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Blockchain Won't Kill the Banks: Why Disintermediation Doesn't Work in International Trade Finance

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Abstract:

In the financial services industry, many people assume blockchain to have significant impacts. From research and practice, we observe two main paradigms of how organizations interact with blockchain. First, organizations use blockchain to optimize existing processes (blockchain-based business process optimization (BPO)). Second, organizations use blockchain to disrupt existing processes, foster disintermediation, and enable disruptive business models (blockchain-based business process disruption (BPD)). However, we lack scientific research that evaluates its de facto potential. We bridge this gap by following a design science research approach to design blockchain-based business process re-engineering (BPRE) for a letter of credit that combines the advantages of BPO and BPD. We conduct three design cycles and develop three artefacts: a BPO, a BPD, and a BPRE approach. Our BPRE approach combines the advantages of partial disintermediation (i.e., increased efficiency and transparency) with the advantages of intermediaries (i.e., process flexibility, liquidity provision, and dispute mediation).

Keywords: Blockchain, Business Process Management, Disintermediation, Letter of Credit, International Trade Finance, Smart Contract.

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1 Introduction

Digitalization forces organizations to constantly observe and evaluate emerging technologies regarding their potentials to disrupt and reshape current industries (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013). Blockchain technology has emerged as an emerging technology that many regard as a significant technological innovation (Ghosh, 2019). Originally, blockchain's creator invented it to enable the cryptocurrency Bitcoin (Nakamoto, 2008). Several experts from both practice and academia attribute ground-breaking impacts on society and organizations to blockchain (Beck & Müller-Bloch, 2017; Niederman, Clarke, Applegate, King, & Beck, 2017; Rossi, Mueller-Bloch, Thatcher, & Beck, 2019; Schweizer, Schlatt, Urbach, & Fridgen, 2017). The dynamic development of the technology and the introduction of smart contracts (Wright & de Filippi, 2015), which allow blockchains to embed and autonomously execute program logic (Szabo, 1997; Wright & de Filippi, 2015), led to various applications that went well beyond the first implementations (Beck, Stenum Czepluch, Lollike, & Malone, 2016). Researchers have discussed initial blockchain-based prototypes in crowdfunding (Schweizer et al., 2017), such as initial coin offerings (Fridgen, Regner, Schweizer, & Urbach, 2018b), fraud-resistant supply chain applications (Korpela, Hallikas, & Dahlberg, 2017; Nærland, Müller-Bloch, Beck, & Palmund, 2017), Internet of things (IoT) security and privacy (Dorri, Kanhere, Jurdak, & Gauravaram, 2017; Lockl, Schlatt, Schweizer, Urbach, & Harth, 2020; Smith & Dhillon, 2017), and several use cases in the public sector (Rieger, Guggenmos, Lockl, Fridgen, & Urbach, 2019) and in the energy sector (Munsing, Mather, & Moura, 2017) as valid blockchain applications. Some approaches go even further and try completely to avoid intermediaries or build entire organizations on a blockchain—so-called decentralized autonomous organizations (DAOs).

In particular, the scientific literature assumes that blockchain will reshape the financial services (Fanning & Centers, 2016; Glaser, 2017; Guo & Liang, 2016; Hughes et al., 2019; Walsh et al., 2016; Zachariadis, Hileman, & Scott, 2019). Thus, institutions have either concerns about or see high potential in blockchain-based use cases and regard blockchain technology as a valid alternative to existing information technology (IT) infrastructures (Fanning & Centers, 2016; Glaser & Bezzenberger, 2015; Rieger et al., 2019; Schweizer et al., 2017; Walsh et al., 2016). However, despite high expectations and the attributed potentials, researchers have conducted little scientific research into blockchain technology and its practical applicability and potential consequences (Atzori, 2015; Beck et al., 2016; Schweizer et al., 2017). Research projects have focused on specific technology details (Becker et al., 2013; Decker & Wattenhofer, 2013), cryptocurrencies (Böhme, Christin, Edelman, & Moore, 2015), and law (Wright & de Filippi, 2015). Glaser (2017) and Lindman, Tuunainen, and Rossi (2017) called for design science research (DSR) to establish a common blockchain knowledge base in information systems (IS) research and to identify and validate potential blockchain ecosystems and application scenarios—a recent issue for practitioners and researchers. Rossi et al. (2019) outline that we require broader research that goes beyond application scenarios of blockchain technology. Researchers from the business process management domain have only recently started to look into the implications that blockchain may have for business processes (López-Pintado, García-Bañuelos, Dumas, & Weber, 2017; Rimba et al., 2017). In particular, they have identified various promising avenues for further research and call for work that analyzes use cases in depth (Mendling et al., 2018).

From the diverse use cases for blockchain in the financial services sector, international trade finance seems particularly promising. For instance, blockchain could significantly benefit the letter of credit (LoC), a bulky and slow major payment instrument (Fridgen, Radszuwill, Urbach, & Utz, 2018a). LoC usually involves an importer, an exporter, and two banks. Several industry initiatives seek to develop improved blockchain-based solutions for trade finance generally and LoCs in particular. For instance, we.trade (Suberg, 2018) and Marco Polo (Thompson, 2020)—two consortia of several major banks—have begun working on trade finance platforms based on blockchain technology. However, we lack comprehensive analyses that evaluate blockchain's potential for a letter of credit. Thus, we pose the following research question:

> **RQ:** Can blockchain technology provide an alternative compared to centralized approaches for a letter of credit?

To answer this research question, we followed a DSR approach (Hevner, March, Park, & Ram, 2004; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007) with three design cycles. We developed three artefacts in international trade finance and derived a blockchain-based re-engineered process (BPRE) for LoCs as our final artefact. In the first and second design cycles, we implemented two blockchain prototypes. We developed the first prototype, which we call blockchain-based business process optimization (BPR), to incrementally optimize existing processes. We developed the second prototype, which we call blockchain-based business process disruption (BPD), to radically disintermediate existing processes. In our research process, we recognized that a "solution in the middle" seems most practically applicable. Thus, based on our evaluation in and the first and second design cycles, we proposed and evaluated a third artefact, the BPRE approach, that combined the strengths of both the BPO and BPD approaches.

We make three main contributions. First, we analyze whether blockchain can enable novel and disintermediating business process management solutions for financial services. Accordingly, we gain theoretical knowledge about blockchain technology's uses and benefits and, thereby, enrich blockchain, business process management, and financial services research. Second, we derive generalizable implications for research and practice with a focus on disintermediation by conducting a design evaluation-based analysis. Third, we derive conclusions for practitioners that describe third parties' (e.g., banks) future roles in blockchain ecosystems.

