experts and potential users of a blockchain-based PHR, it appeared that further access options beyond a pure web interface should be offered. In addition, intensive work was carried out on extending the "standard" data recorded in a PHR by additional information (e.g., X-ray scans, medication plans) to obtain a holistic view of a person's the health status. A possible approach is presented in Contribution F, titled *"FeelFit – Design and Evaluation of a Conversational Agent to Enhance Health Awareness"* (Meier et al. 2019). The following research question is investigated:

(i) *How can conversational agents for wearable health monitoring systems be designed and implemented to enhance users' health awareness?*

Conversational agents (CA), especially the voice-based assistants (e.g., Alexa, Siri), are becoming more and more established in everyday use. In January 2019, Amazon confirmed that more than 100 million devices with Alexa voice control have already been sold. This success with customers can be explained, at least partly, by the fact that questions can be directly asked in natural language and dialogue form, without typing or having to search through various pages and sub-pages. During preliminary work it was identified that people often have little knowledge about their own health status and vital parameters (e.g., blood pressure, pulse, overweight), which can lead to chronic diseases such as diabetes (Palumbo 2017). In addition, vital parameters are often found in different applications, as they are sometimes measured with sensors from a wide variety of manufacturers and are usually not summarized in one central application. The "FeelFit" prototype was developed to provide these data in a user-friendly way and via a central application. It provides insight into the data measured by different sensors (e.g., blood pressure, steps, weight, heart rate) and displays them in different ways (cf. Figure 9).

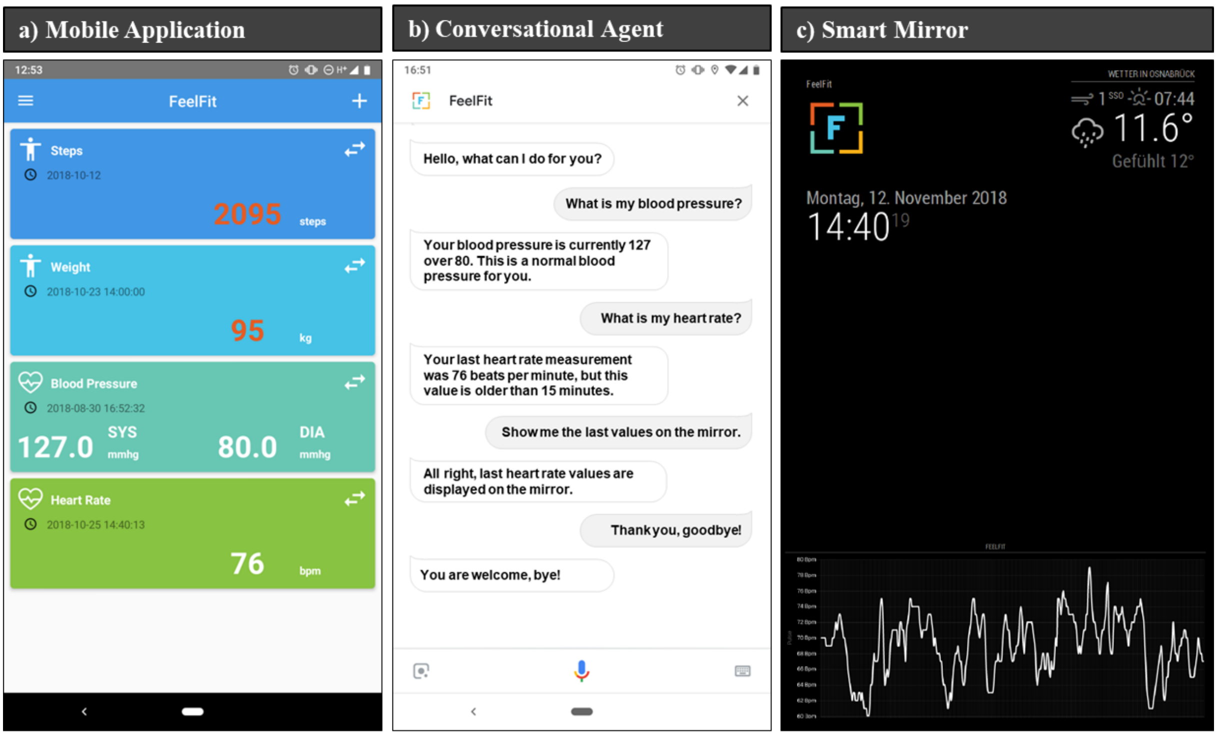

Figure 9: User Interface of a) Mobile Application, b) CA, and c) Smart Mirror (Meier et al. 2019)

