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Unchaining Social Businesses – Blockchain as the Basic Technology of a Crowdlending Platform

by

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Completed Research Paper

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Abstract

Social businesses are increasingly gaining relevance as alternatives to traditional businesses. Nonetheless, such organizations face specific problems. The emerging blockchain technology may represent an opportunity to solve several problems of social businesses and an alternative to established technologies. However, evidence about the potential of blockchain in social businesses is missing. We bridge this gap by designing, developing, and evaluating a blockchain-based crowdlending platform of a social business, following the design science research approach. The evaluation and comparison to a non-blockchain solution allows us to generate generalizable knowledge and derive implications for both research and practice. Our research shows that blockchain enables otherwise unsustainable social business models, mainly by replacing intermediaries and requires changes in software engineering practices. Further, our findings illustrate that blockchain raises challenges and uncertainties and opens promising avenues for further research.

Keywords: Blockchain, Social business, Smart contracts, Crowdlending, Design science, Prototype

Introduction

The concept of social business, in which market-based approaches are used to create social value (Wilson and Post 2013), has increasingly gained recognition over the past years (Doherty et al. 2014). These distinct organizations borrow principles from both traditional (profit-oriented) as well as non-profit businesses (Yunus 2007) and perform some commercial activity to achieve social goals (Doherty et al. 2014). They face several challenges and often have conflicting objectives. One pressing question is how these organizations can achieve their social objectives while maintaining competitive advantage (Doherty et al. 2014). Examples of social businesses are certain crowdlending platforms that serve an altruistic and philanthropic purpose (Agrawal et al. 2014; Haas et al. 2014). Concurrently, the concept of crowdlending has also increasingly drawn attention from the general public (Blohm et al. 2016). Crowdlending enables capital-seekers to call for the funding of loans for private consumption, private purposes, or business purposes (Blohm et al. 2016) and allows individual investors to combine their investments to fund various projects (Bruton et al. 2015). Specialized crowdlending platforms have been enabled by technological advancements and represent an alternative to traditional financial intermediaries (Lehner 2013). Nonetheless, trusted third parties such as banks are needed to conduct the financial transactions involved in funding projects (Moritz and Block 2014), mainly for legal reasons (Funk et al. 2011). Thus, banks remain part of the value chain, focusing on account management and transaction fee-oriented business models. Since social businesses must recover their costs but should from then on focus on creating social value rather than on maximizing profit (Yunus 2007), the intermediary fees of social crowdlending businesses and bank cooperations remain a hindrance. However, there has been little research into alternative intermediary structures of crowdfunding platforms (Haas et al. 2014). In addition, Haas and Blohm (2017) note that, owing to the complex interplay of multiple service providers such as banks, it is hard to efficiently design crowdfunding offerings.

Currently, there is increasing interest in the blockchain technology in both practice and academia (Glaser and Bezzenberger 2015). Experts attribute a fundamental impact on diverse areas of society to blockchain (Beck et al. 2016; Wright and Filippi 2015). While the technology was originally invented to enable the cryptocurrency Bitcoin, numerous applications are now available that go well beyond its first instantiation (Beck et al. 2016). Blockchain technology enables the realization of concepts designed to simplify human interaction and collaboration on a large scale. Prominent application examples include marketplaces for financial assets or fraud-resistant supply chain records (Mattila 2016). Most of these use cases build on certain fundamental functionalities such as autonomously executing smart contracts (Wright and Filippi 2015) and represent decentralized autonomous organizations, which act on business rules embedded in smart contracts and ownership rights registered in a blockchain (Forte et al. 2015). A survey conducted by the World Economic Forum (2015) supposes that by 2027, more than 10% of global GDP will be processed via blockchain technology. Yet, despite these claims, there has been little scientific research into blockchain technology and its practical applicability (Atzori 2015; Beck et al. 2016). While initial research efforts focused on specific aspects of the technology, such as technical aspects (Becker et al. 2013; Decker and Wattenhofer 2013) or specific application areas such as cryptocurrencies (Böhme et al. 2015) and law (Wright and Filippi 2015), Glaser (2017) notes that we lack a common knowledge base in Information System (IS) research. In particular, "[i]dentification and valid analysis of blockchain ecosystems and application scenarios impose a prevailing issue for practitioners and researchers" (Glaser 2017, p. 1543). Further, Lindman et al. (2017) call for an analysis of various blockchain-based prototypes, suggesting a design science research approach.

Blockchain technology, especially decentralized autonomous organizations, can potentially provide a solution to the abovementioned problems of social business crowdlending platforms by autonomously fulfilling the actions of entrusted third parties (Beck et al. 2016). Researchers also argue that blockchain-based organizations should be explored as potential enablers for building social finance (Brett 2016). Yet, research and practitioners are lagging behind providing reliable evidence to better understand the potential of blockchain as a basic technology of social businesses. This is particularly surprising, since peer-to-peer (P2P) markets (especially crowdlending platforms) have been called "natural candidates" (Glaser 2017, p. 1550) for profiting from blockchain infrastructure, which could replace intermediary services and payment providers (Glaser 2017). Further, research into smart contract development is in its infancy, and we still lack best practice approaches and development project experience (Delmolino et al. 2016). Thus, insights into the peculiarities of blockchain-based software development would be helpful. To address this lack of research, we define the following research question:

How can blockchain technology as an alternative infrastructure for crowdlending platforms enable social businesses?

We seek to bridge the identified research gap and answer this question by developing and evaluating a prototype blockchain-based crowdlending platform following the design science research approach. Further, we derive generic knowledge on blockchain applications from our prototype development process and evaluation. By doing so, we seek to make two primary contributions. First, studying blockchain technology as a driving force for social business allows us to gain theoretical insights about the opportunities and challenges of implementing blockchain-based solutions, expanding the fields of both social business and blockchain research. Considering that we still lack IS research into blockchain technology applications (Glaser 2017), the creation of such knowledge seems a desirable outcome. Second, it allows us to draw conclusions for practitioners on how to implement efficient intermediating platforms based on blockchain technology.

The remainder of the paper is structured as follows: In Section 2, we introduce the foundations of this study and review related work on social business, crowdfunding and crowdlending as well as blockchain. In Section 3, we introduce the chosen research method, while in Section 4 we provide an overview of the chosen crowdlending use case. Section 5 contains a description of the derived design objectives. In Section 6, we provide a detailed account of the prototype development, which is evaluated in a wider context in Section 7. In Section 8, we derive conclusions and recommendations for further research.

Foundation

To better understand the organizational problems that motivate our research, and to derive suitable solution objectives, it is key to gain a detailed understanding of the underlying concepts and related research. Thus, we will now introduce the foundation and review the relevant work in the research fields of social business, crowdfunding, crowdlending, and blockchain.

Social Business, Crowdfunding, and Crowdlending

With rising scholarly interest in the phenomenon of social businesses, definitions are abundant and differ across geographical areas (Kerlin 2010). Common among all definitions is that such businesses pursue some commercial activity to achieve social goals (Doherty et al. 2014). For our purposes here, we refer to the generally accepted definition of the social business pioneer Mohammad Yunus. Yunus (2007) defines a social business as an entity that must recover its full operational costs, but with a focus on creating social value rather than on maximizing profit. Thus, social businesses act as hybrid organizations, borrowing principles from both non-profit and profit-maximizing businesses (Doherty et al. 2014; Yunus 2007). They face multiple challenges, tensions, and tradeoffs, especially regarding their social missions and financial resource mobilization, securing competitive advantages (Doherty et al. 2014). A particular tradeoff mentioned by Doherty et al. (2014) is related to the conflict between aiming at a social value and capturing economic value. Smith et al. (2013) further mentions the management of increased short-term costs while achieving long-term social expansion as a specific challenge of social businesses. Social businesses generally face strong economic constraints (Smith et al. 2013).