2 Theoretical Background

2.1 Blockchain technology

Blockchain is a decentralized data structure that allows one to store transactions transparently, chronologically (Porru, Pinna, Marchesi, & Tonelli, 2017), and in a tamperproof way (Beck & Müller-Bloch, 2017; Carvalho, 2020) in a distributed network. With these properties, blockchain technology allows for disintermediation by providing trust in a decentralized system (Baskerville & Pries-Heje, 2010; Beck et al., 2016; Nakamoto, 2008; Schweizer et al., 2017) and, thus, enables trust-free ecosystems (Pedersen, Risius, & Beck, 2019). Companies must become aware of blockchain's properties since decentralization may enable new business models or disrupt existing ones (Fanning & Centers, 2016); however, that may take even decades (Hughes et al., 2019). Further, many attribute huge potential to blockchain as an enabling technology by using smart contracts (Lauslahti, Mattila, & Seppälä, 2016). One can describe smart contracts source code that is stored and executed on certain blockchain types (Porru et al., 2017), such as Ethereum. By using smart contracts, one can incorporate exogenous effects or to check exogenous conditions. However, despite their name smart contracts, face large regulatory uncertainty (Gilcrest & Carvalho, 2018), and one cannot consider them legal contracts.

2.2 The Process of a Letter of Credit

An LoC is a payment instrument in international trade. Banks offer it to their customers (i.e., companies actively conducting international trade). An LoC secures payment when certain conditions (certain documents submitted correctly) have been met. Grassi (1995) explains the entire LoC process in more detail; however, we depict a simplified but typical LoC process in Figure 1. The LoC process generally involves four parties: an importer (applicant), an exporter (beneficiary), and two banks (advising bank and issuing bank). The procedure for an LoC is supposed to avoid fraud and ensure payment. However, in the way an LoC works today, the process is bulky and requires high manual effort, which makes it slow (Fridgen et al., 2018a). The process runs as follows: the exporter and the importer conclude a contract on a specific good (1). The importer applies for an LoC at their bank (issuing bank) (2) before the LoC is concluded between the issuing and advising bank (3). The advising bank then contacts the exporter and advises the LoC (4). Next, the exporter sends the trading goods (e.g., by courier service and ship) to the importer and submits all documents to the advising bank (5). The LoC specifies the necessary documents beforehand. In an LoC, the so-called bill of lading represents an important and most popular document (Grassi, 1995). This document states that the carrier has taken over the goods (Grassi, 1995). The advising bank then checks the documents and forwards them to the issuing bank if they meet the predefined criteria. The issuing bank performs this procedure analogously. In case both banks consider the documents to be submitted correctly, the issuing bank triggers the payment of the trading goods (6). The importer can then collect the trading goods (e.g., from the harbor) and provide the necessary shipping documents such as a bill of lading. In its current version, the process works by sending and manually processing a pile of paper-based documents from one process participant to the other. Thus, participants must literally send paper-based documents in multiple versions around the world (Fridgen et al., 2018a). This process usually needs several days to complete (sometimes even longer than the shipping). In such cases, participants need to use case-specific workarounds (Korpela et al., 2017).

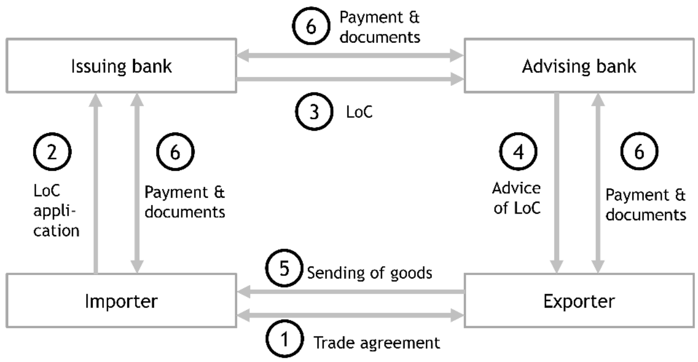

Figure 1. Schematic View for the Process of a Letter of Credit

2.3 Novel Blockchain-enabled Avenues for the Letter of Credit

An LoC still builds on a process that relies on trusted third parties: the two intermediary banks. One can assume a trusted third party to act as an escrow agent without misbehaving or colluding with one of the participants (Ray & Ray, 2002). An escrow agent generally receives an item from each participant (e.g., importer and exporter) and performs an exchange (Ray & Ray, 2002). For instance, Goldfeder, Bonneau, Gennaro, and Narayanan (2017) described how such an escrow smart contract may work using Bitcoin's multisig feature. Recently, financial technology startups such as LC Lite (see ttps://lclite.com/) have emerged in international trade that seek to develop solutions without an intermediary service. Further, different bank consortia such as we.trade (Suberg, 2018) and Marco Polo (Thompson, 2020) have begun working on blockchain solutions for international trade financing.

We observe two main paradigms for how organizations interact with blockchain: 1) blockchain serving as technology for (incumbent) organizations and to optimize existing processes (Guo & Liang, 2016) and 2) using blockchain as an approach to disrupt existing processes and intermediaries, foster disintermediation, and enable novel and disruptive business models (Beck & Müller-Bloch, 2017; Glaser, 2017; Gupta, 2017; Schweizer et al., 2017). Although organizations have begun working on blockchain solutions for international trade and emerging financial technology startups have entered the market and promise to achieve significant improvements compared to existing intermediary-based solutions, we lack scientific research evaluating the potentials (Glaser, 2017; Lindman et al., 2017; Yli-Huumo, Ko, Choi, Park, & Smolander, 2016). We seek to cover this recent phenomenon and to evaluate how blockchain technology may enable LoCs without or with fewer intermediaries.

3 Research Method

We followed the DSR approach (Gregor & Hevner, 2013; March & Smith, 1995; Nunamaker, Chen, & Purdin, 1990; Peffers et al., 2007; Walls, Widmeyer, & El Sawy, 1992), an established research paradigm in IS research (Gregor, 2006; Wagner, Prester, & Schryen, 2017) that allows one to solve organizational problems by developing artefacts that serve a meaningful human purpose (Hevner et al., 2004). A build-and-evaluate process that results in IT artefacts such as constructs, models, methods, and instantiations guides a typical DSR process (March & Smith, 1995). In particular, DSR allows one to derive generalizable knowledge that applies to a general problems class (Baskerville & Pries-Heje, 2010; March & Smith, 1995). Thus, a DSR project must 1) demonstrate a solution artefact's technical feasibility, 2) address an important problem by building an innovative artefact, and 3) significantly increase knowledge about a general problems class (Niederman & March, 2012). We built on the well-recognized and widely accepted DSR method that Peffers et al. (2007) proposed and conducted three design cycles. We depict our research process in Figure 2.

In the first design cycle, in a joint effort with a German bank, we developed a BPO prototype to improve the specific cross-organizational document workflow associated with LoCs (Fridgen et al., 2018a). We evaluated our BPO prototype using predefined design objectives and conducting semi-structured interviews with industry experts. In this preliminary stage, we still included all four process participants (one importer, one exporter, and two banks). Since we focused on understanding the business processes in detail, combining them with blockchain technology, and achieving incremental improvements (i.e., improved workflows between different organizations), we did not focus on eliminating the intermediary banks from this workflow (Fridgen et al., 2018a). Thus, the process still ran as in Figure 1.