A consolidated view of the data can be accessed in a typical mobile application (Fig. 9 (a)). Furthermore, there is the option of a textual (and linguistic) output (b) as well as the option of displaying the data in a so-called smart mirror. By analyzing the evaluation data, it becomes evident that the users appreciated the seamless integration of the different sensors and especially older people highlighted the possibility of accessing the data in several ways. Overall, the contribution demonstrates that health awareness can be increased by an application such as FeelFit.

4 Discussion

4.1 Implications for Research

This cumulative dissertation includes seven contributions, each of which investigates specific aspects of the overarching research questions formulated in the introduction. In each contribution, one or more research gaps are identified, and the relevant implications for science and practice are elaborated. The overall aim of this dissertation is to investigate the impact of blockchain technology on business model innovation. Therefore, this dissertation considers different perspectives and examines the topic with different accentuation in three sectors. By analyzing the impact of blockchain technology on business model innovation from different perspectives, a comprehensive and multifaceted view on the topic is enabled. Focusing on three selected sectors, an in-depth analysis facilitates (preliminary) conclusions about the transferability of results from one sector to another. In this section, the implications are elaborated in accordance with the overarching research questions.

First, this dissertation contributes to a deeper understanding of business models in token-based ecosystems (RQ 1). In Contribution A 195 companies are examined regarding their business models. Thereby, numerous characteristics (e.g., token type, token function) are systematically identified, which can be used for further scientific investigations. Moreover, the characteristics are presented in the form of a taxonomy, which according to several studies significantly facilitates the structuring of a field, in this case business models in token-based ecosystems. Furthermore, it is demonstrated that it is a special challenge for companies to increase the value of their tokens. For science, the interesting challenge is to investigate factors that influence the token value of different token types (e.g., staking/security tokens and usage/utility tokens).

The second overarching research question (RQ 2) addresses the (potential) benefits that can be gained in the financial sector through blockchain technology. Hence, Contribution B explores how startups in the finance sector use blockchain technology and how their business models are configured. In this contribution, the characteristics are also structured in the form of a taxonomy, and prevailing archetypes are determined by a cluster analysis. In this way, the focus of entrepreneurial activities and "white spots" are elaborated and can serve as a starting point for further investigations. Although it is scientifically proven that digital technologies (e.g., blockchain) and digital transformation have an impact on traditional industries, according to Yoo et al. (2010), this has not yet been satisfactorily assessed.

In Contribution C, the perspective shifts away from companies and towards the entire banking sector. The current lack of standardization, technical challenges (e.g., high energy consumption in consensus mechanisms such as proof-of-work) and unclear legal frameworks (e.g., data protection) offer interesting perspectives for (interdisciplinary) research for the information systems, computer science and legal scholar communities. In addition, several application areas (e.g., [international] payment transactions) are pointed out in which blockchain can significantly influence and reshape business models.

Temporary employment is analyzed in Contribution D as a concrete business model that could be influenced by blockchain technology. With this example, possible implications on a process level are analyzed (RQ 3). It is apparent that blockchain technology can lead to increased automation and a reduction of errors in the billing process, thereby accelerating this process. On the one hand, this confirms previous findings on the effects of the blockchain technology at a process level (Deubel et al. 2017; Weber et al. 2016) (Deubel et al. 2017); on the other hand, it also indicates research opportunities such as privacy impact assessment.

