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Distributed Ledger Technology in the Financial Industry: Managerial, Organizational, and Technological Challenges

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DISTRIBUTED LEDGER TECHNOLOGY IN THE FINANCIAL INDUSTRY: MANAGERIAL, ORGANIZATIONAL, AND TECHNOLOGICAL CHALLENGES

Research Paper

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Abstract

Although the potential of distributed ledger technology (DLT) is generally acknowledged, there is still little evidence of effective widespread use in the financial industry. Coming from this observation, this study aims at analyzing the key challenges of DLT in banking and insurance not only from a technical but also from a managerial and organizational perspective addressing people- and process-related issues. For this purpose, twelve German and Swiss industry experts are interviewed. The resulting eight hours of interviews or around 120 transcribed pages are deductively and inductively categorized as well as qualitatively analyzed. The findings of the interview indicate that there are significant managerial and, in particular, organizational challenges that outweigh the technical barriers and impede the progress of DLT in the financial industry. In conclusion, the insights of this study show the importance of non-technical issues concerning DLT and guide future research in this direction.

Keywords: Distributed Ledger Technology, Blockchain, Challenges, FinTech, Expert Interviews.

1 Introduction

The financial industry, i.e., banks and insurance companies, looks back on a history of more than 150 years of financial technology (FinTech) with its origins in the transatlantic telegraph cable (FinTech 1.0) in 1866, followed by the digitalization of financial services in the second half of the century (FinTech 2.0), and resulting in the modern, digital financial ecosystem (FinTech 3.0) (Arner et al., 2016). However, there might be the next revolution of FinTech waiting in the wings: Distributed ledger technology (DLT)—as blockchain, the most famous instance of DLT—is expected to have a significant or even the largest impact on the transformation of technology in the financial industry (Fanning and Centers, 2016). Whereas the above-mentioned historical technologies took decades to gain acceptance, the practical application of DLT became a reality within a few years.

Today, there are a wide variety of conceivable but also already implemented use cases: For instance, in banking, DLT offers new technological opportunities like decentralized digital money (e.g., Bitcoin; Eyal, 2017), clearing for interbank transactions (e.g., Ripple; Guo and Liang, 2016), or peer-to-peer lending and transactions (Lindman et al., 2017). In the insurance industry, smart contracts in particular are a key instance of the application of DLT, e.g., clients could store their will publicly in the distributed ledger, and life insurance policies could automatically transfer the coverage to the beneficiary in case of death (Gatteschi et al., 2018).

Hence, DLT is an innovative pathway to increase trust, reduce transaction costs, and prevent fraudulent behavior (Rossi et al., 2019; Zhao et al., 2016). While these advantages are attributable to the decentral premise of DLT, the distribution leads to open questions and challenges in the financial industry, especially with regard to the role of banking and insurance regulation (Lacity, 2018; Peters and Panayi, 2016), making it questionable if true decentralization is even achievable (Guo and Liang, 2016). While DLT is clearly categorized as a disruptive breakthrough technology (Gomber et al., 2018) and expected to transform the fundamental operating models of finance and economy (Guo and Liang, 2016), we currently do not observe this disruption yet: The German digital association Bitkom (2019) has assessed that—although the majority of banks and insurances are confident about its immense potential (above-average compared to other industries)—just 20 % of the financial organizations (n=100) are tangibly interested and open towards the technology, only 13 % have already invested in this field, and just further 5 % are discussing investments in the near future (as of 2019). The result is that merely 6 % of banks and insurance companies had a use case of DLT deployed in the field in 2019. According to this survey, the real-world actions of financial industry players do not reflect the promising opportunities from the literature. Since the Bitkom study, there have been new initiatives and implementations of DLT in banking and insurance such that the gap between potential and application might have become smaller. However, based on these numbers, it can be expected that a substantial discrepancy still exists today.

From this evidence, the guiding question of why we cannot observe the phenomenon in practice arises. Consequently, this study aims at investigating the key challenges of DLT in the financial industry. In doing so, we restrict our analysis to banking and insurance companies in Germany and Switzerland. Furthermore, we focus on managerial and organizational as well as technical key challenges—with an emphasis on the former. These perspectives are related to the dimensions of people, process, and technology that are proposed as key areas of activities in standard management models (Pee and Kankanhalli, 2009): Managerial tasks particularly deal with people-related activities such as leadership, where organizational tasks are primarily concerned with structure and methods resulting in processes.

Consequently, our key research question is:

What are the key problems and challenges of DLT in the financial industry from a managerial and organizational as well as technical perspective?

To answer this question, we draw on the qualitative research approach, in particular semi-structured expert interviews, that represents an in-depth examination with the goal of creating a deeper understanding (Palvia et al., 2003). For this purpose, we have interviewed twelve experts from banking, insurance, and cross-sectional support functions such as consulting or IT service providers. Since all experts are from Germany or Switzerland, we must restrict our insights to this context. The interviews were analyzed via a qualitative content analysis (Mayring, 2014, 2019) leading to quantitative results regarding the count of statement categories and qualitative results regarding the meaning and content. In total, our analysis can draw on 8 h of interviews resulting in more than 33 thousand words or around 120 standard pages of transcript.