In the second design cycle, we followed a disintermediated approach and developed the BPD prototype. We adjusted the practice-inspired design objectives from the first prototype (Fridgen et al., 2018a) to serve the more disruptive approach's goal. We defined nine design evaluation criteria (DEC), which we used for evaluation in this cycle. We also used workshop discussions with industry experts from five German regional state banks to gain further feedback. We iteratively developed and tested both prototypes, which we implemented on a private Ethereum blockchain instantiation. We chose the Ethereum protocol as prototype infrastructure since it allows one to build self-administered private blockchain networks and many regarded it as the most advanced platform for smart contracts at the time we conducted our development efforts (Atzei, Bartoletti, & Cimoli, 2017; Koblitz & Menezes, 2016). We instantiated the demonstration phase by conducting end-to-end tests of the solution's intended functionalities.

In the third design cycle, we conceptualized the BPRE approach. We grounded this re-engineered solution in the insights that we gained from the first and second cycles and represents the idea of business process re-engineering (Hammer & Champy, 2009), which challenges existing processes via integrating significant changes. We refrained from a prototypically implementing this approach since we expected no additional insights from the implementation. We evaluated the BPRE approach using our DEC and then compared and evaluated the BPO, BPD, and BPRE approaches in semi-structured interviews with industry experts. To do so, we integrated the empirical observations and expert interviews with a conceptual perspective and arguments derived from the literature (Gregor & Hevner 2013).

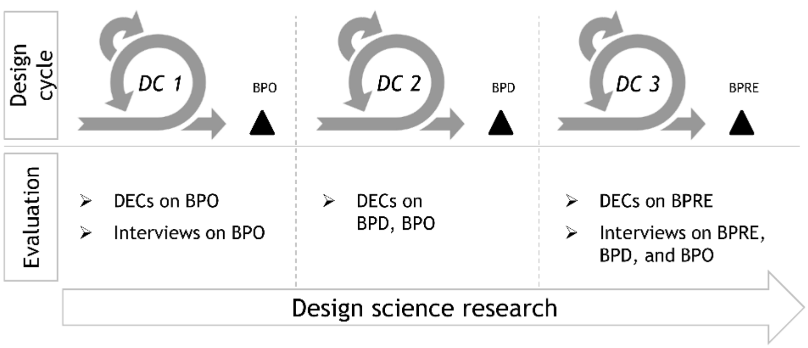

Figure 2. Design Science Research Approach with Three Design Cycles

We followed a convenience sampling approach and interviewed experts in international trade finance and blockchain who were already familiar with both topics through projects and workshops. We conducted 11 semi-structured interviews (Myers & Newman, 2007) with experts from five German regional state banks. We conducted the first four interviews in the first design cycle (Fridgen et al., 2018a). The interviews took place from May to June, 2017, and each lasted 30 to 45 minutes. In the third design cycle, we conducted the fifth to eleventh interviews and discussed all three approaches. These interviews took place in April and May, 2018, and each lasted 45 to 60 minutes. Because we used a semi-structured approach with designed questions and interview guidelines, we could ensure comparability and foster our research's explorative nature. We list the interviewees' role, company size, and work experience in Table 1. All the interviewees had in-depth experience in international trade finance or innovation management; they were already familiar with potential scenarios in which one could apply blockchain technology in international trade finance. We briefly introduced our research before focusing on specific aspects of our three approaches. In the interviews, we focused on questions such as:

- Do you regard a fully automated process, as in the BPD case, as realistic for LoCs in the future?
- Which milestones must be achieved before a BPD solution can work in practice?
- From your perspective, what major challenges must be overcome before the use of blockchain technology can provide significant benefits?
- When thinking about BPO and BPD solutions' advantages and disadvantages, does a BPRE seem more realistic to you?

We recorded the interviews, analyzed them, and summed up the central statements according to scientific standards (Dexter, 2006). We outline the research process, the evaluation results, and research and practical implications in the following sections and communicate them throughout this paper.

Table 1. Details on the Semi-structured Expert Interviews

#	Interviewee's role	Company size (employees)	Work experience in the financial services industry
1	Director in the strategy department	> 6,000	> 10 years in the financial services industry, with a focus on strategy development
2	Software architect, IT innovation manager	> 6,000	> 25 years in software development and innovation management
3	Head of department, international payment transactions	> 6,000	> 20 years in international payment transactions
4	Group leader and expert in payment obligations	> 6,000	> 25 years in international trade finance
5	Head of department, international trade finance	> 2,000	> 25 years in international trade finance
6	Expert in international trade finance	> 2,000	> 20 years in international trade finance
7	Group leader in a German banking association	N/A	> 15 years consulting in the financial services industry with a focus on cyber-security
8	Expert in international trade finance	> 6,000	> 30 years in international trade finance
9	Group leader, innovation management	> 7,000	> 5 years in innovation management in the financial services industry
10	Expert in international trade finance	> 7,000	> 5 years in international trade finance
11	Inter-bank collaboration manager	> 7,000	> 10 years in financial services industry, with a focus on regional business clients

4 Problem Identification and Design Evaluation Criteria

An LoC process involves at least four parties and is slow and bulky, which provides room for improvement via blockchain (Fridgen et al., 2018a). In the first design cycle, we found that using blockchain for LoCs can increase the process efficiency through digitizing documents and automating the document-checking process by using smart contracts that handle pre-defined conditions in LoCs. For example, often the shipping date must lie before a certain day that can be automatically checked by using smart contracts. We already published the results from the first design cycle in more detail in Fridgen et al. (2018a). In the first design cycle, we used design objectives with a focus on process optimization (Fridgen et al., 2018a). In the second and third design cycles, which we focus on in this paper, we focused on disintermediation's potential in the LoC process. Thus, we defined design evaluation criteria based on the design objectives and what we learned from the first cycle and the financial services, blockchain, and business process management literatures. First, the financial services literature suggested including specific evaluation requirements for the LoC, such as the capital tie-up period (Bradley, Jordan, Yi, & Roten, 2001; Lazaridis & Tryfonidis, 2006). Second, since we evaluated scenarios for disintermediation (BPD and BPRE) in our research, we included dependency on intermediary services, reliable and secure transaction processing, and trust and identification mechanisms as evaluation criteria from the blockchain research (Schweizer et al., 2017). Third, to account for the business process perspective, we defined process time, process flexibility, process costs, and process transparency and tracking. We summarize and describe our DECs in Table 2. We do not include research on the legal requirements for smart contracts that needs to be the basis for many blockchain applications in the future. Other researchers such as Gilcrest and Carvalho (2018) have partly discussed this topic, but legal professionals should address it in future research.