In contributions E, F and G, the healthcare sector is closely examined. These contributions analyze how blockchain technology can be leveraged in this sector and which possible business models might arise (RQ 4). The developed models, architectures and design principles contribute to enriching the knowledge base in information systems for blockchain-based PHR and EHR as well as for CAs. Additionally, this synthesized knowledge can be utilized as guidelines for prototypes with the employed technologies (e.g., blockchain applications and conversational agents) as well as for the application background (PHR, EHR and WHMS) (Gregor and Hevner 2013). The systematic stakeholder identification and analysis can serve as an overview for other researchers who wish to analyze, for instance, stakeholder specific effects of introducing technologies (such as blockchain and AI). Furthermore, it is outlined that business model innovation can arise, for example, in the area of data analysis and tracking[14] of health data. Also, it is argued that the combination of a CA with a PHR could both individualize health care and enhance its effectiveness, thus enabling the delivery of individually-tailored care services. Finally, the three contributions point out further research needs (e.g., acceptance and cost-benefit analyses).

[14] Blockchain-based tracking of drugs in logistics across the entire supply chain is also a promising business model, but is not the core of the contributions.

4.2 Implications for Practice

The concept of "business model innovation" already emphasizes the strong practical relevance of this dissertation. The range of addressed practice-relevant actors includes entrepreneurs, companies, employees and further involved stakeholders such as supervisory authorities and associations.

In contribution A, the characteristics of business models in token-based ecosystems are elaborated. Using the developed taxonomy, for example, companies can classify their own business model, reflect critically, and compare it with other (more successful) business models. This might support companies in improving their business model. In addition, regulators and legislators obtain an insight into token-based ecosystems, which is crucial for regulation, especially when considering the difficulty of regulation and taxation of platforms (Busch 2020).

Contribution B uses a taxonomy of blockchain-based business models in the financial sector to demonstrate which prevailing archetypes have been in the foreground so far. At the same time, it reveals "economic niches" that can be occupied by new companies. Furthermore, the taxonomy can be employed as a creativity tool to design new blockchain-based business models (Remane et al. 2016).

Contribution C proposes eight recommendations for employees and decision-makers in the banking sector that are helpful in dealing with blockchain technology. In an extension of this contribution, a process model is developed on this basis in multiple iterative development cycles to support companies in adopting blockchain technology (Beinke et al. 2020). A case study (Contribution D) identifies concrete implications and weaknesses that a blockchain-based system in temporary employment would entail. The analysis is carried out at the process level so that the transfer of the findings of certain processes (e.g., payment settlement) to other fields of application is possible.

The contributions E, F and G contain a variety of artefacts that can be utilized by actors from the industry. The identified requirements provide a consolidated list that can be integrated into future applications. The same applies to the synthesized design knowledge and the system architectures which can be taken as reference structures. In conclusion, the identified opportunities can be used either to create new business models or to expand existing ones (e.g., implementing blockchain-based PHR and data sharing).

4.3 Limitations and Future Research

All contributions to this cumulative dissertation are published in peer-reviewed journals and on conferences after a multi-stage double-blind review process. This procedure attests to the quality, rigor, and relevance of the contributions. Nevertheless, this dissertation is subject to limitations which need to be considered, but equally represent starting points for further research.

As principally every research method has advantages and disadvantages, a broad variety of qualitative and quantitative research methods have been combined in the sense of a mixed-method approach and to reduce possible limitations and distortions. However, when mixed-method approaches are employed, the question arises as to the relation between the applied methods (Recker 2013; Venkatesh et al. 2013, 2016). In this dissertation mainly qualitative methods are used (cf. Table 3), as the topic has not been investigated sufficiently so far. In the following, the main limitations of the individual contributions as well as the cumulative dissertation as a whole are summarized.

In contributions A and B, taxonomies for business models are developed (Nickerson et al. 2013) and selected startups are analyzed. Both the selection and the analysis process may be subject to distortions and biases. In order to counteract this in the best possible way, relatively large sample sizes are used. Furthermore, at least two researchers independently coded and analysed the data.

In contributions C and D (as in contributions E and F) expert interviews were conducted. Despite the fact that the coding and evaluation of the interviews was also carried out independently by at least two researchers, misinterpretations and distortions could still have occurred. Furthermore, only experts from the European Union were interviewed; an extension to other areas could broaden the research perspective.

Contributions E, F, and G focus on the development of models, concepts, and prototypical implementation. Although the respective artefacts have been evaluated in several cycles, the evaluation results of prototypes with limited functionality do only partly allow for generally valid statements. The prototypes could be further developed and/or incorporated into marketable products, preferably in cooperation with actors from industry. Nevertheless, the findings of these contributions offer important design knowledge for future application developments.