In this research, we address the concept of DLT as an umbrella term for consensus-based distributed transactional databases that also encompasses technologies such as blockchain (Beck et al., 2017). We make use of this term since DLT is more widely used in the IS community compared to blockchain—although the terms are often used synonymously (Ostern, 2020).

The remainder of this paper is structured as follows: after this introduction, we give an overview on the concept of DLT, particularly based on the example of blockchain, and present related work. Subsequently, our research methodology describing our process of data collection and analysis is introduced. Afterward, we present the results of the interviews and discuss our findings before we, finally, conclude the paper.

2 Distributed Ledger Technology and Related Work

In this section, we illustrate the background of DLT and discuss related work.

2.1 Distributed Ledger Technology (DLT)

We define a DLT system as "all initiatives and projects that are building systems to enable the shared control over the evolution of data without a central party, with individual systems referred to as 'distributed ledgers' " (Hileman and Rauchs, 2018, p. 24) whose principles are decentralization of consensus, transparency, and security as well as immutability (Tasca and Tessone, 2019).

However, in the literature, there is an ambiguity in the terminology of how to call and define different concepts such as distributed ledger and blockchain technology: Ostern (2020) identified that DLT and the paraphrases blockchain, decentralized database, distributed ledger technology, shared digital ledger, blockchain ledger, decentralized platform, and digital record system are all used in the literature, sometimes applied interchangeably within the same article. As we have stated in the introduction section, we use DLT as an umbrella term for consensus-based distributed transactional databases including blockchain.

A DLT system is a distributed database (ledger) consisting of interconnected sets of data (Friedlmaier et al., 2018). The consensus of the contributors (nodes) in a DLT network governs and controls the rules for using and extending the interconnected sets of blocks (Walport, 2016). These blocks are protected by cryptographic concepts against tampering and stored permanently. Within a DLT system, each node may have a complete copy (full node) or depend on the other participating nodes for the complete information (lightweight node). The most well-known DLT applications are Bitcoin and Ethereum. For instance, on November 1st, 2021, Bitcoin had a market capitalization of more than $ 1.1 trillion (Coinmarketcap, 2021).

Core functionality and properties of DLT systems include distributed nature, data integrity and security, anonymity, transparency and traceability, decentralized nature, cost saving, efficiency, interoperability, and persistence of data (Catalini and Gans, 2020; Chen, 2018; Governatori et al., 2018; Rauchs et al., 2018; Sanka et al., 2021; Zhao et al., 2016; Zyskind et al., 2015).

Generally, three DLT system architecture patterns can be identified (Lin and Liao, 2017): The first type, public DLT systems, are open and publicly available. They do not require permission to be used. Users and contributors can join and participate in public DLTs by simply installing the application (e.g., wallet in the case of blockchain) on their computers. Everybody has the right to participate in the consensus and can read or write to the DLT system. Bitcoin and Ethereum are examples following this pattern. Public DLT systems are fully decentralized but, on the other hand, they have privacy issues. Both selfish mining and 51 % attack vulnerability are additional weaknesses. In the second type, private DLT systems, the access requires permission. Once users are authorized, they can read or write the data sets of the system and validate transactions. Due to their closed nature, private DLTs are more secure and centralized. Further, private DLTs are more scalable and have no 51% attack, privacy, and selfish mining issues (Lin and Liao, 2017). Concerning the third type, the consortium DLT pattern also describes a permission setup but can be located in between the public and the private DLTs. Following the consortium pattern, networks are formed by independent parties that work together and share information with limited trust. The users of a consortium DLT initially need to go through an approval process in order to gain the ability to perform write operations. However, in contrast to a private DLT system, no need for approval is needed in order to send transactions, read, and verify new data sets (i.e., typically blocks). A consortium DLT is partially centralized, has no risk of a 51 % attack, and, in general, there exist fewer privacy and security concerns. Corda and Hyperledger are known examples following the consortium DLT pattern.

Since DLT systems are distributed, there is a need to synchronize the network. In particular, updates as well as which user will create a new block at a particular instance of time need to be coordinated. These aspects are governed by a consensus agreement between the users (nodes) of the DLT. DLT systems'

technology mostly draws on the Byzantine generals' problem for its consensus. For some governmental and commercial applications, no consensus mechanism is needed. Sliwinski and Wattenhofer (2019) present a DLT system implementation without this feature. The presented setup leads to significantly lower energy consumption and also offers performance improvements.

2.2 Related work

Related work to this study can be separated into three categories: 1) research dealing with the general introduction and application of DLT at an enterprise level, 2) research describing how the DLT is currently used in the financial industry and at insurance companies, and 3) contributions describing challenges in the applications of DLT systems from a business perspective.

Representatives of the first category include Wang et al. (2016) describing how the comparative analysis method was used to create a DLT maturity model and its adoption process. This adoption process is particularly relevant as some of the interviewed experts stress the challenge of integration into established process structures and systems of DLT systems (see Table 4 in Section 4). Rossi et al. (2019) present a multi-paradigmatic IS research agenda emphasizing the need for behavioral design science and IS economics research on DLT. The authors highlight, among others, the need for DLT governance, affordances, constraints, as well as the consequences of its use. Yet again, these are topics raised by the experts (see Section 4).

