Unveiling the Key Challenges to Achieve the Breakthrough of Blockchain: Insights from the Payments Industry

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Abstract

The emergence of blockchain technology has led to an animated discussion among both researchers and practitioners about its future prospects. Similar to other upcoming technologies, in the foreground of the analysis are often the potential benefits of blockchain. Much less discussed are the challenges the technology must overcome before achieving breakthrough in traditional areas, such as the financial services sector. To close this gap, and to identify the challenges blockchain needs to overcome, we explore its impact in the payments industry, which represents a major pillar of banking and the cradle of blockchain. For this purpose, we performed a Delphi study and subsequently conducted a number of dedicated interviews. The findings enable us to delineate six key challenges that have to be tackled. Our study contributes to the literature on blockchain and has important practical implications as it indicates issues that should be addressed in order to foster its dissemination.

1. Introduction

New technologies have always been a driving force behind major changes in the past. With the current megatrend of digitalization, digital technologies are at the center of attention for new products and services, as well as improvements to existing information technology (IT) systems.

Under this scenario, blockchain has been particularly attracting the attention of actors in the financial services sector for its potentially revolutionary enhancements of operations and financials. Following Roßbach [29], blockchain represents a radical shift towards direct transactions conducted between end-parties without intermediary services. It builds on decentralized record keeping of all transactions, and a consensus mechanism to verify new transactions.

The payments industry has been the starting ground of blockchain development, with the first application of blockchain in the cryptocurrency Bitcoin [25]. Although the misuse of Bitcoin (e.g., financing of illegal activities or facilitation of payments in the darknet) and the lack of regulation have aroused some skepticism in the payments industry, the underlying technology has gradually imposed an evocative presence. Over recent years, blockchain-based applications have multiplied, underlining the fact that blockchain is much more than just Bitcoin. Applications that allow peer-to-peer transactions and offer instant payments, as well as use cases that cross over the boundaries of payments, have been envisioned. Blockchain is thought to have extraordinary potential [33, 34], and its adoption in the traditional payments industry is believed to be groundbreaking [5].

However, blockchain is currently far from being an established technology in the financial services sector, especially in the payments industry. Despite some transactions involving selected major legal tenders that have taken place between banks, as well as proof of concepts that have been tested by several institutions, the technology has still not reached its final stage of development. Currently, researchers are rather at the beginning of understanding the magnitude of the technological, organizational, and social implications of blockchain. As a result, most observers of the technology have been left wondering why the adoption of this technology has not been immediate, although the huge potential of it has been widely discussed and acknowledged. Problems with the dissemination of blockchain might be due to the underestimated challenges the technology still faces. This represents an essential but currently overlooked facet in the literature on blockchain. In effect, previous literature on the topic has mainly focused on investigating the likely applications of blockchain [39], paying less attention to barriers towards its eventual broad adoption. Conversely, the identification of challenges allows us to understand what still needs to be done to achieve the breakthrough of blockchain. Hence, we formulate the following research questions (RQs):

RQ1: What are the challenges currently hindering the breakthrough of blockchain technology?

RQ2: How can the rationale behind the challenges be explained at the current stage of development?

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In studying the challenges of blockchain technology, we focus on its adoption and industry-wide application, rather than on specific technical features. The findings of our work are based on a Delphi study complemented by dedicated interviews with experts in the payments industry. The Delphi study is composed of three rounds with 45 experts from European countries.

The findings of our study point in various directions and underline the complex issues the technology is facing. Hence, our findings have been structured into six key challenges ranging from the lack of practical use cases to technical issues, such as the need for standardization, unification, and interoperability.

The contributions of this article are twofold. On the one hand, we provide practitioners with clear insights into aspects that should be addressed in order to accelerate development of this technology. On the other hand, we contribute to the literature on blockchain with a new perspective, by unveiling aspects that have been previously overlooked in the academic literature. Additionally, we outline the potential for further research and provide new fields of interest for scholars.

The article is organized as follows: Section 2 outlines the conceptual background of the paper, specifically the cornerstones of blockchain technology and the current situation in the payments industry. Section 3 explains the methodology of our research, while section 4 presents the findings of the two-stage analysis. Section 5 discusses the implications of the study. Section 6 concludes the paper.

2. Background

Banks, insurance companies, and the plethora of other financial institutions are currently in the midst of a significant transformation. Drivers include the move toward near-entire digitalization of products and services, excessive regulation, crumbling income sources, and fast-changing customer behavior. In particular, digitalization, a sociotechnical process [35], is triggering innovations that are affecting the entire business landscape. The newly introduced digital technologies could fundamentally change how firms capture value, and might even redefine what can be considered as value-generating activities and what cannot.