Further limitations can be identified in the overall research design of the dissertation. This dissertation limits the scope to three sectors; an extension to other sectors could provide further interesting perspectives and insights. Furthermore, this dissertation investigates in particular startups and their business models. Therefore, it would be interesting to investigate the use of blockchain technology in established companies and to identify possible differences.

5 Conclusion

This cumulative dissertation investigates and explores the impact of blockchain technology on business model innovation. To this end, models, taxonomies, stakeholder analysis, requirement analyses, recommendations for action and prototypes are developed within a mixed-methods approach. In each contribution as well as in the whole dissertation the current states of research and developments from practice are taken into account. The results and findings of the respective contributions are used to develop the associated implications for science and practice, thus contributing to the understanding of the state of research.

In summary, this dissertation contributes to a holistic understanding of business models using blockchain technology. For this purpose, the underlying elements and characteristics of blockchain-based business models are investigated (Contribution A & B). Furthermore, the recommendations formulated are helpful both for companies and employees in the banking sector wanting to leverage blockchain technology within their business models and for those who want to find out what new business models may result from blockchain technology (Contribution C). Furthermore, the effects of blockchain technology on the business process level are explained, using temporary employment as an example (especially the payment settlement process). The insights gained are also transferable to other business models and processes and therefore contribute to the understanding of the way processes are influenced by blockchain technology.

In addition, the health sector is investigated as a possible application for blockchain technology. In the Contributions E, F, G, for example, models and prototypical implementations for EHR and PHR are developed to demonstrate that blockchain is a suitable and beneficial technology if high demands are imposed on data security and availability. Within these contributions, design knowledge for such applications is derived and the potential for business model innovation is highlighted. Finally, this dissertation discusses the implications for science and practice and points out limitations of the work.

Due to the high dynamics of business model innovation and the low maturity of blockchain technology, this dissertation does for sure not mark the end of the research. It rather contributes to an improved understanding of the impact of blockchain technology on business models, business model innovation and business processes, especially by analyzing different sectors and areas of application as well as by including different perspectives.

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Part B: Research Contributions

Contribution A

Understanding token-based ecosystems – a taxonomy of block-chain-based business models of start-ups

Authors	Tönnissen S.; Beinke, J.H.; Teuteberg, F.
Year	2020
Outlet	Electronic Markets, 30, 307-323 (2020)
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Online	https://link.springer.com/article/10.1007%2Fs12525-020-00396-6

Understanding token-based ecosystems – a taxonomy of blockchain-based business models of start-ups

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Abstract. Start-ups in the blockchain context generate millions by means of initial coin offerings (ICOs). Many of these crowdfunding endeavours are very successful, others are not. However, despite the increasing investments in ICOs, there is still neither sufficient theoretical knowledge nor a comprehensive understanding of the different types of business models and the implications for these token-based ecosystems. Scientific research equally lacks a thorough understanding of the different business model forms and their influence on collaboration in token-based economies. We bridge this gap by presenting a taxonomy of real-world blockchain-based start-ups. For this taxonomy, we used 195 start-ups and performed a cluster-analysis in order to identify three different archetypes and thus gain a deeper understanding. Our taxonomy and the archetypes can equally be seen as strategic guidance for practitioners as well as a starting point for future research concerning the token-based business models.

Keywords. Blockchain, Ecosystems, Token-based business models, Collaboration, Taxonomy

Contribution B

Towards a Business Model Taxonomy of Startups in the Finance Sector using Blockchain

Authors	Beinke, J.H.; Nguyen Ngoc, D.; Teuteberg, F.
Year	2018
Outlet	Proceedings of the 2018 International Conference on Information Systems (ICIS 2018), San Francisco, USA
Identification	ISBN 978-0-9966831-7-3
Online	https://aisel.aisnet.org/icis2018/crypto/Presentations/9/

Towards a Business Model Taxonomy of Startups in the Finance Sector using Blockchain

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Abstract. In recent years, the blockchain technology has aroused growing interest in science and practice. Particularly the financial sector has high expectations of this technology, as is evidenced by numerous established start-ups and large amounts of venture capital. However, to date, there is only little scientifically founded knowledge on how such business models function. By addressing this research gap, we contribute to a better understanding of start-up business models using the blockchain technology. To this end, we develop a theoretically sound taxonomy of the elements of such business models. On that basis, we carry out a cluster analysis and identify business model archetypes that provide a better understanding of the topic. Based on the results achieved, we discuss implications of our research for both science and practice and point to future research directions.