Table 2. Design Evaluation Criteria

Design evaluation criterion	Description
DEC_1: Process time	In the digital age, real-time processes and rapid decision making are key factors in providing a competitive advantage. Further, long process times may increase costs and the capital tie-up period.
DEC_2: Process flexibility	Non-standardized business relationships often use LoCs. Thus, flexibility is a key evaluation criterion of LoC solutions.
DEC_3: Process transparency and tracking	To ensure transparency, traceability, and archiving requirements, LoC solutions need to store data persistently and immutably.
DEC_4: Process costs	Since organizations seek to recover costs, how much an LoC process costs for each process participant represents a valid evaluation criterion.
DEC_5: Reliable and secure transaction processing	Prevent malicious changes to LoC-related data requires reliable and secure transaction process (George & Haritsa, 1997). LoCs require such processing since untrusted organizations often use them for valuable high-volume trades
DEC_6: Trust and identification mechanism	LoC solutions require mechanisms to establish trust in the offered service and identification instruments to control the accessing participants. Nevertheless, they should not be a barrier to entry for organizations using LoCs.
DEC_7: Dependency on intermediary services	In the financial service industry, intermediaries provide various services such as lot size, maturity, and risk transformation (Gambacorta & Mistrulli, 2004). However, their integration may imply consequences such as additional IT system interfaces, increased costs, or contradicting business strategies (Schweizer et al., 2017).
DEC_8: Capital tie up period	We define the capital tie-up period as the time in which capital is frozen and an illiquid asset. For an LoC, this period is important from an importer's perspective. For instance, once trading partners conclude an LoC, capital will likely be frozen at some point to allow for payment once they meet the LoC's conditions. Thus, the capital tie-up period will likely directly influence the importer's cash conversion cycle, one of the most important ways to measure an organization's liquidity and its overall health (Nobanee & Al Hajjar, 2014; Richards & Laughlin, 1980).

5 Design and Develop

In this section, we describe our three approaches (BPO, BPD and BPRE) before outlining our evaluation steps in detail in Section 6. While we present our research in this order to allow readers to fully understand our design artefacts, it does not reflect the chronological order in which we conducted our research (i.e., design cycle by design cycle). We only briefly outline our BPO approach in this paper since we provide a comprehensive explanation in Fridgen et al. (2018a).

5.1 Blockchain-based BPO Approach

In our first cycle, we developed our BPO prototype together with a German bank. For a detailed overview and the entire analysis, please refer to Fridgen et al. (2018a). We briefly summarize the major findings here. We targeted process optimization in our BPO implementation. Therefore, the process runs as Figure 1 depicts (i.e., we did not alter the standard workflow for LoCs). We found that BPO for LoCs increases the process efficiency through digitizing documents and through automating the document-checking process. Further, our BPO prototype allows all LoC participants to access processes' status in real time and to check documents from both banks in parallel. As such, it could greatly shorten how long the LoC workflow took overall. Further, the prototype ensured the entire process history remained immutable across organizational boundaries. However, the BPO prototype remained based on both banks' intermediary services.

5.2 Blockchain-based BPD Approach

With our BPD prototype, we wanted to offer an LoC without an intermediary bank. In our prototype, the smart contract on the blockchain takes over the role that the intermediary banks play in traditional LoCs. Thus, the blockchain-enabled process differs significantly from the traditional approach. We depict this novel disintermediated approach in Figure 3.

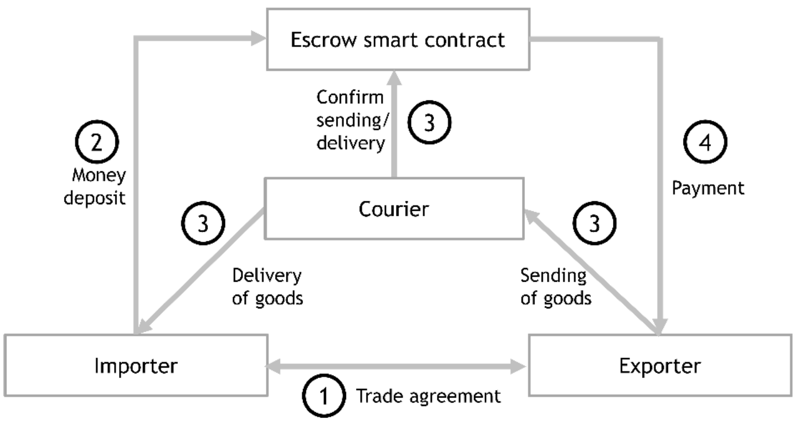

Figure 3. Schematic View of a Payment Process with Escrow Smart Contract (BPD)

To develop our BPD prototype, we implemented the LoC via a smart contract on the Ethereum blockchain. Our application obtained blockchain characteristics such as a decentralized structure, a peer-to-peer network, a consensus protocol, and the ability to autonomously execute smart contracts (Schweizer et al., 2017). For the interaction with the smart contract, we developed a Web front-end using the web3j API. In the current version, we set the price in ether, and the smart contract accepted only payments in ether, the Ethereum cryptocurrency. However, one could address this limitation via creating and using settlement tokens. These settlement tokens represent fiat currencies, collaterals at the central banks back them, and they allow for more efficient processing. Various blockchain initiatives have commonly adopted this approach as prominent examples such as ripple and the utility settlement coin initiative show (Bech & Garratt, 2017).

To initiate the process, the trade partner must agree on a trade before the importer deposits (sends) money to the address of the escrow smart contract. From a technical perspective, we implemented a function that allows the exporter to create an offer and transmit it to the importer. Another function then enables the importer to answer the initial offer and confirm the bilateral trade agreement (1). By accepting the initial offer from the exporter, we transferred the price (in ether) from the importer to the smart contract and locked it (2). After receiving a deposit notification, the exporter sends the trading goods via a courier service. The courier service notifies the escrow smart contract about the sending (3). Since the courier delivers the physical goods off the blockchain, we implemented no related smart contract function. However, in a future scenario, one could modify the smart contract to allow parties to, for example, securely track sensor and GPS data about the delivery process in real time. Once the goods arrive, the importer, the delivering courier, or, in an extended scenario, real-time secure sensor and GPS data confirm that they have received the goods and the exporter gets paid from the smart contract (4). The exporter may still decide to not send the goods; in that case, the money is trapped in the escrow smart contract. Thus, once a time limit runs out and the exporter has taken no action, the money returns to the importer. Further, in such a situation, one could integrate a contractual penalty into the smart contract that the exporter must pay to the importer. Also, only if any disputes arise (e.g., about delays in delivery, damage, or non-delivery) does a third party mediator need to become involved. These processes require additional legal actions: an LoC usually does not include them, and LoCs (even non-blockchain LoC solutions) do not cover them. However, to integrate such cases into a blockchain, one needs to implement certain and complex mechanisms need in a smart contract. Yet, no one has yet established a standard interface for integrating third party mediators developed logic for how one could achieve such mediation. Standardization initiatives have been begun to work on these challenges (Anjum, Sporny, & Sill, 2017). Thus, further research needs to examine how to implement mediation processes on the blockchain. In our prototype development, we did not focus on these exception cases and treated the legal mediation aspect as independent from the blockchain-based service.