Zhao et al. (2016) is a member of the second category of related work describing use cases of DLT in the financial industry. In Zhao et al. (2016), the conclusion that the adoption of DLT systems in finance will lead to many business innovations, as well as many research opportunities, is drawn. Hence you can argue that our paper is following this encouragement. The authors of Lindman et al. (2017) focus on one particular area of the financial industry: payments. They present a research agenda including three focal areas of DLT-enabled payment processing. Gatteschi et al. (2018) include the discussion of several DLT use cases in the insurance sector, including an analysis of advantages and disadvantages. These findings can be compared to the ones identified in Section 4.

Lacity and Khan (2019) represent an instance of the third category of related work. The authors conduct interviews and performed observations, which led to the identification of five challenges: competing DLT standards, adjusting to different shared governance models, intellectual property concerns, industrial espionage risks, and regulatory uncertainty. Lacity (2018) presents managerial challenges in the areas of standards, regulations, shared governance models, and viable ecosystems that impede progress. Eyal (2017) explores how DLT research beyond Bitcoin is closing these gaps and some of the challenges that remain when it comes to the application of DLT systems in the FinTech domain. In Sanka et al. (2021), a survey on the usage and challenges of DLT is presented. The authors identify that costs and the inability to realize tangible benefits are the most common reason for the discontinuation of DLT projects. For the readers of our paper, it might be interesting to read the related work mentioned in this category.

The question of challenges of DLT in the financial industry—with a focus on managerial and organizational issues in particular—has not been sufficiently answered so far. According to the taxonomy of Gregor (2006), there are five types of theories in the field of information systems: I. *analysis* (what is), II. *explanation* (what is, how, why, when, where), III. *prediction* (what is and will be), IV. *explanation and prediction* (what is, how, why, when, where, and will be), and V. *design and action* (how to do something). The main contribution of our work is the development of greater knowledge and understanding of the challenges in the addressed context. Consequently, our findings intend to provide an explanation (type II) for the phenomenon that DLT solutions are still seldom implemented in banks and insurance companies. Conclusively, this work intends to lay a fundamental understanding for subsequent research addressing explanation and prediction (type IV) as well as design and action (type V) that both build upon such a "theory for understanding" (Gregor, 2006, p. 624).

3 Methodology

For the purpose of this study, we chose the qualitative research approach of semi-structured expert interviews—along with a qualitative content analysis—since it allows an insightful in-depth examination (Palvia et al., 2003). In the following, we will present the four steps of our process: A. Development of the Interview Guide, B. Selection of Experts, C. Conduction of Expert Interviews, and D. Qualitative Content Analysis (see Figure 1).

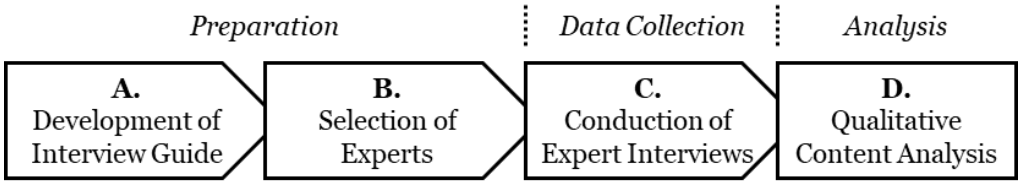

Figure 1. Methodological process of this study.

A. Development of Interview Guide. The research question was operationalized into an interview guide that, on the one hand, structured the interviews and, on the other hand, provided an operational instrument for the interviewer. The interview guide was developed in accordance with Kaiser (2014): First, the interviews started with a short briefing before introductory general questions were asked to open up and ease the interviews. Afterwards, the experts were asked open questions concerning the status quo of DLT in the financial industry as well as specifically in their organizations. In the main part of the interviews, the interview guide focused on problem areas and challenges with regard to technical and organizational barriers as well as possible solution approaches and actions for these. Concluding, the interviewees were asked about the future of DLT and how it might transform the financial industry.

B. Selection of Experts. To cover the financial industry from multiple perspectives, we decided to involve three major perspectives on the topic: Bank (BA), Insurance (IN), and IT service providers including consulting companies (IC). While the first two are the central branches of the financial industry, IT service providers and consulting companies can give cross-sectional insights on the whole industry since they partly collaborate with different financial business models. Furthermore, they are important partners for the implementation of DLT and are more likely to have specialized experts in this field.

Based on their job description and industry, we searched for appropriate interview candidates from Germany on the social business network LinkedIn and on the web. When approaching the experts, we promised to ensure the anonymity of their identity and their employing companies. When selecting the experts, we carefully considered a preferably balanced mix of the three addressed industries (banking, insurance, IT services and consulting) and successfully tried to obtain diverse corporate insights, i.e., all experts work in a different company. We made sure to not only consider technical experts but also parts of the functional "elite". Elite interview partners not only draw on their high knowledge and experience but also are in responsible and powerful positions as decision-makers (Littig, 2009). Furthermore, we aimed for a combination of IT and business experts to cover technical as well as managerial and organizational perspectives. Initially, we intended to conduct four interviews per industry at first. The availability of DLT experts in the insurance industry appeared to be very limited in Germany such that we extended the scope to Switzerland. Because of the difficulties in finding adequate interview partners, we decided to initially conduct three interviews with insurance experts and, in exchange, look for a fifth banking interview partner (as the expert search conveyed the impression that banks are fundamentally more active in this field). Within the banking industry, we paid attention to having a good balance between major and private banks. In total, we contacted around 50 persons. From these requests, we could acquire twelve experts from twelve different companies.