Crowdfunding allows individual investors to combine their investments in order to fund various projects (Bruton et al. 2015) and is usually based on open calls for funding via the Internet (Belleflamme et al. 2014). Crowdlending is the most relevant subtype of the crowdfunding phenomenon and is drawing increasing interest (Blohm et al. 2016). In crowdlending, capital-seekers ask a large audience of investors for loans in order to finance diverse projects (Blohm et al. 2016), rather than for equity in companies or donations, which is common practice in other crowdfunding categories (Blohm et al. 2016). According to the authors, crowdfunding also offers liquidity and financial resources for markets that could not be adequately served under traditional financing mechanisms. However, as Haas et al. (2015) describe, in an archetypal crowdfunding ecosystem, the majority of these crowdfunding platforms only operates on top of the traditional financing mechanisms. Intermediaries such as banks and payment service providers represent an integral part of the crowdfunding ecosystem and are responsible for the processing of financial transactions. Thus, the current ecosystem heavily relies on trusted third parties. Figure 1 provides an overview of the current architecture of crowdfunding ecosystems. For a detailed description of the services please see Haas et al. (2015).

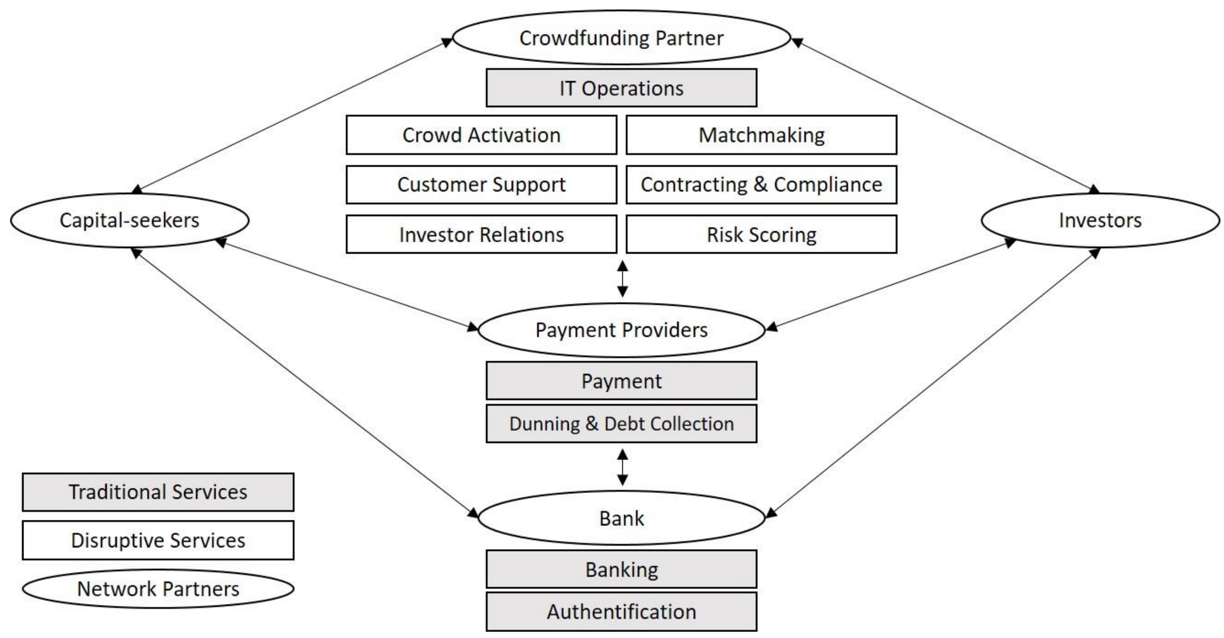

Figure 1. Crowdfunding Service Ecosystem (Haas et al. 2015)

Although crowdfunding platforms have been the subject of multiple research endeavors, which have proven crowdfunding platforms to operate successful business models (Belleflamme et al. 2015), several downsides and open research questions remain. In particular, Agrawal et al. (2014) note that "[t]he rules, technical features, and cultural norms established by individual platforms will shape the behavior of creators and funders and ultimately determine the extent to which the market for crowdfunding operates efficiently" (Agrawal et al. 2014, p. 79). Further, concerning technical features, Milne and Parboteeah (2016) mention that platform failure risks remain and should be confronted more openly. Haas et al. (2015), who analyzed the operation and structure of crowdfunding services, contend that technology (specifically the Internet) enables the combination of traditional financial service intermediation with services such as matchmaking; they also note that these services add costs in the crowdfunding process and encourage researching the appropriate design of crowdfunding platforms for different business types, such as social businesses. In addition, while mediation by financial institutions is no longer required, they remain part of the value chain, operating as intermediaries required by law (Funk et al. 2011). Giaglis et al. (2002) note that research expects a move towards direct interaction and elimination of intermediaries in electronic markets, often described as *disintermediation*. In the *Harvard Business Review*, Gupta (2017) suggests that blockchain technology could lead to a world without intermediaries. Thus, blockchain technology may prove to be a suitable alternative option, as its characteristics offer comparable benefits to that of traditional financial institutions. Additionally, Giaglis et al. (2002) argue that technology advances can internalize and therefore significantly lower transaction costs in electronic markets. However, they argue that transaction settlement would still require an intermediary, a notion that is argued is being changed by blockchain (Peters and Panayi 2016). Lauslahti et al. (2016) suggest looking at blockchain technology as an enabler of digital platforms and their boundary resources. Specifically, Glaser (2017) names P2P lending (and generally crowdlending) platforms as natural candidates for infrastructural replacement through blockchain technology, decentralizing intermediary services and trust-free payment mechanisms.

Blockchain

The global interest in blockchain has increased substantially in the past years, as various practitioners and researchers see in it the potential to radically change several spheres (Beck and Müller-Bloch 2017). Blockchain was first conceived and used as the enabler of the crypto-currency Bitcoin (Beck et al. 2016; Beck and Müller-Bloch 2017; Nakamoto 2008), but soon evolved into a multipurpose technology applied in fields such as supply chain records (Korpela et al. 2017), IoT security and privacy (Dorri et al. 2017), energy trading (Munsing et al. 2017), and prediction markets (Clark et al. 2014). A blockchain is a transactional, distributed database stored on every node of a P2P network (Glaser 2017). (Data) transactions between users (which are represented by a public key address) are grouped into blocks that are cryptographically chained to one another in chronological order (hence, blockchain). The transaction order and the valid blockchain for the nodes are determined by a consensus algorithm run by the participating nodes, providing consistency between them (Glaser 2017). Multiple such algorithms exist, providing slightly varying levels of security, latency, and energy consumption (Christidis and Devetsikiotis 2016; Zheng et al. 2016). Further, blockchains can have different designs with varying levels of read/write permissions, centralization, and efficiency (Christidis and Devetsikiotis 2016; Peters and Panayi 2016; Zheng et al. 2016). Most importantly, for our purposes here, all blockchain systems have the following characteristics:

- Data redundancy (Porru et al. 2017) owing to storage on all nodes of the distributed P2P system (Christidis and Devetsikiotis 2016). Thus, data persistency is ensured (Zheng et al. 2016).
- Use of cryptography (Porru et al. 2017).
- A consensus method for coordinating the state of the blockchain among the different network peers (Christidis and Devetsikiotis 2016; Porru et al. 2017).
- Decentralization (Zheng et al. 2016) and trusted direct interaction among peers (Christidis and Devetsikiotis 2016).
- Auditability (Zheng et al. 2016), transparency, and verifiability of network activities (Christidis and Devetsikiotis 2016).