5.3 Blockchain-based BPRE Approach

In this section, we show that combining the advantages of BPO and BPD represents a promising direction. We combined the two approaches in the re-engineered BPRE approach that we illustrate Figure 4. We assumed that trade partners conduct any payment using settlement tokens and use private-public key encryption as blockchain solutions commonly adopt. The process started with a trade agreement between importer and exporter (1). In the second step, the importer deposits (sends) a settlement token to the address of the smart contract either by directly sending (2a) or by using the bank's creditor service (2b). In the latter case, the bank provides liquidity for the importer and will likely charge a fee or an interest on credit. In contrast to the international monetary system (McLeay, Radia, & Thomas, 2014), on the blockchain, the bank must deposit the exact amount to an escrow smart contract; thus, multiplication of money is not possible. As for why, banks usually invest the money they receive to earn interest; however, when the money is trapped in an escrow smart contract, they cannot invest it. After having received a deposit, the smart contract sends a deposit confirmation to the exporter, which triggers the exporter to send the goods (3). The smart contract then expects to receive a sending confirmation. To date, the exporter needs to deliver physical documents. As we discussed in our previous paper in which we developed our BPO prototype (Fridgen et al., 2018), we assumed that, for future LoCs, trade partners could conduct all necessary procedures in a fully digitalized and automated way. From this step on, the BPRE works analogously to the BPD case. For this reason, we did not conduct a prototypical implementation for the BPRE approach since we did not expect additional insights from combining the previous prototypes.

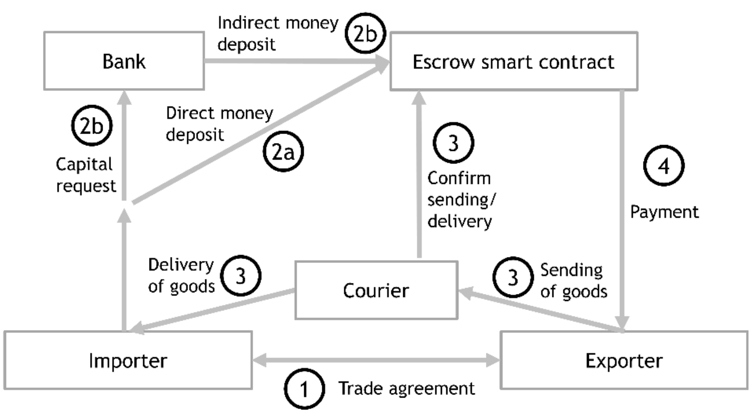

Figure 4. BPRE Process for a Letter of Credit

6 Demonstration and Evaluation of BPO, BPD, and BPRE

To demonstrate our prototypes' functionalities and suitability, we repeatedly conducted end-to-end executions and thorough testing of the core processes. In line with DSR fundamentals (Gregor & Hevner, 2013), in the first design cycle, we evaluated the BPO approach and compared it to the LoC process status quo (Fridgen et al., 2018a); in the second design cycle, we evaluated the disruptive BPD prototype and also compared it to the BPO prototype. Thus, at many points, we compared the process's status quo. Then, we built on the results from both design cycles and conceptualized a BPRE approach whereby we combined benefits of the BPO and the BPD approaches in our third design cycle. We introduced all three artefacts to experts from international trade finance and conducted semi-structured interviews to evaluate our research.

6.1 Interview-based BPO Evaluation

We conducted the first explorative interview round to evaluate the BPO prototype with the first four interviewees (Fridgen, Radszuwill et al., 2018). In short, the interviewees agreed that the BPO solution's decentralized nature and trust achieved via a blockchain solution constituted its main advantages since it facilitated a new way to achieve cross-organizational workflow management and improved process efficiency. However, one can only achieve the improvements in combination with increased process standardization and advancements in other technologies (Fridgen et al., 2018a). Although the BPO prototype showed improvement compared to the status quo, it also turned out that one could improve it in various other aspects. In particular, the interviewees pointed out disintermediation as a valid aspect to consider in the future.

6.2 Criteria-based BPO, BPD, and BPRE Evaluation

We state the results from our DEC-based evaluation and comprehensive clarifications in Table 3. We outline our findings and an interim conclusion for each design evaluation criterion.

Table 3. Comparison of the BPO, BPD and BPRE Case

Design evaluation criterion	Comparison of design evaluation criteria for the BPO, BPD and BPRE case
DEC_1: Process time	**Finding** The BPO prototype significantly improves the process time since it avoids the need for participants to engage in lengthy manual document exchanges, diminished manual auditing, and made parallel document processing possible. Although a smart contract automates certain steps (with a specific focus on the document management), the process handling still requires clerks to manually initiate, proceed through, check, and close the process. In contrast, the BPD case comprises a fully digitalized process that relies on smart contracts. Once participants initiate the process, they need to make no manual actions except for where the courier or a sensor confirms sent/received goods. The BPRE approach also provides a fully digitalized process that avoids manual actions similar to the BPD case. In addition, the option to integrate a bank in the BPRE case may allow for further manual checks that lead to an increased process time. Since it involves only one bank, we assume the process time decreases compared to the BPO case. **Conclusion** [The BPO differs from the BPD case mainly in that, for LoCs, clerks still need manually check documents in the BPO case since it involves complex conditions that an automated process cannot check (e.g., custom regulations for hundreds of countries or authenticity certificates for a vast number of products). In contrast, in the BPD case, we have not yet considered such complex conditions. In the BPRE case, the process time depends on the chosen implementation and whether it optionally includes a bank.
DEC_2: Process flexibility	**Finding** Since our BPO prototype requires standardized processes, it has limited process flexibility. The same effect inherently appears in the BPD and BPRE cases since a smart contract fully standardizes and embeds the process. The prototype allows limited flexibility to deviate from the given standard case, and it depends on the implementation. This limitation comes from smart contracts' immutable and generally uneditable nature (Christidis & Devetsikiotis, 2016). **Conclusion** All solutions impair process flexibility. The BPD case only allows for simple and fully standardized scenarios. The BPO solution can still handle any LoC scenario; however, it features a trade-off between automation level and process flexibility. For the BPRE case, we want to achieve both a flexible solution with a high automation level. Thus, the smart contract needs to be designed and programed with specific functions that change predefined smart contract variables when called to (Schweizer et al., 2017). This approach has downsides. First, one needs to foresee all changes that may occur in the LoC process prior to developing the smart contract (Schweizer et al., 2017). Second, it increases the source code's complexity, which leads to higher transaction costs when executing the smart contract.
DEC_3: Process transparency and tracking	**Finding** All approaches allow participants to track and historicize all process steps with timestamps on the blockchain. In all cases, the entire process fosters transparency for all participants. However, the BPO case still contains the manual checking process, which the process history cannot display in full detail. Some BPRE case configurations that include a bank also have the manual checking process. The BPD case contains no manual effort; thus, the process is fully transparent and provides an end-to-end history without media gaps. The same holds true for the BPRE case unless it includes a bank. **Conclusion** Theoretically, we can regard the BPD and BPRE cases as having transparency than the BPO case since they reduce manual activities.