During the interviews, we noticed increasing redundancies and decreasing new information. This saturation of data was our stop criterion for further interviews (see Guest et al., 2006). The overview of the backgrounds of these experts is shown in Table 1. Five experts originate from banking (three from major banks and two from private banks), three experts from insurance, and four experts from IT service

providers and consulting companies (two from IT service, two from consulting). Some experts are also functional elite since they work, e.g., in senior management, as department head, or in a board position. The combination of IT and business position is evenly distributed over all experts but differs within the sub-industries; e.g., the IT service branch is naturally dominated by IT experts. All interview partners work either in Germany or Switzerland.

As we observed a progressive saturation (e.g., later interviews tended to be shorter than earlier ones) and an increasingly reduced variability of statements in these twelve interviews, we decided against further interviews with more than those experts (stop criterion).

ID	Sub-Industry	Job Title	Experience & Expertise	Dur. (min)
BA1	Major Bank (GER)	Senior DLT Product Owner	Senior Product Owner within the DLT lab; has worked in several DLT areas (e.g., capital markets, trade finance, central bank digital currency, supply chain, identity management)	30
BA2	Major Bank (GER)	Senior Manager	Collaborator in the area of innovations and digitalization with other specialized areas and group companies; operates innovation lab, in which DLT-related prototypes have been developed for 5 years, and a trend lab, in which new developments are initiated such as digital currencies based on blockchain technologies	48
BA3	Major Bank (GER)	Software Engineer	Software development within the realm of digital identities; founder of the team for digital identities based on DLT and responsible for various tasks regarding this	22
BA4	Private Bank (GER)	Chief Digital Officer (CDO)	Works with all kinds of digital innovation within the bank; managing director and founder of a company for financial digital applications; participated in the bank's pilot project as a crypto custodian	39
BA5	Private Bank (GER)	Head of Business Management	Deals with DLT applications for bank business management, especially in the area of payments and structured products; monitors market trends and innovative developments	31
IN1	Insurance company (GER)	Chief Information Officer (CIO)	Head of IT of the insurance group; works in the area of DLT at previous employer; was involved in the construction and implementation of a DLT prototype at an insurance association	35
IN2	Insurance company (CH)	IT Architect	Initiator of DLT in the company; supports the construction of a proof of concept in the insurance company	30
IN3	Insurance company (CH)	IT Architect	Initiates pilot DLT use case in company; facilitates the enhancement of knowledge in the insurance industry	39
IC1	IT service company (GER)	IT Architect	Has been working on the matter of DLT in the company for 5 years; advances relevant issues on his own (cryptocurrencies, use cases, impact on banking)	54
IC2	IT service company (GER)	Digital Transforma-tion Agent	Works in DLT context; specialized in the development of digital currency	40
IC3	Consulting company (GER)	IT Architect	Expert for DLT and multiparty systems; in addition to the technology consulting, also involved in implementations and incubator programs	63
IC4	Consulting company (GER)	IT Architect	Member of practice group for DLT solutions; involved in the ISO committee “ISO / TC 307 blockchain and distributed ledger technologies” for the standardization of DLT; supports different working groups in building up expertise in the area of DLT & Blockchain	51

Table 1. Background of the experts.

C. Conduction of Expert Interviews. The interviews were conducted between December 1st and 17th, 2020. Since there were public restrictions that obstructed personal meetings due to the Covid-19 pandemic, all interviews were held and recorded via video conferencing software. All interview partners along with the authors are native German speakers; therefore, German was chosen as the interview language. Thus, the quotes, which we provide in the following, are not the original words but exact one-to-one translations to English. The interviews lasted between 22 min and 63 min (see Table 1) with an average duration of 40 min. Based on the records, we created a detailed transcript of every interview that was the basis of our qualitative content analysis. In total, our analysis can draw on 8 h of interviews resulting in more than 33 thousand words or around 120 standard pages of transcript.

D. Qualitative Content Analysis (QCA). For the analysis, we draw on qualitative content analysis (QCA) after Mayring (2014, 2019). This method is a systematic, rule-based procedure that creates a theory-guided categorial system based on a set of deductive and/or inductive coding rules. An overview of the general content-analytical procedural model is given in Figure 2 after Mayring (2014).

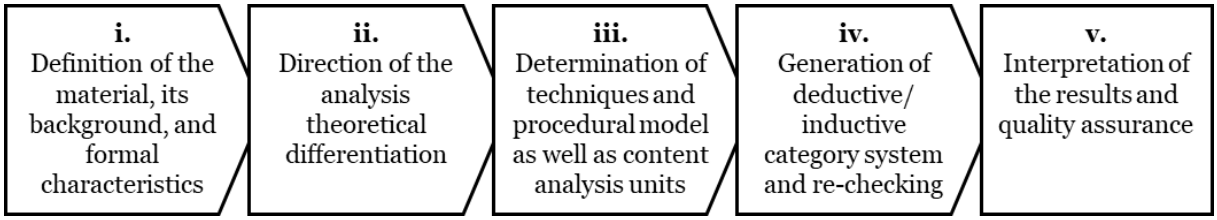

Figure 2. General content-analytical procedural model after Mayring (2014) (simplified).