In addition, Porru et al. (2017) note that blockchain systems can optionally have a transaction scripting language. Two notable design options of blockchain systems can be distinguished: Bitcoin-like designs, which can be used for tracking and transferring tokenized assets and account-based designs, which can be programmed to run arbitrary logic on the nodes of the P2P network (Christidis and Devetsikiotis 2016). These latter blockchains support the deployment of smart contracts. The concept of smart contracts has first been defined as a transaction protocol that executes the embedded and programmed terms of a contract by Szabo (1997) and can be implemented on a blockchain. Here, they act as code that is stored on the blockchain (Christidis and Devetsikiotis 2016) and is executed on every node of the network when triggered (each node therefore runs a virtual machine) (Christidis and Devetsikiotis 2016; Glaser 2017). A very prominent example of a blockchain that provides a Turing complete programming environment for smart contracts is Ethereum, a foundation located in Switzerland that launched a public blockchain allowing anyone to participate and deploy their own smart contracts or to create private blockchains that for instance can be used by a consortium. The smart contract programming language of Ethereum is called Solidity.

Huge potential is attributed to smart contracts, since they are able to self-execute if terms of the contract are met; they are also tamper-proof owing to the blockchain characteristics (Lauslahti et al. 2016). Thus, they allow for the option to design generic interactions between mutually distrustful parties (Christidis and Devetsikiotis 2016). This is especially interesting, as for instance Giaglis et al. (2002) recognized the requirement for protection against opportunistic behaviors by market participants in Internet-based commerce applications. Yet, multiple questions regarding the de facto security provided by smart contracts related to the interaction with and the development of such contracts remain unanswered (Luu et al. 2016). Porru et al. (2017) recognize the need for specialized, blockchain-oriented software engineering practices. Thus, we also share and evaluate our findings on the development of our blockchain-based platform. Further, Lindman et al. (2017) call for research into de facto applications of blockchain technology that go beyond descriptive accounts or anecdotes. They particularly encourage the IS community to answer questions about what new application areas could be for blockchain-based platforms, or which potential new business models could be enabled by blockchain and who would benefit from these.

In short, blockchain systems are "cryptographic economic systems" (Beck et al. 2016, p. 2) that "organize transactions completely reliable, without any human interaction, following intractable rules set in the computer protocol" (Beck et al. 2016, p. 2). Thus, we evaluate a blockchain system as a potentially superior alternative to the current design for our crowdfunding platform.

Research Method

We follow the design science research approach (March and Smith 1995; March and Storey 2008; Nunamaker Jr et al. 1990; Walls et al. 1992) for the development of the blockchain-based crowdlending platform. Design science research generally seeks to solve identified organizational problems in a build-and-evaluate process, ultimately producing purposeful Information Technology (IT) artifacts (Hevner et al. 2004) that should serve a meaningful human purpose. Design science research outputs can generally be distinguished between constructs, models, methods, and instantiations, such as prototypes (March and Smith 1995). The derived knowledge should be generalizable and therefore applicable to similar settings. To achieve this objective, we drew from experienced peculiarities while developing our blockchain solution and derive generalizable insights from the artifact evaluation. In particular, we address the aforementioned organizational research problems by developing and evaluating an instantiation of a blockchain-based crowdlending platform. Thus, we build on the widely accepted research approach by Peffers et al. (2007) and apply it as illustrated in Figure 2.

In line with common design science approaches, our research starts with the identification and description of a practical relevant problem (Hevner et al. 2004). We analyze the problems of a specific social business in Section 4. Our investigation reveals that the challenges of the examined social business are mainly rooted in a reliance on intermediaries, which imply high transaction costs and complex interfaces to external parties. To resolve the identified issues, we derive objectives that a solution must fulfill in the next research step. The definition of our solution objectives builds on the literatures of social business, crowdlending, and blockchain technology, as well as on the examination of the current solution. Accordingly, we established 17 objectives that are used for the design, implementation, and evaluation of the prototype. Additionally, drawing on the literature, at this stage, we define criteria to establish measurable parameters to later evaluate the prototype against. Using the solution objectives as a starting point for the design and development stage, we define the required data elements and the functions of the intended solution. Based on the defined design attributes, we build an instantiation of our blockchain-based crowdlending platform. We developed the prototype on the Ethereum blockchain, since it supports smart contracts and is currently regarded as the most advanced platform for smart contract development (Koblitz and Menezes 2016). For the demonstration, we repeatedly conduct an end-to-end execution and testing of core processes to ensure and verify the platform's functionality. In the evaluation section, we link our prototype to the derived objectives and the determined evaluation criteria. We also compare the current non-blockchain solution and our prototype. Thus, we combine the empirical observations with a conceptual perspective and arguments derived from the literature (Gregor and Hevner 2013). In the research process, we applied the design science phases *design and development*, *demonstration*, and *evaluation* in an iterative and partly overlapping manner (Beck et al. 2013). We outline the evaluation results as well as research and practical implications in the discussion section and communicate them through this paper.

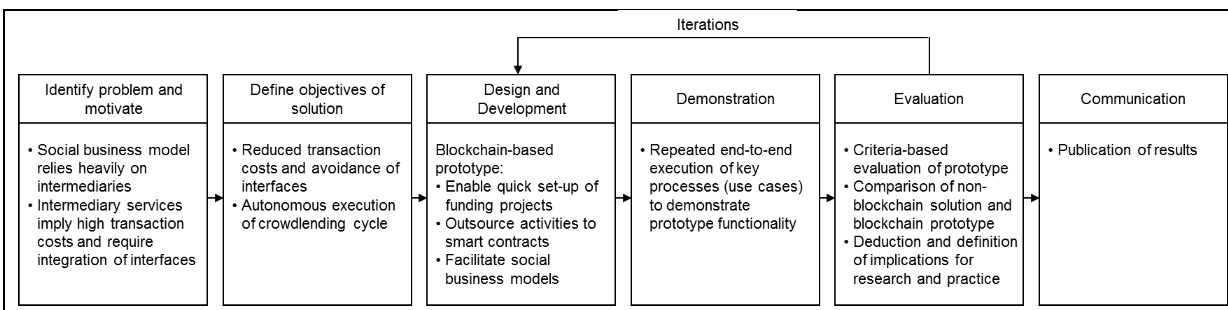

Figure 2. Applied Design Science Research Approach (based on Peffers et al. 2007)

Problem Identification and Motivation

In 2013, a group of students initiated a social business to improve funding for studies in Germany by offering a crowdlending platform that connects students with private investors. The number of students is rising year by year, and students are increasingly seeking adequate ways to finance their education (Müller 2014). However, traditional student loans are inflexible and fairly expensive. Further, scholarships are only available to a selected few, while governmental support is mostly connected to high bureaucratic hurdles. Thus, the initiative – as a social business – offers an alternative that covers specific student demands (e.g. flexibility, risk limitation, and transparency). To achieve this objective, private investors get opportunities to fund students' personal projects via a crowdlending platform that allows one to invest small amounts. Students seek funding alternatives, and investors are increasingly interested in social investments (Nicholls 2010) – thus, the social business delivers contributes in two ways. On the one hand, students benefit from a transparent and direct credit alternative that avoids long and tiresome credibility checks and seeks to reduce costs. On the other hand, investors get an individual, sustainable, and direct investment option with social and financial returns on investment.