Keywords. Blockchain, Taxonomy, Startup, Digital transformation, Business models

Contribution C

Diffusion der Blockchain-Technologie im Bankensektor - Revolution oder Evolution?

Authors	Beinke, J. H.; Samuel, J.; Teuteberg, F.
Year	2018
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Diffusion der Blockchain-Technologie im Bankensektor - Revolution oder Evolution?

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Abstract. Der Blockchain-Technologie wird aktuell bescheinigt, begünstigt durch den Hype um Kryptowährungen wie Bitcoin, den Bankensektor und die Finanzindustrie massiv zu verändern. Für Unternehmen in diesem Sektor stellt sich daher die Frage nach den Chancen und Herausforderungen, die diese Technologie mit sich bringt und welche Schritte notwendig sind, um das Potential auszuschöpfen. Der Artikel zeigt auf, dass die Blockchain-Technologie diverse Chancen für den Bankensektor (u. a. Vereinfachung von Know-Your-Customer Verfahren, Erhöhung der Transaktionsgeschwindigkeit, hohe Ausfallsicherheit) bietet denen jedoch auch Herausforderungen (u. a. Skalierung, mangelnde Standardisierung) sowie Risiken (u. a. Disintermediation) gegenüberstehen. Insgesamt wird der Blockchain-Technologie, trotz aller Herausforderungen, mittelfristig ein hohes Disruptionspotential attestiert. Unternehmen im Bankensektor sollten sich daher schnellstmöglich mit dem Thema auseinandersetzen, um Wettbewerbsvorteile zu realisieren. Dafür bieten sich zunächst kleinere Eigenentwicklungen an, um sich gegenüber Kunden als innovative Unternehmen zu präsentieren und/oder die Partizipation in Kooperationen.

Keywords. Blockchain, Bankensektor, Disruption, Handlungsempfehlungen, Digitale Geschäftsmodelle

Contribution D

Disruptionspotenzial und Implikationen der Blockchain-Technologie am Fallbeispiel der Zeitarbeit – Eine Prozess- und Schwachstellenanalyse

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Disruptionspotenzial und Implikationen der Blockchain-Technologie am Fallbeispiel der Zeitarbeit – Eine Prozess- und Schwachstellenanalyse

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Abstract. Der Blockchain-Technologie wird hohes Disruptionspotenzial für bestehende Geschäftsmodelle nachgesagt. Im Vordergrund stehen dabei Geschäftsmodelle in denen ein Intermediär für die Abwicklung von Transaktionen von zentraler Bedeutung ist (z. B. Überweisungen bei Banken, Tracking von Lieferungen in der Logistik). Bisherige Betrachtungen sind jedoch recht allgemein gehalten und gehen weniger stark auf konkrete Chancen und Herausforderungen der Blockchain-Technologie ein. In diesem Beitrag wird anhand der Zeitarbeitsbranche das Disruptionspotenzial der Blockchain-Technologie dargestellt, in dem zunächst der aktuelle Prozess der Arbeitnehmerüberlassung erfasst sowie dargestellt und darauf aufbauend ein schematischer Soll-Prozess für die beteiligten Akteure entwickelt und präsentiert wird. Dies erfolgt auf Basis einer systematischen Literaturrecherche sowie Experteninterviews. Des Weiteren werden die Implikationen eines Blockchain-basierten Systems aus sozialer, ökonomischer, rechtlicher und ethischer Perspektive analysiert und die Veränderungen für die Branche dargestellt. Die Analyse zeigt, dass die Einführung eines Blockchain-basierten Systems in der Zeitarbeit Vorteile wie bspw. höhere Transparenz sowie eine höhere Automatisierung durch Smart Contracts für Unternehmen bieten kann, jedoch Herausforderungen in Bereichen wie bspw. Technologieakzeptanz sowie Datenschutz noch zu adressieren sind.