Our material of focus are the transcripts that originate from particular expert interviews and are characterized by the rules of transcription rules (i.). The direction of the analysis and theoretical differentiation is based on our research question regarding challenges and barriers (ii.). In this study, a combination of a summarizing and content-structuring QCA is applied (iii.): For the content-structuring part, we created a categorical system deductively, i.e., based on the literature from related work (see section 2.2), and coded the statements of the interviews accordingly. The deductive system follows our research design and, therefore, is aligned to the categories in the interview guide (see step A). We defined categories as well as anchor examples and coding rules for these categories resulting in a coding guide (see Figure 3).

Category	Definition	Anchor Example
Technical barriers	This category mainly focuses on the technical challenges and barriers of Blockchain and DLT applications.	"[...] it requires efficient consensus algorithms for different reasons. Firstly, for reasonable transaction rates such that you can achieve transaction rates just like it is possible in credit card payments [...]. And, secondly, it needs to be worked towards energy efficiency [...]. This is the key aspect from a technology perspective." (IN1)

Figure 3. Example for deductive coding guide.

After that, for the summarizing QCA, we extended the categorical system inductively, i.e., based on the interviews themselves. For the inductive coding (as shown in Figure 4), we paraphrased statements from the source material that we generalized in the following. Subsequently, we reduced them to an essential set of categories (iv.) (Mayring 2014, 2019).

Source Material	Paraphrase	Generalization	Category
"Education and knowledge are a very big problem. So, I have started to study books about the crypto industry [...] With such issues and articles, we try to be part of it and develop the education in the field, so that, when we come up with the next project, more people will understand this topic". (BA4)	Education and knowledge about the technology are identified as major problems. The experts educate them-selves and try to pass the knowledge on to the co-workers.	The lack of knowledge and education of the employees is emphasized as a manag-erial challenge.	***Lack of knowledge and technical skills***

Figure 4. Example for inductive category development.

Finally, the interpretation and discussion of the results is presented (v.). For the execution of the QCA, we used MAXQDA that is a specialized software tool for—among others— transcribing, coding, analysis of categories, and mixed-method approaches (Kuckartz and Rädiker 2019).

4 Results: Key Challenges of DLT in the Financial Industry

In the qualitative content analysis after Mayring (2014, 2019), we created deductive and inductive categories. The inductive method was directly applied to the material of focus (transcripts of the twelve interviews). By doing so, a total of 226 inductive categorizations were generated in addition to the deductive categorization. In the results section, we focus on the inductive findings in terms of quantitative frequencies of statements as well as the qualitative content of the statements themselves.

The focus of this study are the key problems and challenges of DLT with respect to technical, managerial, and organizational challenges in banks and insurance companies. In doing so, we investigated banks and insurance companies collectively because the insurance experts reported only low levels of activity in the field of DLT making adequate comparisons between the two sub-industries very difficult. In general, we could identify 15 key challenges from the interviews—coincidentally, five key challenges in each dimension.

Concerning technological challenges, the experts generally did not mention any technical challenges of DLT in the financial industry initially. Only after further inquiries and in relation to the use cases that have already been implemented, the interviewees were able to identify some technical challenges that emerged in previous activities. Table 2 shows the technical challenges including their frequency of mention as well as their frequency rank between all 15 key challenges (Table 2–4 combined).

Technical Challenges	Frequency	Rank
Scalability	4	6
Privacy Issues	4	6
Usability / error correction	2	12
Consensus mechanism	2	12
Interoperability	1	15

Table 2. Categories of technical challenges.

One question regarding the technology and architecture of the systems relates to the scalability, i.e., how many transactions can be processed and what data should be stored for which time period. However, these issues are only relevant for certain use cases that demand high transaction rates and are designed based on a centralized thought (IC3). As an illustration for such needs, BA1 stated: “For example, if I'm operating in the machine-to-machine environment and want to establish micropayments and so-called payment streams, then I need a technology that can scale incredibly quickly. A Bitcoin blockchain, in this case, is by far not enough”. Consequently, the scalability aspect is only a technical problem if the use case is not compatible with the scalability of a DLT application.

Another technical key challenge is the issue of data privacy that was particularly stated by experts from the insurance industry. The technology is considered as easily susceptible to attacks that could modify or delete customer data and, thus, make recovery impossible (IN1). IC1 explained: “It is a significant problem of blockchain because […] I keep everything always visible […]“. Hence, privacy is a major concern and cost factor in business-to-customer (B2C) applications but not of special importance in business-to-business (B2B) applications due to less strict B2B privacy regulations (IN1). Despite anonymous and pseudonymous approaches, these promises cannot be completely ensured. Furthermore, anonymity contradicts regulations such as the premise of know your customer (KYC) to prevent money laundering (IC4).