From a process perspective, the platform encompasses four main activities. First, the communication of credit acceptance conditions between students and investors concerning individual interest rates, payback periods, payback cycles, and the relationship characteristics during the contract period. Second, the contracting process between students and investors includes the creation and activation of a contract as well as the contract document instantiation, which complies with the latest country-specific regulation standards. Third, the processing of financial transactions, i.e. the transfer of investment and payback amounts from a creditor account to a debtor account, and vice versa. Thus, the social business engaged in a partnership with an online bank that brought in account management expertise and the legal requirements to conduct banking business. Fourth, the contract management functionalities, such as handling of change requests to existing contracts, reminder, and dunning processes. To cover the partner bank's transaction costs and the internal costs, a small fee per funded student was raised.

The founders, who were in a one-year incubation program, were able to design and set up required processes to enable credit transfer between students and investors. From an architecture perspective, in line with Haas et al. (2015), the crowdlending platform strongly relied on intermediaries such as banks. Also, during the incubation program, investments in student projects with a total volume of approximately 60,000 euro were mediated, contracted, and the processing initiated. However, investigations in the incubation program also revealed crucial deficits of the status quo and the unsustainability of the associated business model. Based on an interview with one of the founders, we were able to identify four main problem areas. Table 1 provides an overview of these deficits, explains their impacts on the social business and why they should be resolved.

Table 1. Deficits of the Status Quo

Problem area	Description
High transaction costs for processing student projects	The status quo builds on the traditional banking infrastructure to transfer funds from investors to students, and vice versa. Thus, transaction costs remain a dominant factor in the examined social business's cost structure. In fact, all financial transactions are processed via an intermediary bank, which takes care of bank accounts, bank transfers, and interbank clearings. Consequently, the need for a traditional intermediary undermines the further reduction of these costs.
Manual processes	Although several processes, such as registering a new student project, and changing information of an existing project, have been automated, there remain manual activities in the current solution. These activities are mainly located in cross-company processes with partner organizations. For instance, the manual reconciliation of bank accounts to identify outstanding payments indicate further automation potential.
Complex interfaces	A seamless integration of third parties (e.g. banks, regulators) requires considerable effort in interface development. The reasons for this are manifold and are located in various areas, such as IT security, IT certifications, and adapting to partner organizations' ongoing software update cycles.
Trust and personal identification	The current business is based on trust and personal identification mechanisms. Thus, prior to investments or the search for funding, users must open an account with the partner bank and must successfully complete an identification process. This procedure is time-consuming and costly, and may also represent a barrier for potential new customers.

Table 1. Deficits of the Status Quo

As described in the foundation section, the blockchain literature suggests that the identified deficits can be addressed by blockchain as a basic technology (Glaser 2017). Thus, we decided to develop a blockchain-based crowdlending platform to further analyze blockchain as a basic technology for social businesses.

The Derivation of Objectives of the Blockchain Prototype

We derived the objectives of our blockchain prototype from both use case-specific details and related literature. This approach ensures that these not only rely on the case-specific information that may contradict a generalization of potential findings. To derive objectives from the examined case, we conducted an interview with one of the founders and discussed possible solutions to overcome previously identified and analyzed problem areas. Further, drawing from the founders' experience, the interview includes a general discussion on requirements of crowdlending platforms. In the literature analysis, we focused on relevant research discussing characteristics and peculiarities of social businesses, crowdlending, and blockchain technology. Thus, we guarantee that the prototype fulfills crowdlending and use case-specific characteristics as well as the purpose of a social business. We defined 17 objectives for our solution that are used for the design of the prototype as well as for the subsequent evaluation. We describe the objectives, including a description and justification why the factors are included, as well as evaluation methods, in Table 2.

Table 2. Objectives of the Blockchain Prototype

	Objective	Description and evidence	Evaluation
Social business	*Financial sustainability*	Since the social business is not based on donations, it must support the recovery of costs (Yunus et al. 2010). Thus, a balanced profit equation between cost and revenue is needed (Boons and Lüdeke-Freund 2013). Further, the startup's management indicated that, owing to their long-term commitment to investors and students, financial sustainability is necessary.	Comparison of (expected) costs and revenues
	Social purpose	Social businesses act as a change agent for the world and pursue the creation of social benefits (Yunus et al. 2010). Thus, although the prototype is required to cover its costs, the social perspective and more cause-driven character are first priority (Boons and Lüdeke-Freund 2013).	Evaluation of sustainability of social purpose
Crowdlending	*Allow small amount investments*	The crowdlending platform needs to allow the investment of small financial amounts (Lins et al. 2016). Therefore, low transaction costs are necessary for achieving a cost-efficient social business investment model.	Evaluation of minimum investments and transaction fees
	Provide editable information about funding projects	The crowdlending platform needs to provide details about projects in search for funding, as information is seen as a crucial factor of the funding success (Lins et al. 2016; Overby et al. 2010). Furthermore, the ability to update the auction with recent project information has a positive effect on the funding outcome (Agrawal et al. 2014; Ward and Ramachandran 2010).	Evaluation of fulfillment
	Provide mechanism to establish and measure user reputation	To address the market design parameter of user reputation the platform needs to provide a feedback function, enabling that a user can provide insights about their experience with a specific user after a transaction (Cabral; McDonald and Slawson 2002).	Evaluation of fulfillment
	Define and enforce platform rules	The platform needs to be designed to act according to predefined rules (Agrawal et al. 2014). To adhere the existing standards, we follow industry regulation standards and define a maximum invest per investor as well as a maximum funding amount per student project. Furthermore, we evaluated and confirmed that assumption through the interview with one of the founders.	Evaluate implementation and enforcement