Keywords. Blockchain, Disruption, Zeitarbeit, Prozessanalyse, Digitale Geschäftsmodelle

Contribution E

Towards a Stakeholder-Oriented Blockchain-Based Architecture for Electronic Health Records: Design Science Research Study

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Towards a Stakeholder-Oriented Blockchain-Based Architecture for Electronic Health Records: Design Science Research Study

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Abstract. Background: Data security issues still constitute the main reason for the sluggish dissemination of electronic health records (EHRs). Given that blockchain technology offers the possibility to verify transactions through a decentralized network, it may serve as a solution to secure health-related data. Therefore, we have identified stakeholder-specific requirements and propose a blockchain-based architecture for EHRs, while referring to the already existing scientific discussions on the potential of blockchain for use in EHRs. Objective: This study aimed to introduce blockchain technology for EHRs, based on identifying stakeholders and systematically eliciting their requirements, and to discuss the key benefits (KBs) and key challenges (KCs) of blockchain technology in the context of EHRs. Methods: The blockchain-based architecture was developed in the framework of the design science research paradigm. The requirements were identified using a structured literature review and interviews with nine health care experts. Subsequently, the proposed architecture was evaluated using 4 workshops with 15 participants. Results: We identified three major EHR stakeholder groups and 34 respective requirements. On this basis, we developed a five-layer architecture. The subsequent evaluation of the artifact was followed by the discussion of 12 KBs and 12 KCs of a blockchain-based architecture for EHRs. To address the KCs, we derived five recommendations for action for science and practice. Conclusions: Our findings indicate that blockchain technology offers considerable potential to advance EHRs. Improvements to currently available EHR solutions are expected, for instance, in the areas of data security, traceability, and automation by smart contracts. Future research could examine the patient's acceptance of blockchain-based EHRs and cost-benefit analyses.

Keywords. Blockchain, Electronic health records, Data security, Information storage and retrieval

Contribution F

FeelFit – Design and Evaluation of a Conversational Agent to Enhance Health Awareness

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FeelFit – Design and Evaluation of a Conversational Agent to Enhance Health Awareness

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Abstract. In the course of digitalisation, healthcare systems are undergoing a major transformation. The generation and processing of health-related data are intended to improve health concerns. However, individual health awareness remains inadequate. To counteract this problem, issues in the fields of health awareness, wearable health monitoring systems, conversational agents, and user interface design were identified. Meta-requirements were derived from these issues and then converted into design principles. We developed the FeelFit conversational agent under consideration of those design principles. FeelFit measures vital parameters with various wearable sensors and presents them, enriched with personalised health information, to the user in the form of a conversation via individually configurable input and output devices. The conversational agent was evaluated by two experiments with 90 participants and a workshop. The results confirm a positive usability and task fulfilment of our conversational agent. Compared to known applications, the participants highlighted the more natural interaction and seamless integration of various sensors as strengths of FeelFit.

Keywords. Conversational Agent, Health Awareness, Wearable Health Monitoring System

Contribution G

Generating Design Knowledge for Blockchain-based Access Control to Personal Health Records

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A German Perspective on the Design and Evaluation of a Blockchain-based Personal Health Record

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In the course of digitization in healthcare, personal health records (PHRs) are handled as a key solution. Despite the indisputable benefits, the dissemination of PHRs in Germany is hampered by data security and data privacy concerns. Blockchain technology offers promising potential to address these issues by enabling secure transactions of sensitive data. Apart from existing generic architectures, we systematically identified issues for the German healthcare sector that need to be considered for the development of a PHR. We subsequently derived eight meta-requirements that were consolidated into three design principles. Within a one-year design science research project, we developed the blockchain-based PHR prototype, OSHealthRec, and we evaluated the system in four evaluation cycles. The findings of our research are twofold. On the one hand, we contribute to the design knowledge base by presenting three design principles. On the other hand, we present the development of a real, operating blockchain-based PHR and the findings from its continuous evaluation, which may serve as useful advice for further solutions.

Keywords. Blockchain, Personal Health Record, eHealth, Design Science Research