This is closely linked to the aspect of error correction in DLT systems. Since data is stored in a fixed way in DLT, IN1 further stated: “I have a problem with the creation of faulty data constellations, which I have to correct […]”. This requires further activities by the developers in order to create risk-free solutions since software sometimes produces errors (IN3). Similar to scalability, this technical challenge

depends on the way in which the corresponding use case is intended to be implemented (BA3). Furthermore, the European Union's General Data Protection Regulation (GDPR) also regulates the right to be forgotten and the right to rectification that contradicts the lacking mechanisms of subsequent deletions and corrections.

The interviewees discussed consensus mechanisms but found that they do not represent a challenge that basically have to be overcome. According to the experts, efficiency and optimization are especially relevant here. Regarding the former, IN2 stated: "Well, we need efficient consensus algorithms, efficient in many ways: first of all, for reasonable transaction rates [...] and the second thing is that we also work towards energy efficiency". Regarding the latter, IC3 declared: "[...]we have to decide which consensus algorithm is the best […], but [the question] is not 100 percent technical."

Considering the development of different DLT architectures, one expert identified the interoperability, i.e., the unrestricted interaction between the systems, as technical barrier. It is important to establish the interoperability between the different chains and not to run thousands of systems in parallel (IC2).

Regarding non-technical key challenges, some of the most mentioned and discussed categories originate from people-related challenges representing the managerial perspective, as shown in Table 3.

Managerial Challenges	**Frequency**	**Rank**
Lack of knowledge and technical skills	8	1
Lack of the right mindset and understanding of the technology	7	2
Existing culture and habits	4	6
Barriers due to decision-makers and executives	3	10
Incentive and purpose problems	2	12

Table 3. Categories of managerial challenges.

The majority of the experts emphasized the lack of knowledge and technical skills as a managerial key challenge. BA3 illustrated this: "I just think the lack of knowledge is the biggest challenge. Therefore, you have to educate employees and explain to them what's behind it". In this context, it is important to mention that not all divisions of the company have the same level of knowledge about DLT. Additionally, many employees reduce the field to merely cryptocurrencies, such as Bitcoin. As initially discussed, Bitcoin, blockchain, and DLT are not fully identical concepts and a variety of use cases can be implemented with these technologies (IC1, BA3). In the view of the experts, part of this challenge in the companies is also the lack of technical skills that banks and insurance companies have not been able to deal with yet. IN2 said about this: "But then there are barriers that are called 'know-how acquisition', that are called 'how can I operate this thing', 'how secure is this from a data privacy perspective' " (IN2). These managerial challenges require the development of technical skills in the workforce by enhancing education and training (BA4). For technical issues, experts from consulting firms are also involved. There is a noticeable demand from banks and insurance companies for technical consultation but they need to build up technical skills with their own employees. For this purpose, they need to figure out how they can obtain these skills and need to learn how the implementation of DLT systems should be carried out by themselves (IC3).

Closely connected, the right mindset and understanding of the technology is a frequently stated challenge. The area of DLT remains new territory for many employees in large companies and needs comprehensive education on its basic functionalities (BA3). Here, any negative headline related to cryptocurrencies matters as well. This type of negative reporting has an impact on the perception of the technology in general (IC1). The experts also saw the need for the right mindset concerning the conflicting thinking about current software applications in banking and insurance that are traditionally based on in-house developments. This self-contained way of thinking must be changed because DLT is only useful in conjunction with other players that operate within these networks (BA1).

According to the experts, culture and habits constitute a managerial challenge as well. BA4 illustrates this with an example from private banking, in which private customers contacted their advisors and

asked about cryptocurrencies. In this case, most of the advisors were only able to give no or unqualified answers and, therefore, they failed to satisfy the customers' demand. Another aspect related to culture and habits refers to management practices. It is explained that due to the still low importance of DLT topics, the executives habitually focus on other issues in the company and hand over this field of topics to single departments with very restricted possibilities (IC2). Indeed, it should rather be the case that many divisions and departments work together in this field of action (BA5).

For three experts, decision-makers and executives represent an obstacle for DLT in their companies. As BA4 stated: "It has to be decided by people who are of a certain age typically and are on the boards of directors. They can be open to innovation and, perhaps, also promote such things. But 99 percent of the people in a bank do not understand these issues as they should—and these are mostly the decision-makers". Many managers do not see the importance and urgency of implementing these technologies, and a broad understanding of DLT usually does not exist at the higher management level yet (IC2, BA1). In this context, one expert also mentioned that the managers of a large number of banks are currently concerned with very pressing issues that require urgent decisions. In the banking industry, these are for example new competitors on the market and the very low-interest rate environment. These strategic challenges require the full attention of the management resulting in less attention being given to future-oriented topics such as DLT (BA1).

The experts saw another managerial challenge in lacking incentives and motivation for DLT-supporting decisions in the companies. This challenge is closely connected to the above-mentioned issue that decision-makers do not see a high importance of DLT, consider its commercial significance low, and, therefore, assign related tasks to small departments without substantial investment capabilities. Consequently, there is no incentive for the decision-makers in the companies to take actions or be open for innovations (IC2).

Besides technical and people-related challenges, some barriers are concerned with processes, methods, and structure. The challenges from this organizational perspective is shown in Table 4.