	Crowd due diligence	Research studies on the crowdfunding platform Kickstarter suggest that a greater number of perspectives available to recognize something amiss are a useful tool to detect fraud (Agrawal et al. 2014). Thus, our platform must allow for comments to a project by any user.	Evaluate implementation and enforcement effectiveness
	Provision point mechanism	The provision point mechanism is a common practice in crowdlending platforms to address the free-rider problem, where investors wait and observe what others do before investing. Thus, our platform needs to include a parameter for minimum funding, which needs to be reached before funding is provided to a student (Agrawal et al. 2014).	Evaluate implementation
Use case	*Provide reporting functions*	For regularly reporting and statistics on the social business development, the prototype must provide the functionality to run reports on the transactions of a specific period.	Evaluation of fulfillment
	Transaction time	As soon as the funding limit is reached, the subsequent transactions should be executed for student projects to start. As the management interview indicated, to date, this has required an active trigger from staff. A time gap existed due to the intermediary bank.	Evaluation of transaction times / delays
	Data persistency	To ensure transparency, traceability, and archiving requirements, the prototype needs to store data persistently and immutably. According to management, to date, this has only been done in centralized systems with classic backup redundancy.	Evaluation of fulfillment
	Transaction volume	Currently, the volume of funded projects is fairly low; thus, the number of transactions should be manageable without constraints. However, an improved solution must be scalable.	Evaluation of throughput rates
	Trust and personal identification	Trust and personal identification mechanisms should be seamless and should not represent an entry barrier for potential users.	Evaluation of trust and personal identification mechanisms
	Reduction of manual activities	The manual activities involved in the processing of the transactions and the management of project lifecycles should be further automated to reduce costs and the possibilities of fraud. Management especially mentioned cross-company activities with intermediary institutions.	Evaluation of manual activities
	Reliable and trustworthy transaction processing	To avoid malicious changes of funding related data, the prototype must be able to process transactions in a reliable and trusted way.	Evaluation of trust mechanisms
	Stability of credit currency	To ensure a stable and calculable payback amount, the credit currencies should not be subject to high fluctuations.	Evaluation through historical values
	Avoidance of complex interfaces	To reduce the implementation efforts and system maintenance, and to increase independence from legacy applications, the prototype must be developed in a way that avoids complex interfaces.	Evaluation of needed interfaces

Table 2. Objectives of the Blockchain Prototype

In addition to our prototype objectives, the literature mentions credit default rates and the integration of social networks as success factors (Agrawal et al. 2014; Everett 2015). We agree with these findings and inherently integrate the idea of social networks in the objective *crowd due diligence*. Since, an analysis of default rates requires a long-term examination we did not include this criterion and call for further research to examine this phenomenon.

The Design and Development of the Blockchain Platform

Considering the aforementioned objectives, we drew on Unified Modeling Language diagrams, which are established and well recognized, to design our platform requirements (Eriksson and Penker 2000).

Specifically, we apply the use case diagram to picture user stories and develop activity diagrams to design the program flow. The defined user stories and expected platform interactions are shown in Figure 3.

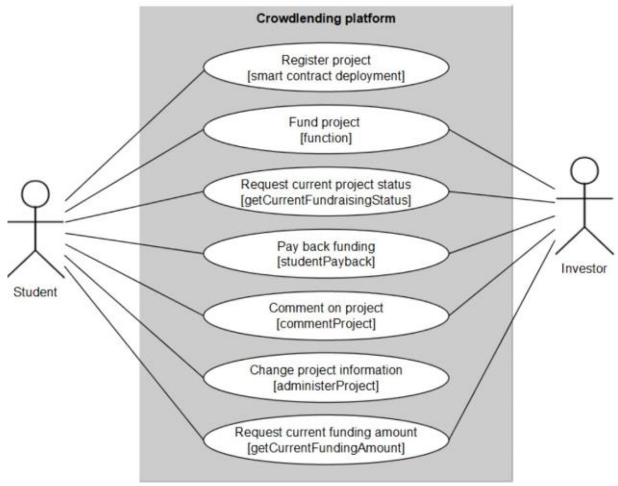

Figure 3. Use Case Diagram

Based on these design efforts, we implemented the crowdlending platform's software specifications via smart contracts on the Ethereum blockchain. Thus, investments are possible and accepted only in ether, the cryptocurrency of Ethereum. We developed the smart contracts, using solidity, Ethereum's built-in Turing-complete programming language. From a contract design perspective, each fundraising auction, which represents a student project in a search for funding and all associated activities, is implemented in separate smart contracts. This has several implications, such as the security aspect that each auction is independent from the others and potential loss of access to one smart contract would not affect other. Further, the modularization allows us to implement unforeseen changes prior to the deployment of an auction, which would be impossible if all auctions were part of one smart contract.

The most important variables to store relevant data of our fundraising auction smart contract were (1) *fundingGoal,* (2) *minimumFunding*, (3) *currentFundingAmount,* (4) *currentFundraisingStatus,* (5) *typeOfProject*, (6) *startOfPaybackPeriodInMinutes, (7) paybackCycleTimeInMinutes*, *(8) raisingStudent,* (9) *investmentDurationInMinutes, (10) endOfInvestmentPeriod, (11) investmentPerInvestor, (12) exchangeRateEtherStudentBond, (13) interestRate*. Variables 1, 2, 3, and 4 relate to the funding amount and the current funding status. Variable 5 describes the student project type that is in need of funding. Details about the payback conditions are stored in the variables 6 and 7. Variable 8 is defined to store the Ethereum address of the student looking for funding. Once the smart contract is deployed on the blockchain, it obtains an address that makes it reachable as long as the blockchain exists (Luu et al. 2016). An example of our smart contract is shown in Figure 4. Investments are accepted within the predefined durations 9 and 10 only. When an investor sends ether to the smart contract's address, the fallback function *function()* is called. This function stores each investor and the corresponding investment amount in 11. In exchange for the ether invested, an investor receives student tokens that function as bonds. In our prototype, the exchange rate of token to ether (12), for simplicity, was set to 1:1 and the interest rate (13) to 1. Further, the function *getCurrentFundingAmount()* was implemented to allow requests for the current funding amount. Since the function *administerProject()* is only available for the corresponding student to change project specifications, access rights validations are needed. Thus, the smart contract is extended by a validation that examines whether the requesting account is equivalent to the account of the student who initiated the smart contract. In case the check is negative, the requesting account is not permissioned to change any details. Comments to a specific project can be added by any user via the *commentProject()* function. We included this functionality to foster social engagement on our platform, which is seen as a crowdfunding success factor (Agrawal et al. 2014). Owing to the divisibility of ether up to 18 decimal places, a large number of investors can invest reasonably small amounts in a student project (Buterin 2014). If the minimum funding is not reached within the investment duration, the invested ethers are released and all investors can reclaim their invested amounts. Only if the fundraising is successful, the student is able to withdraw the invested ether after the investment period. Since smart contracts behave as passive artefacts, we use solidity events to listen to the smart contract and trigger activities at specific due dates, like at the start of the payback period (Glaser 2017). Further, we allow request about the status of an auction via the function called *getCurrentFundraisingStatus()* that delivers the information regarding the smart contract's status. Replies contain information if the payback period has started and if any amount has been paid back by the student. To pay back the investment, including the interest rate, to an investor, we implemented a function called *studentPayback()* that expects the student to send ether and the beneficiary's address. Thus, the smart contract keeps track of the balance and the outstanding payments and is able to provide an overview of each investor balance (similar to an account statement). Thus, services such as an autonomous trigger of the reminder and dunning processes through the smart contract, although out of scope, could be easily integrated into the smart contract. After the entire payback sum is paid, the smart contract's status is set to *closed* and no more actions can be performed by the smart contract. However, the history and related transactions of the smart contract will reside immutably in the blockchain.

The proposed platform is characterized by attributes of the blockchain, revealing a decentralized structure, a peer to peer network topology, a consensus mechanism, and the ability to autonomously execute smart contracts. These characteristics allow for the transfer of investments from investors to students, and vice versa, in a closed trust-free system without intermediaries (Beck et al. 2016). Further, the platform allows one to increase the transparency of investments and to keep track of the payment status. To access the developed platform, only the contract address and knowledge about the contract functionalities are required. Thus, the interaction is not bound to a specific application. For instance, a developed web frontend using the Ethereum API or an Ethereum wallet can be used.