Table 3. Comparison of the BPO, BPD and BPRE Case

DEC_4: Process costs	**Finding** In the BPO case, participants have no realistic estimation if the overall process costs change for the better or the worse (Fridgen et al., 2018a). However, as increasing blockchain technology continues to develop, costs will most likely decrease. Thus, one can assume the fully automated BPD and BPRE cases to have significantly lower costs than the BPO case, which features mandatory manual activities. Nonetheless, situations in which a mediator becomes necessary may also affect the BPD and BPRE cost structures. **Conclusion** On average, one can presume the BPD and the BPRE cases to have lower costs. However, in case disputes arise, external mediators or lawyers need to get involved, which significantly increases the costs in these cases. In the BPO and the BPRE cases, the bank(s) can handle most mediation. Further, the costs for exchange rates, from cryptocurrency to fiat money and vice versa, currently represent a factor of uncertainty that participants could eliminate using settlement tokens.
DEC_5: Reliable and secure transaction processing	**Finding** We can consider all cases to be reliable and secure. However, they differ significantly in one respect: human interference. In the BPO case, the fact that people have to process documents introduces subjectivity and insecurity, while the BPD case involves no human interference as long as the process proceeds without dispute. Finally, the BPRE case involves no manual human interference similar to the BPD case. Nonetheless, smart contracts must be implemented, and this implementation requires governance (Luu, Chu, Olickel, Saxena, & Hobor, 2016). **Conclusion** All cases provide high security levels. We cannot sufficiently stress the need for governance measures for implementing and auditing smart contracts. Further, participants need to consider the aforementioned trade-off between flexibility and security. The more flexibility the participants need in defining LoCs, the more it will impact security.
DEC_6: Trust and identification mechanism	**Finding** In the BPO case, the two banks provide trust. They ask their customers to undergo an identification process usually termed "know your customer" and conduct credit checks to ensure sufficient solvency and liquidity. In the BPD case, the blockchain technology and the fact that a mediator may back an escrow smart contract when disputes arise. However, although blockchain technology allows for high data integrity, it comes with no built-in identification processes The BPRE case allows for the flexibility to either use the blockchain-based trust and identification mechanism or to combine the smart contract solution with a bank's identification mechanisms. **Conclusion** In the BPO case, trust depends on intermediaries; in the BPD case, trust depends on blockchain technology. In all cases, partners need to establish identification mechanisms, if required and foreseen, through a trusted third party.
DEC_7: Dependency on intermediary services	**Finding** The BPO process strongly depends on the intermediary banks. The BPD case depends on a software provider to provide a platform and implement smart contracts. Although we argue above that the BPO process dispenses with intermediaries, it only does so if the process works without any dispute. Further, in the BPD case, partners can conduct only simple payment processes. The BPD solution cannot yet provide all the benefits in the BPO case. The BPO solution has the advantage that partners can specify many and different conditions concerning the good or the process and—most importantly—that a third party can independently check them. The BPD case allows only predefined checks that partners can implement in a smart contract. The BPRE approach reduces the number of involved third parties and can even work without a third party. However, the BPRE approach allows partners to integrate a bank on an optional basis. **Conclusion** Our comparison reveals that complete disintermediation does not seem feasible for LoCs. In particular, complex situations or processes (such as with an LoC) need intermediation to check processes or resolve disputes between trade partners. Therefore, the BPRE approach allows partners to reduce the number of involved parties and integrate a bank if needed.

Table 3. Comparison of the BPO, BPD and BPRE Case

DEC_8: Capital tie-up period	**Finding** Besides functioning as intermediaries for the document checking, banks function as creditors for importers in the BPO case. Usually, as part of its LoC service, the issuing bank provides liquidity for an importer; that is, an importer has many options for when it needs to pay for goods (when the importer receives the goods, when the importer has been using it for one year, etc.) because the bank bears the credit risk. In a BPD case, the importer must send the money to the smart contract before the exporter will send the goods, which ties up liquidity for at least the shipping time. Also, the importer has no flexibility about when it can pay for goods because any other option than paying beforehand does not work with an escrow smart contract. Further, cryptocurrency payments, which disintermediated solutions such as the BPD case commonly use, add another exchange rate-related risk during the capital tie-up period. Partners could overcome this problem by using a settlement token. In the BPRE approach, a bank can still function as creditor that provides liquidity without freezing the importer's payment. The provision of liquidity allows partners to overcome the disadvantages in a fully disintermediated approach (BPD). The importer must contemplate whether the liquidity provision is worth the interest rate for a bank loan. However, the importer can make the payment using only the escrow smart contract (i.e., the bank does not participate). **Conclusion** The BPD case ties up capital directly from the importer. In contrast, the BPO solution gives the importer more flexibility since the bank can directly provide liquidity. The BPRE approach can provide liquidity through a bank on an optional basis. This scenario moves the cases away from pure disintermediation.

Our analysis reveals that BPO and BPD approaches have advantages and disadvantages compared to each other. We found support for these advantages and disadvantages from the insights we gained in workshops with experts from practice. In the BPO case, banks as intermediaries are a key part of the LoC process and responsible for the entire LoC process. Thus, all design evaluation criteria at least partially relate to the banks and their internal procedures. In contrast, in the BPD case, most criteria directly relate to the underlying blockchain technology. This fundamental difference does not favor the BPD solution in all evaluated aspects. Also, it reveals that conflicts of interest exist between disintermediation and some design evaluation criteria. For instance, the decreased process flexibility and a long capital tie-up period may prevent organizations from using a BPD solution. Further, the BPD approach does not yet offer several payment options and a stable currency or token system that many organizations demand. However, the BPD solution also reveals advantages such as rapid process time, almost no dependency on intermediary services, and (presumably) lower process costs. Our evaluation indicates that both approaches do not perfectly address the LoC process's requirements. Thus, the BPRE approach we propose combines the other two approaches in a way that complements their benefits.

Using the idea of an escrow smart contract allows partners to reduce the number of involved third parties and can even work without a third party (DEC_7). Thus, it positively influences process time and process costs (DEC_1 and DEC_4). Further, the trade partner uses the smart contract like an escrow agent and to check predefined LoC conditions to allow for reliable and secure transaction processing (DEC_5). Moreover, Moreover, the immutable predefined conditions that escrow smart contracts offer can help partners avoid third parties (e.g., lawyers) from becoming involved. As such, escrow smart contracts can improve trust in the process (DEC_6). Combining both BPO and BPD allows one to include a bank on an optional basis, which increases process flexibility (DEC_2). The fact that the escrow smart contract freezes money requires a bank to provide liquidity in many cases because an importer will not likely be able to provide a large amount of liquidity at any time. Thus, a bank functions as a creditor and provides liquidity without having the importer's payment frozen in the smart contract. In this way, we improve the solution in terms of capital tie-up period (DEC_8). The importer must contemplate whether the liquidity provision is worth the interest rate. However, for small amounts of money, parties can conduct the payment using just the escrow smart contract (i.e., the bank does not become involved). A blockchain platform provider for LoCs that provides LoC services and financing on the blockchain could conceivably emerge. Here, banks may have an opportunity to establish an extended business model or to use the technology to more efficiently process LoCs. Further, such a platform would also provide opportunities for smaller banks to outsource their services; thus, it allows for specialization. Overall, the blockchain documents all process steps, which enables high process transparency and tracking (DEC_3).