Organizational Challenges	**Frequency**	**Rank**
Consortium formation challenges/ Lack of cooperation	7	2
Integration into established process structures and systems	6	4
Regulatory and legal issues	5	5
Identification problems/ Not suitable for use cases	4	6
Market competition	3	10

Table 4. Categories of organizational challenges.

Many experts identified the lack of collaboration or industry-wide cooperation in the area of DLT as an organizational key challenge. The central premise of DLT is shared interaction. In most companies, this idea has not been received yet or is not desired (IC1). Here, it is also important to consider the respective infrastructure of the company. A successful collaboration will only work if there is an agreement ensuring the same technological standards. However, the problem is that companies are primarily involved in projects and prototype development on their own. As a result, collaborations often fail or are more difficult to realize because participating partners have different levels of development and individual technical infrastructures (BA2).

In the assessment of many experts, the integration of DLT into existing process structures, process landscapes, and the software systems of banks and insurance companies represent a significant organizational challenge. One example is the settlement of securities. This is traditionally structured in a way that securities are physically certificated with a global document and must contain many regulations regarding the access and authorizations. Moreover, the process also includes several different authorities. The challenge is that DLT does not fit into the established processes of the financial industry and that there are no standards for regulating these processes yet. Thus, relevant processes have to be adapted (BA4).

The experts recognized problems in current standards, regulations, and guidelines issued by legislators and regulators. In particular, this subject is intensively discussed in banking. The inclusion of the crypto custody business as a new financial service in the German Banking Act has created not only a tangible legal regulation in 2020 but also dynamism in this topic. However, there are still no uniform standards, e.g., for the securities business (BA1, BA2). In the insurance industry, legal issues are very important as well and require appropriate regulations and provisions for DLT decisions by the government (IN2).

The identification of relevant use cases and their requirements in the field of DLT are emerging as a challenge for banks and insurance companies. The experts indicated that there is a lack of awareness of the application fields of the technology. In addition, many companies attempt to derive use cases from DLT. Instead, the companies should design tangible use cases and only then address the question of whether DLT provides a beneficial solution for them (IC3).

Three experts identified the competition within the respective markets as another organizational challenge. This challenge is expressed in two ways. On the one hand, companies have to create value for their customers to differentiate them from their competitors. In the context of DLT, this leads to the question of how differentiation can be achieved if all the providers use the same platform at the same time (IC4). On the other hand, competition also exists even if there is no cooperation on a platform referring to other issues that increase external pressure on companies, especially banks (BA1).

5 Discussion

In the empirical study, we have identified managerial, organizational, and technical challenges that are shown as an overview in Table 5. In the following, we discuss the implications of our findings, the connection findings to the body of literature, and the limitations of our study.

Managerial Challenges	Organizational Challenges	Technical Challenges
1. Lack of knowledge and technical skills 2. Lack of the right mindset and understanding of the technology 6. Existing culture and habits 10. Barriers due to decision-makers and executives 12. Incentive and purpose problems	2. Consortium formation challenges/ Lack of cooperation 4. Integration into established process structures and systems 5. Regulatory and legal issues 6. Identification problems/ Not suitable for use cases 10. Market competition	6. Scalability 6. Privacy Issues 12. Usability / error correction 12. Consensus mechanism 15. Interoperability

Table 5. Overview of the challenges and their rank in the empirical study.

The dimensions of management, organization, and technology closely correspond to the standard dimensions of people, process, and technology in common management models (Pee and Kankanhalli, 2009): Managerial tasks particularly deal with people-related activities such as leadership, where organizational tasks are primarily concerned with structure and methods resulting in processes.

Concerning people-related barriers, our study has found a lack of knowledge and technical skills as well as mindset and understanding of the technology as the two most mentioned challenges. Accordingly, Sanka et al. (2021) state that 45 % of discontinued blockchain projects were cancelled due to uncertainty about how to start; further, lack of understanding and skills is one of the most prevalent adoption inhibitors. Similarly, Lacity (2018) also has found that there are uncertainties about the technology and that managers need to know about the technical principles as well. These two frequently mentioned challenges could be overcome by training and successful implementation of pilot projects that make DLT tangible and, hence, more comprehensible. As DLT application scenarios are growing and become

more common, these challenges are naturally going to be addressed. The emergence of the technology should also lead to a clearer vision of DLT that aids decision-makers and executives in forming a strategic plan and position within this topic. Consequently, the managerial challenges might be resolved rather easily, except for cultural and habitual issues that require a long-term transformation. To overcome these barriers, training, education, communication, and experience might play a key role but must be managed purposefully.