As noted by Beck et al. (2016), Ethereum does not yet provide a testing library. Therefore, we also abstained from a complex testing environment, and focused on the examination of implemented functions through use cases. Further, as our focus is on examining the blockchain technology as the basic technology of social businesses, we did not focus on the evaluation of the user interface.

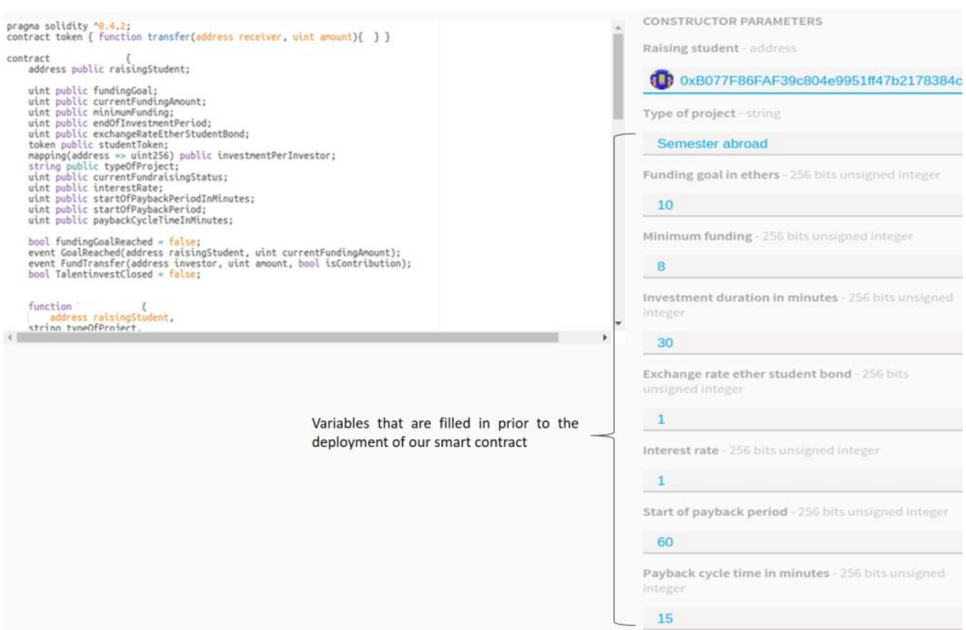

Figure 4. Smart Contract Deployment

Evaluation, Discussion, and Implications for Theory and Practice

The developed prototype proves that it is possible to implement the crowdlending platform of our social business on an Ethereum blockchain. In contrast to the traditional crowdfunding service ecosystem of Haas et al. (2015), our blockchain prototype reduces the number of intermediaries from three to zero (Figure 5).

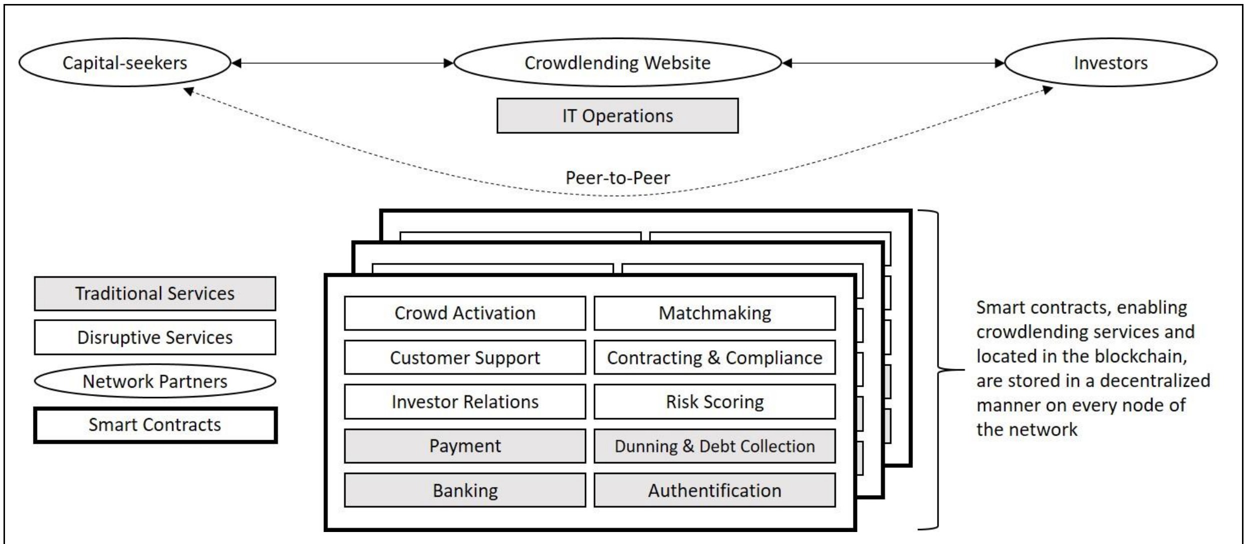

Figure 5. Blockchain Crowdlending Service Ecosystem (based on Haas et al. 2015)

Since banking and payment services are inherent traits of the blockchain technology (Nakamoto 2008), no financial intermediaries are required in the blockchain-based crowdlending service ecosystem. Further, all relevant services and corresponding transactions are stored in the blockchain, replicated on each node of the network and accessible through smart contracts. Thus, the crowdlending website stated in Figure 5 is not counted as an intermediary since it only has user comfort functions, but is from a purely technical and functional perspective not needed. In consequence, no central crowdlending partner, responsible for services like crowd activation and matchmaking is required.

As described in the previous section, during the implementation, we focused on services that are relevant to achieve the derived objectives and thus we did not implement all ecosystem services in our prototype. In addition we not only strive for the confirmation that a blockchain solution is applicable; we strive for an evaluation whether a blockchain solution is beneficial compared to the status quo of the introduced social business case, as proposed by Gregor and Hevner (2013). Thus, we evaluated the blockchain platform and compared it to the non-blockchain solution based on the derived design objectives. The results and corresponding explanations are illustrated in Table 3.

Table 3. Criteria-based Comparison between the Non-blockchain Solution and the Blockchain Solution