6.3 Interview-based BPO, BPD, and BPRE Evaluation

In our second interview round, the experts in international trade finance (5, 6, 8, and 10) agreed that the greatest challenges for the international trade finance's future development will be standardization and customer acceptance of new solutions. Interviewees 5 and 6 pointed out high saturation, high acceptance of blockchain infrastructure, and political stability as important for establishing improved processes and new solutions on a global scale. Further, they stated that blockchain needs to become an IT commodity service and that banks need to accept it as trusted infrastructure. This process will be gradual but decisive for encouraging organizations to use blockchain solutions more widely. Otherwise, the technology may only be a niche product. Interviewees 9 and 10 saw the developments in the next five years as decisive for market saturation and for whether blockchain will become established infrastructure. This period will also determine whether the involved parties can and will work together on consortium solutions because blockchain use cases require these cooperation approaches (9). In some areas, LoCs have been the only payment instrument that allowed for international trade at all for many years (5). Currently, in politically unstable regions, LoCs often remain "the only possibility to establish trade with a minimum level of risk mitigation" (5). Also, interviewee 5 stated that, while current processes are still very complex and paper based, new technological solutions may only work in niche areas first. For instance, new solutions will be easier to introduce in highly standardized trade relationships in politically stable regions. In contrast, traditional LoCs may more likely see use in the short run for unstable regions and non-standard products. Interviewees 8 and 9 saw a good chance that a blockchain-based solution will add significant value in the future. They estimated that such a solution may become standard within five to 10 years.

Concerning our BPD prototype, interviewees 5 to 8 believed that such a fully automated solution is feasible in the long term. However, again, it requires a high standardization level. Interviewee 9 emphasized that the BPD solution's feasibility depends on a trade relationship's products and complexity and that it seems feasible for some cases. Interviewee 10 pointed out that importers and exporters with an existing long-term relationship are more likely to use a blockchain-based BPD solution. However, all interviewees agreed that a large-scale BPD solution will not be possible in the short run. The BPD solution suffers from a major disadvantage in that it ties up capital (8). Today, many customers use LoCs not only for risk-mitigation purposes but also as a funding instrument. For importers, LoCs are only "contingent liabilities as long as the goods are not delivered"; thus, they do not affect credit limit (8). Interviewee 8 stated that, particularly for small and medium-sized enterprises, tying up capital can be a real issue because it would significantly decrease their liquidity. An LoC gives the importer the possibility to promise a payment without the need for de facto payment until the exporter delivers the goods, which the BPD solution does not make possible (8). Also, in case disputes arise, it requires an additional third party (8).

The interviewees agreed that a BPRE solution proved the most likely to see use in reality in the near future for three major reasons: 1) it provides more process flexibility, 2) it does not necessarily tie up capital, and 3) it includes a third party that can handle dispute or particularities and hedge risks if needed (10). However, interviewees 8 and 10 noted that a new approach needs to add significant value compared to the existing one. Interviewee 8 pointed out that a BPRE that incorporates one bank resembles the current process in principle. In the current process, "only the issuing bank has a payment obligation" (8). However, the advising bank only "acts as a contract agency" (8). The similarity between a BPRE and the current process also means that it is likely a "positive development for the exporter to exclude their bank" because doing so will ultimately save costs (8). In particular, this approach can help provide organizations with liquidity without having them deposit money into the smart contract (10). Interviewee 7 emphasized that exchanges and large banks are in a good position to play the role of the remaining bank. Other interviewees also stated that a bank must not fulfill this position, although the remaining intermediary should be able to provide capital. However, banks will put much effort into remaining in the central position of this process, and likely they will keep this central position as they can provide risk hedging and knowledge about cross-country risks and regulations (6, 7, 9-11). Interviewees 5 and 6 mentioned that the banks' roles may change and could ultimately result in their only being responsible for transaction processing. All interviewees agreed that, in principle, an LoC requires only one bank.

6.4 Discussion

To address our research question (i.e., whether blockchain technology can provide an alternative to existing centralized approaches), we analyzed the BPO, BPD and BPRE approaches using eight design evaluation criteria. All three approaches provide an improvement regarding DEC_1 (process time), DEC_2 (process flexibility), and DEC_3 (process transparency and tracking) compared to the status quo. However, digitizing the entire process resulted in most of the improvements. However, the tracking and transparency aspect is a property of blockchain solutions that can also have high value in financial services applications in general. One cannot easily estimate the overall costs (DEC_4: process costs) because, among other reasons, very few productive blockchain systems exist. However, organizations need to be able to estimate overall costs to ensure they adopt blockchain solutions in the future. For instance, Rimba et al. (2017) analyzed the monetary cost of blockchain transactions in a business process context and compared the results to a cloud service. As examination objects, they used the public Ethereum blockchain and the Amazon Simple Workflow Service in an incident management process (Rimba et al., 2017). While their results suggest that the process execution on the public Ethereum blockchain is two orders of magnitude higher than on the cloud service, their findings' generalizability comes with strong limitations. First, García-Bañuelos, Ponomarev, Dumas, and Weber (2017) investigated options that allow one to reduce the transaction execution cost on blockchain and reduce costs by up to 25 percent. Second, as blockchain infrastructure becomes more and more an IT commodity, costs associated with implementation and maintenance will likely decrease. Third, organizations do not develop and deploy LoC solutions on public blockchains but rather in private or consortium blockchains. Thus, a ring-fence separates these private blockchain instantiations from the volatility that public cryptocurrencies such as ether experience. Fourth, technical advancements allow one to use energy-efficient and less costly consensus mechanisms in private or consortium settings. For our blockchain-based BPO, BPD, and BPRE approaches, costs will remain an uncertain factor in the near future. However, solutions such as the ones that LC Lite (see ttps://lclite.com/) or Marco Polo (Thompson, 2020) offer will provide evidence in the mid-term if blockchain-based solutions become competitive in this regard. All three approaches feature reliable and secure transaction processing (DEC_5) compared to the status quo. For the BPD and BPRE approaches, future research needs to examine how future governance mechanisms will review and assess smart contracts.

(Dis)intermediation closely binds DEC_6 (trust and identification mechanism), DEC_7 (dependency on intermediary services), and DEC_8 (capital tie-up period). To allow for complete disintermediation, blockchain technology would need to entirely replace the trust-provision and identification services that banks provide—an unrealistic scenario. Indeed, blockchain systems (e.g., cryptocurrency systems) can provide trust to a certain extent. However, for LoCs, we see in the BPD case that the entire process may run smoothly if no dispute in the LoC process occurs. Unfortunately, that case constitutes the only simple and unproblematic one. In case a dispute or even just an unclear situation that the two trade parties cannot resolve arises, a need for intermediation also arises immediately. Put differently, the BPD case may work in an ideal scenario or in (far) future scenarios when disputes have no chance to arise in the real-world process. Any realistic valuation of LoCs in today's economy, however, emphasizes that dispute occurs, if not often, at least on a regularly basis, which explains why we designed our BPRE approach with the possibility for intermediation. Having the optional possibility for intermediation allows one to combine the BPD approach's efficiency with the BPO approach's flexibility.