The organizational challenges—addressing process-related barriers to the greatest extent—partly appear to be more challenging to overcome. One particular instance we found is the consortium formation. Already in 2017, Gratzke et al. (2017) counted as many as 40 consortia with the most (26) in the financial sector. A key decision in this context is the choice between broader and industry consortia—the former promises a higher maturity and the latter a larger specialization (Lacity and Khan, 2019). To ensure fair play, there is also an increased need for inspection in collaborations on classical consensus infrastructures (Eyal, 2017). Also, in the process dimension, the integration into established processes as well as regulatory issues are also challenging. In line with our findings, Sanka et al. (2021) also show integration with legacy systems and regulatory issues as major adoption inhibitors for DLT. Regarding the former, the lack of standardization, common architecture, and interoperability between DLT and legacy systems (as well as in between different DLT protocols) is found to be a hindering factor for the financial industry (Hughes et al., 2019). Therefore, innovation might be driven by start-ups that have no legacy systems and entrenched processes such as in banking and insurance enterprises (Lacity, 2018). Besides the integration aspect, legacy systems also constitute an enormous cost factor that competes with budgets for innovations such as DLT (Van Steenis et al., 2016). Concerning the regulatory issues, these are partly out of control of the organizations and are subject to the activities of the regulatory authorities, i.e., they presumably are going to be solved rather in the long run. Nonetheless, regulation has already started to address DLT and blockchain (Lacity, 2018). Due to the nature of the financial industry, regulatory requirements concern not only financial supervision but also data privacy and, due to its internationality, territorial regulation as well (Paulavičius et al., 2019). One key factor here is the uncertainty about the regulations which might be solved by proactively working with regulators to generate clear and supportive regulations (Lacity and Khan, 2019). As a result, the organizational dimension, in particular regarding processes, bears a lot of demanding barriers. These obstacles are not only frequently and substantially mentioned by the interview partners but also hard to tackle due to their dependencies and complexity. Consequently, they represent outstanding challenges for the banking and insurance industry in the field of DLT.

The technical barriers are mostly immanent to DLT. Thus, ongoing technical development that is created rather generally than by individual banks or insurance companies may help to overcome these challenges—although propriety protocols are also developed by individual companies in some cases (Lacity 2018). This development can already be seen in the example of scalability. According to Sanka et al. (2021), the consensus mechanism of proof of work in Bitcoin (from 1999) has a throughput of fewer than 20 transactions per second (tps), the Ripple mechanism (from 2012) can provide more than 1,500 tps, the Raft (from 2013) mechanism in Corda can provide more than 10,000 tps, and the DPoS (from 2014) mechanism in Bitshares can provide approx. 100,000 tps. As the experts stated, scalability does not appear to be a major issue for most use cases—even if there are some cases such as payment in which it is a relevant factor (Lindman et al., 2017). Finally, the transparency of DLT leads to privacy issues making it inappropriate for sensitive information that must not be connected to a specific person (Hughes et al., 2019). Moreover, the immutability of data in DLT contradicts, e.g., the right of rectification in privacy regulations such as the GDPR (Paulavičius et al., 2019).

The generalizability of our findings is subject to certain limitations: The main limitation of this study is that expert interviews principally suffer from restricted generality—the limited breadth of the findings is the price for the increased depth in understanding that is, of course, limited to the knowledge of the experts. Furthermore, we acknowledge that the financial service industry is very diverse such that general claims are in principle difficult. Another limitation involves the issue that the experts are selected as DLT experts. During the acquisition of interview partners, several contacted banks and especially

insurance employees rejected the request because they either had no or little knowledge about the topic and/or their organizations are not concerned with DLT yet. On that basis, we have to assume that we have a selection of rather enthusiasts. Besides, as previously mentioned, the analysis is restricted to the context of Germany and Switzerland since all interviewed experts come from there. Finally, in this work, we had to explain some interconnections and conclusions very briefly due to the limited space.

6 Conclusion

Our main conclusion is that the key challenges are not technical but rather part of the managerial and organizational domain. Particularly, people-related barriers such as know-how and mindset are standing out and represent leadership challenges in the responsibility of the management. However, even more significant, organizational challenges are shown to obstruct DLT in banks and insurance companies—those barriers appear to be harder to overcome due to their dependencies and complexity. The issues of consortium formation, integration into the existing process architecture, and regulatory issues are outstanding challenges in this context. Finally, regarding technical challenges, the questions of scalability as well as privacy are of special concern in the financial sector.

To summarize, this work delivers deep empirical insights into practical challenges and barriers of DLT in the financial industry using semi-structured expert interviews. Hence, it represents a theory for explaining and understanding (theory type II after Gregor, 2006) that is a groundwork for explanation and prediction (type IV) as well as design and action theories (type V) (Gregor, 2006). Our main contribution is the analysis of the in the literature so far less regarded dimensions of people and process. In this regard, we derive and present empirical evidence for managerial and organizational key challenges that banks and insurance companies are facing. The findings verify that the financial industry is more concerned with these issues in practice than with the technical challenges of this young and promising technology guiding future research into this direction.

Consequently, it is a question of future research to study these findings on a more general level, i.e., the issues addressed should, on the one hand, be confirmed in a quantitative survey and, on the other hand, be investigated beyond the German and Swiss financial industry. Furthermore, future work should focus on the differences between banking and insurance in more detail. In addition to that, the scope can further be expanded by including FinTech start-ups and DLT solution providers that might provide new insights. Additionally, the analysis of stakeholders and their decision processes as well as the role of different market players such as big technological companies is also a promising direction for future research. Finally, future work should be devoted to the development of solution approaches and actions to overcome the identified barriers, e.g., by designing methods, frameworks, and models that support the financial industry in tackling these challenges.

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