	Objective	Non-blockchain solution	Blockchain solution
Social business	*Financial sustainability*	The non-blockchain solution reveals high cost, primarily owing to the bank as financial intermediary (transaction and processing fee). To compensate for this and to achieve a balanced business model, the examined social business would have to raise its service fee. However, internal market research and user acceptance analyses suggested that the cost to the user not be further increased. Further, the social business aims to offer the service at a low cost. Thus, in the status quo, the business model is not sustainable and cannot cover the occurring costs.	The blockchain solution circumvents the bank as intermediary and thus bears only the costs required to conduct transactions on the Ethereum blockchain. The costs are significantly lower in the new solution. Further, with our prototype, we have laid the foundation for a completely self-sustaining and automated social business. Processes are triggered solely via user inputs (Ethereum nodes), while only modification to the source code remain under central responsibility. In a next step, the source code will be available as open source and will be controlled by the community according to the principles of a decentralized autonomous organization (Forte et al. 2015).
	Social purpose	The business currently pursues a social purpose. However, to permanently establish the social purpose, the solution needs to achieve financial sustainability.	The main social objective remains unchanged. However, the idea of a decentralized autonomous organization implies the application of democratic principles, which arguably makes it more social (Wright and Filippi 2015).
Crowdlending	*Allow for the investment of small amounts*	In the current solution, small investments are not economically viable owing to the high transaction costs incurred for each transaction. Thus, the minimum funding amount was set to 500 euro.	Ether are divisible in up to 18 decimal places, allowing a large number of investors to invest reasonable small amounts in a student project (Buterin 2014). This is economically viable due to the decreased transaction costs. Also, investors are not restricted by a fixed minimum investment amount and can therefore enhance their portfolio diversification without increasing the overall investment.
	Provide editable information about student projects	The project description can be edited with reasonably small effort at any point, because it is stored in a mutable database.	Smart contracts and thus the blockchain are immutable and cannot be edited. However, it is possible to include a specifically tailored function in the contract source code that allows for changing predefined variables. Notably, all possible changes and states of a smart contract must be foreseen and integrated in the source code.
	Provide a mechanism to establish and measure user reputation	The current solution allows users to rate other users after the funding of a project is completed and all associated transactions are closed.	Also, the blockchain solution allows users to rate other users after the project funding is completed and all associated transactions are closed.
	Define and enforce platform rules	Platform rules are enforced by associated third parties (e.g. banks) that control the identity mechanisms (Berger and Gleisner 2009). As traditional organizations, they are also able to take legal actions.	Platform rules are incorporated in smart contracts and are autonomously enforced without a third party. Since pseudonymity is a principle of the blockchain, an Ethereum account is not specifically linked to a person or their bank account. Thus, legal actions are not yet possible owing to the uncertain legal status (Wright and Filippi 2015).

	Crowd due diligence	Platform users can add comments to active fundraising auctions, but no automated actions are triggered based on the comments.	To allow comments to active fundraising auctions, a function was implemented in the smart contract. So far, no automated actions are triggered based on the comments. However, smart contracts could simply include a function that releases all funds and closes the auction if several comments raise doubts about a project.
	Provision point mechanism	In the non-blockchain solution, the beneficiary is only paid via a centralized bank transaction when the minimum funding goal is reached (Agrawal et al. 2014).	The provision point mechanism is implemented in the smart contract and executed autonomously on every node of the Ethereum network once the minimum funding goal has been reached (Glaser 2017).
Use case	*Provide reporting functions*	In the current solution, the reporting is based on a manual process that includes reconciliation with the involved bank.	All transaction data are stored in the blockchain and can easily be queried even by third party auditors (Christidis and Devetsikiotis 2016; Zheng et al. 2016).
	Transaction time	In the current solution, the transaction time depends on the partner bank's processing. Due to interbank clearing processes, the average bank processing time differs from hours to a few days.	The transaction processing of the blockchain solution takes only seconds (Beck et al. 2016; Bott and Milkau 2016).
	Data persistency	The transaction data is stored in trusted bank systems.	All data are stored immutably and are decentralized in the blockchain without the need of trust in a third party (Christidis and Devetsikiotis 2016; Zheng et al. 2016).
	Transaction volume	Banking systems can handle more than 4,000 transactions per second (Beck et al. 2016).	Recent blockchains can process seven transactions per second (Beck et al. 2016).
	Trust and personal identification	Trust is established via a solvency and personal identification check of each involved student and investor.	In the blockchain solution, no solvency check and personal identification are conducted. Further, the pseudonymity of Ethereum participants even allows for anonymous investments (Brito and Castillo 2013; Gunten and Mainelli 2014).
	Reduce manual activities	The non-blockchain solution requires many of manual activities, such as triggering payments. However, this is not particularly caused by the underlying technology as, with some effort, improvements could be achieved without blockchain (Davenport 1993; Hammer and Champy 2003).	Although it is not the purpose of blockchain to automate processes, our new solution has simplified certain activities. This is specifically based on the autonomous execution of smart contracts (e.g. transfer of funds once the minimum funding goal has been reached) (Glaser 2017).
	Reliable and trustworthy transaction processing	The current solution relies heavily on trust in the partner bank that is responsible for the transaction processing.	In the blockchain solution, all transactions are independently processed and validated by every network node (Glaser 2017). Thus, instead of trust in a specific party, the blockchain solution only requires trust in the network protocol, which is readable and open to everyone (Zyskind et al. 2015).
	Stable credit currency	Loans in the non-blockchain solution are given in euro. The euro's stability is governed by the European Central Bank and its fiscal policy. Thus, in case of crises, the central authority can take countermeasures in order to ensure currency stability.	Cryptocurrencies such as ether are very volatile (Morabito 2016) and are not governed by a central authority (Zyskind et al.). Thus, only market mechanisms determine their currency value, and no countermeasures can be taken.

	Avoid complex interfaces	In the status quo, the integration of the partner bank requires a complex IT system integration. Thus, the interface causes initial investments and ongoing maintenance costs. Further, interfaces between IT systems are potential security risks.	Blockchain systems are generally considered to operate as closed trust-free ecosystems (Beck et al. 2016). Nonetheless, owing to ether's relatively low point of sale acceptance, our blockchain solution requires the exchange of a fiat currency into ether, and vice versa. Thus, exchanges acting as intermediaries are necessary on the ecosystem edges (Böhme et al. 2015).

Table 3. Criteria-based Comparison between the Non-blockchain Solution and the Blockchain Solution

As Table 3 shows, evaluating the non-blockchain and the blockchain solutions also implies that we compare a centralized to a decentralized system. While in the non-blockchain solution, the intermediary is a key part, the blockchain solution does not rely on any central authority or institution. This fundamental difference allows us to observe and derive several interesting findings.

First, the decentralized structure of blockchains enabled us to store all relevant data via smart contracts on the blockchain network's nodes (Christidis and Devetsikiotis 2016) and therefore allowed us to eliminate the need for a centralized IT infrastructure and data storage and to avoid the single point of failure problem (Bahga and Madisetti 2016). Second, no trusted intermediary was needed to provide the infrastructure for the account management and funds transfer (Bahga and Madisetti 2016), which made transactions with a bank obsolete. A basis for this is the consensus mechanism of blockchains. Third, the absence of a need for a trusted intermediary renders complex interfaces to integrate partners obsolete. Fourth, the effort for reporting and creating statistics is considerably reduced by the blockchain solution owing to the fact that all relevant data are stored in the blockchain and no manual requests for data (e.g. to retrieve payment data from the bank) need to be issued. This is enabled through the transparency and verifiability of network activities, which increase blockchains' auditability (Zheng et al. 2016). Fifth, the cost structure transparency from the investor and student perspectives increase through the real-time calculation, visualization, and traceability of transaction costs of the blockchain solution (Christidis and Devetsikiotis 2016). Sixth, the prototype significantly reduced the transaction processing time, from days or hours to seconds, owing to the blockchain-internal consensus mechanism, which operates faster than interbank clearing procedures. Seventh, the blockchain solution also manifested downsides in terms of scalability, since the non-blockchain solution is able to process 500 times more transactions per second. Although the examined social business aims for scalability, the limiting factor is assumed to be very unproblematic, as the amount of transactions is expected to be well below seven per second. Further, novel blockchain approaches with higher transaction volumes have been proposed and are in development (Croman et al. 2016). Overall, the findings allow us to conclude that the blockchain solution is beneficial in providing a crowdlending solution for the examined social business. Further, these findings allow us to derive implications for both research and practice, as follows.