Our interviewees frequently mentioned the bank's role as liquidity provider. In full disintermediation situations, another provider would need to provide liquidity. Otherwise, one would lose an important property of LoCs. In effect, many companies would likely switch to other funding instruments. Thus, although one could feasibly replace the liquidity provider in theory, we need to ask whether one gains any advantage in replacing banks as liquidity provider in this process. Based on our evaluation, we would answer "no" in most cases. Trading companies can already use any funding available to them when buying goods using LoCs. The natural choice is to use the issuing bank as liquidity provider. The issuing bank combines and simplifies otherwise separate funding and administrating processes. Therefore, our evaluation suggests that LoCs with complete disintermediation are inefficient, inflexible, and, thus, unlikely to be put into practice.

An organization that develops blockchain-based solutions is always necessary for other organizations to use such a solution. Because trade partners are mostly not IT companies, third parties will likely technically develop blockchain-based platforms (for LoCs). For instance, we can see as much in practice with Marco Polo (Thompson, 2020). However, we do not focus on this form of disintermediation by providing a technology platform in this research. We focus on the process perspective. Nonetheless, people discuss implementing technology platforms in many blockchain scenarios. Therefore, we see room and necessity for research on the influence of implementation partners, technology suppliers, and/or service providers in general when it comes to blockchain-based platforms in business process management.

Overall, we answer our research question (i.e., "Can blockchain technology provide an alternative compared to centralized approaches for a letter of credit?") in two parts. First, while blockchain technology offers disintermediation, full disintermediation for LoCs (e.g., via the BPD approach) seems unrealistic and not an optimal solution at least in the short run. The experts we interviewed emphasized the importance of standardization and the difficulties that accompany different international regulatory frameworks and political conditions. Most interviewees pointed out that tying up capital likely prevents a BPD solution from adoption. Second, nonetheless, partial disintermediation seems a realistic and most promising scenario as we illustrate in the BPRE solution.

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7 Conclusion and Outlook

In this paper, we investigate the implications that blockchain technology has for an LoC process with a specific focus on disintermediation. Practitioners seek to unfold blockchain technology's potential based on two prevailing paradigms: BPO and BPD. The BPO approach focuses on improving existing processes whereas the BPD approach focuses on disrupting and redefining existing processes. To date, no studies have analyzed and evaluated BPO approaches, compared them to BPD solutions, and derived generalizable knowledge (Glaser, 2017; Lindman et al., 2017; Yli-Huumo et al., 2016). Although researchers have attributed huge potential to blockchain's disintermediating characteristic (Beck & Müller-Bloch, 2017), research has lagged in providing scientific evidence.

To address this research gap, we conducted three design cycles and developed three artefacts: a BPO, a BPD, and a BPRE approach. The latter combines the advantages of the former two. We particularly investigated how the BPO and BPD approaches differ and which approach one might favor in which regard. Both approaches have advantages and disadvantages. The BPO prototype closely resembled of the current LoC process and primarily offered incremental improvements. The incremental improvements are in line with the literature from business process optimization, which researchers see a systematic approach to continuously improving the status quo (van der Aalst, La Rosa, & Santoro, 2016). In contrast, the BPD prototype builds on an entirely disintermediated process for LoCs. In evaluating our prototypes, we found that both approaches do not perfectly fit the LoC process' requirements. However, it also reveals a striking match between the BPO prototype's weaknesses and BPD prototype's strengths and vice versa. Combining the two approaches, the BPRE solution concurs with what business re-engineering teaches (Hammer & Champy, 2009) and leverages the blockchain-specific characteristics and potential advantages while incorporating holistic business objectives. Thus, the BPRE approach addresses most shortcomings that the first two solutions have and complements their strengths. On the one hand, the BPRE approach fosters disintermediation since escrow smart contracts still allow for a fully automated process. On the other hand, the BPRE approach limits the capital tie-up as banks can be integrated in the process while still reducing the number of intermediaries. We confirmed our findings through interviewing experts who discussed and evaluated all three solutions. Thus, our research aligns well with state-of-the-art DSR and adopts conceptual thinking, sound arguments, and real-world scenarios (Gregor & Hevner, 2013).

Before stating our contributions, we acknowledge that our study has several limitations. First, although our BPO and BPD prototypes validly represent financial services and we based our design evaluation criteria on related literature, domain knowledge, and on the well-recognized DSR approach, our results may still best fit the examined cases. Thus, further research to examine additional financial services may require adjustments to specific criteria. Second, we did not examine productive systems in a real-world environment but in prototypes. Third, since our research originated in the financial services sector and related closely to banks, we conducted our expert interviews with banking professionals. Future research should include interviews with additional stakeholders such as importers and exporters in order to further evaluate how one can use blockchain in international trade finance.

With this paper, we make four theoretical contributions. First, we expand the literature on blockchain research since this study constitutes the first one to analyze whether one can use blockchain for an LoC. Further, we specifically address further research directions that Mendling et al. (2018) raised.

First, with our DSR, we developed two prototypes, evaluated them comprehensively, and derived a re-engineered solution for an LoC. Thus, we not only demonstrated blockchain's feasibility as the basis for *execution and monitoring systems* (process-aware information systems) but also indicate benefits and challenges in different implementations. Second, with our research approach, we respond to the call for valid *methods to analyze and engineer* business processes based on blockchain. Third, via conducting our iterative research and integrating experts from practice, we illustrate and confirm how blockchain allows one to *redesign processes*. Fourth, in line with recent research (Beck, Müller-Bloch, & King, 2018), we show how blockchain significantly *impacts strategy and governance* since we demonstrate how blockchain influences ecosystem participants' existing structures and roles. Fifth, we establish examination criteria to evaluate IT systems that organizations use for an LoC process in international trade. Thus, our research lays the foundation for better understanding the observable blockchain paradigms BPO and BPD and their consequences. Sixth, we derive a novel approach (BPRE) for a blockchain-based LoC. Seventh, we evaluate a BPO, a BPD, and a BPRE approach in the financial services industry. Since we used a BPRE for the first time, we call for further research into combining the BPO and BPD paradigms in other use cases and industries.

Besides our theoretical contributions, our approaches and their analysis and comparison provide practitioners with valuable insights about using blockchain technology generally and in the financial services industry in particular. First, we derive and evaluate blockchain technology's and smart contracts' current strengths and weaknesses. Accordingly, we help practitioners to better understand the opportunities and limitations associated with blockchain and its implementation. Second, we illustrate how one should use blockchain to improve existing processes. Third, based on our research, we can conclude that, while blockchain continues to evolve and while many organizations may accept it, the financial services industry will still require third parties such as banks; however, their roles and business models may change significantly.

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