The characteristics of blockchain technology allow one to efficiently replace intermediaries in crowdlending platform settings, and enable social businesses to operate successfully.

The blockchain technology is able to serve as the basic technology for social businesses and, as our research shows, blockchain enables and propels social business models that are not sustainable with traditional technological approaches. In particular, it replaces intermediaries and therefore offers lower transaction costs while maintaining shorter transaction times; it also substitutes specific interfaces and provides decentralized transaction storage. We provide detailed evidence for this through the evaluation of our blockchain-based crowdlending platform.

Thus, we contribute to research by helping to better understand blockchain's applicability in social businesses and crowdlending, as well as provide a basis for further research – possibly also in other fields of business or niche markets that cannot be served adequately with traditional technology. Although some of the evaluated criteria are also relevant to for-profit organizations, we encourage researchers to evaluate such cases. Most for-profit organizations have very specific requirements concerning data storage, IT security, or integration in an existing IT infrastructure. Thus, our findings can serve as an indication and starting point for for-profit organizations, but cannot be directly transferred. Overall, our research shows practitioners that blockchain technology must be considered as a valid alternative to other technologies.

Yet, the blockchain technology reveals unresolved issues that may hinder a mass market entry, such as the demand for a closed application ecosystem or legal requirements to leverage potential benefits.

Besides the positive impacts of blockchain, our research also indicates that not all deficits are solved, nor are all requirements best met by blockchain technology. Our research reveals that a many functions can be transferred to autonomously executable smart contracts. However, there remain uncertainties in various areas. First, we realized that it seems very difficult to integrate all business requirements into a closed blockchain ecosystem. Although the advantages of blockchain-based solutions are mainly driven by closed system designs (Glaser 2017), interactions with other IT systems and trusted interfaces appear essential and inevitable. A specific problem encountered during our platform development is the exchange of fiat money to ether. As Böhme et al. (2015) note, this problem requires the inclusion of further intermediaries. Second, the exchange rate between ether and cryptocurrencies generally indicate a volatile history (Katsiampa 2017; Morabito 2016). As long as cryptocurrencies are not widely accepted for external transactions such as payments of real-world goods or assets, the volatility may strongly impact on the value of the transferred funds and payback amounts. For the examined case, potential solutions to the volatility risk could be to store the exact exchange rate or the credit amount as fiat currency at the point of funding in the smart contract. This would allow one to couple the credit to fiat currencies such as the dollar or the euro. Third, legal questions remain. For instance, the legal status of smart contracts remains unclear (Christidis and Devetsikiotis 2016). Fourth, we experienced challenges relating to blockchain software development generally. Although first approaches allow one to a link business process modeling and smart contracts (Sheng et al. 2016; Weber et al. 2016), to date, no modeling techniques sufficiently consider the blockchain environment's characteristics, such as the passive nature of smart contracts (Luu et al. 2016; Zhang et al. 2016), data redundancy, the sequential transaction storage, side chains, and the consensus algorithms. Further, when deploying a smart contract to the blockchain, its execution is strictly bound to the programmed source code. Thus, changes that have not been foreseen and considered during programming cannot be handled (Christidis and Devetsikiotis 2016). In case a smart contract is incomplete and misses crucial functionalities after deployment, owing to the immutability of blockchains, it cannot easily be altered. This is not relevant from a business and a technical perspective, and is crucial from a legal perspective (Scott and Triantis 2005). To our best knowledge, we lack comprehensive test techniques that ensure smart contract quality.

Through these findings, we recognize a need for further research into the integration of blockchain and non-blockchain systems, the legal classification of smart contracts, blockchain modeling techniques (Porru et al. 2017), and suitable software development, operation, test and maintenance frameworks that cover the specific traits of blockchain applications (Delmolino et al. 2016). Also, researchers should address if and how non-blockchain systems can be transferred into closed blockchain systems. For practitioners, our research highlights that intermediaries cannot always be fully eliminated and must be considered as part of the ecosystem. Further, we illustrate how smart contracts can be designed and implemented. In addition, our results raise awareness of practitioners that the development, operation, and maintenance of blockchain applications differs from current processes and requires blockchain-tailored approaches. We also identified that the risk of volatile exchange rates of underlying cryptocurrencies and legal uncertainties regarding smart contracts must be considered.

Conclusion

We have investigated the implications of blockchain technology with a specific focus on social businesses. To date, researchers and practitioners have been lagging behind delivering insights on the identification, implementation, and evaluation of suitable blockchain applications, since they have primarily focused on technical knowledge (Lindman et al. 2017). Although social businesses are discussed as potential beneficiaries of the blockchain technology, we lack evidence about advantages and disadvantages (Brett 2016). We addressed this research gap by applying the design science research approach of Peffers et al. (2007) to develop and evaluate a blockchain crowdlending platform of social business. The criteria-based evaluation builds on related literature as well as the specific requirements of the examined social business case. This evaluation, paired with a comparison of the blockchain solution and the existing non-blockchain solution, allowed us to draw generalizable knowledge and implications for research and practice. Following this approach, our results are based on conceptual thinking and sound arguments, as well as evaluated in a real social business case (Gregor and Hevner 2013).

Before stating our recommendations and the paper's contributions, we acknowledge some limitations. Although our crowdlending platform is key to the examined social business and the solution objectives based on the literature are defined at a generalizable level, they may still fit best to the examined case. Thus, the evaluation of other social business' blockchain applications may require an adaptation of certain criteria. In addition, although Ethereum is regarded as a blockchain pioneer, the technology is still in its infancy and may reveal bugs that may limit our study's reliability. Further, this paper has a strong focus on the technical solution of a blockchain-based crowdlending platform and allows for judgment from an IT system and a business perspective. However, since the acceptance of an IT system is based on more than these specifications, future studies should include additional perspectives, such as research on user adoption (Venkatesh and Davis 2000) and legal aspects (Wright and Filippi 2015) of blockchain solutions.

By answering the derived research question, our design science research makes three theoretical contributions. First, we have established specific solution objectives of social businesses and have delivered insights about how blockchain fulfils these specifications to enable social businesses. Further, we have expanded the blockchain research literature, since we compared a blockchain and a non-blockchain solution in social businesses for the first time. Second, our examination affirms the theoretical research of several authors who have been analyzing the advantages and disadvantages of smart contracts (Christidis and Devetsikiotis 2016; Luu et al. 2016; Wright and Filippi 2015). Third, our paper lays the foundation for further research in the area of blockchain, blockchain applications, and their integration into social businesses. We achieved this objective by addressing specific characteristics of blockchain applications to improve the understanding of the blockchain technology and by highlighting promising avenues for future research.

Besides its theoretical contributions, our platform and the insights from our development process provide practitioners with valuable insights. First, our platform illustrates what generalized advantages and disadvantages are associated with a blockchain-based crowdlending platform of a social business. Thus, our results can be used as a blueprint for other social businesses. The modularization of blockchain-based social businesses could be a future research direction, potentially comparable to Haas et al. (2015). Second, our research provides insights on determining design factors of smart contracts and how they differ from recent software artifacts. Third, our evaluation helps practitioners to include advantages and disadvantages of blockchain-based solutions in their decision-making processes.

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