One such digital technology is blockchain, which is attracting the attention not only of financial institutions, but also firms in other industries, such as energy, health, entertainment, and manufacturing [39]. Due to its potential, heavy investments are being dedicated to the development of blockchain in many sectors.

Blockchain was initially launched as an approach to payment transactions based on cryptography to provide an alternative mechanism for the trust between two transacting parties [25]. Previously, two parties depended on a trusted third party to guarantee trust. This third party is now substituted by blockchain, which entails decentralized bookkeeping and trust achieved by the technology. In particular, blockchain enables a collective bookkeeping system via a decentralized ledger, which, by means of a consensus mechanism, allows participants to reach an agreement and, hence, approve transactions. Information stored in the ledger concerning individual transactions is gathered in "blocks." These blocks are reviewed and verified by the network and added in chronological order to the computers of all participants in the network. As a result, the chronologically ordered blocks form a long chain of blocks, which led to the term "blockchain." All blocks together make up the distributed ledger of verified transactions, and are then provided to the network. As the record of all transactions is distributed to the network, blockchain does not require intermediaries for verification. As such, the traditional role played by financial institutions – as trusted third parties who verify transactions and mitigate the default risk behind them – has come under scrutiny.

Bitcoin was the first cryptocurrency [28], and remains the most broadly used to date. Furthermore, it represents one of the most famous applications of blockchain technology. Blockchain is being proposed as a solution in the financial services sector for a wide spectrum of transactions, which range from real-time payments between two parties (involving rapid settlement and without requiring a bank account) to transferring funds across currencies (micro payments, remittances), and digital assets (where records of asset ownership are stored digitally). The impact of blockchain technology, though, might go much further than certain modified processes and a few new products and services. Due to its disruptive potential, a number of authors expect that the consequences could even go as far as to affect entire business models [17, 33, 34]. In this sense, the impact of blockchain on business models in the financial services sector might be a good example of the disruptive potential of IT [6].

Accordingly, blockchain, or the more general term distributed ledger technology (DLT), has raised interest in the Information Systems (IS) community – e.g., with regard to trust and cryptographic aspects [4], procedures and implications [29], and various issues pertaining to virtual currencies [19]. Nevertheless, literature on the topic has yet to provide a clear overview of the likely challenges that blockchain faces during its path to achieve breakthrough.

Due to a number of initial blockchain applications and its huge potential, the payments industry represents a promising ground for research on blockchain. Payments also constitute an exciting source of tension for banks. On the one hand, payments represent a major

source of revenue for financial institutions in terms of providing fundamental and often-used services to customers. On the other, the payments industry has been the focus for a number of innovations, e.g. mobile payment. Furthermore, payments represent the anchor product for various other services, and a critical element for access to customer data. Payment information is a source of knowledge about and data on customers, and an opportunity to generate points of reference into the processes of banks' customers – whether private, business, or institutional. Thus, losing stakes in payment transactions to players utilizing blockchain would have disastrous consequences for banks.

Squeezed between the need for investments in compliance and IT, the erosion of income from traditional sources, and fierce competition, the business models of many financial institutions are under pressure. Therefore, any further attempts to make the current payment infrastructure obsolete or to pull away payment transactions from financial institutions will contribute to deteriorating banks' business base. In this regard, blockchain technology represents a significant threat, especially since it might switch off the third-party function of financial institutions in payments and other areas. At the same time, however, the reduction of costs that could be realized by using blockchain is inducing financial institutions to closely look at, and sometimes actively push forward, its development.

The disruptive potential of blockchain has evoked considerable attention at existing payment infrastructure operators such as SWIFT, providers of international payment transactions such as Western Union and MoneyGram, as well as regulators. Enterprises from both technology and financial services sectors are considering launching prototypes of blockchain-based solutions. In particular, incumbent companies are trying to defend their business by applying various strategies, from developing in-house platforms to directly investing in blockchain firms, partnering with them, or offering accelerator services to explore blockchain.

Despite the potential and far-reaching implications of blockchain, its development in payments appears to have slackened in terms of speed and intensity. The technology could potentially enhance many existing services (e.g., by reducing transaction fees and facilitating direct transactions by eliminating intermediaries [17]); however, the challenges to its development have to be carefully considered and fully understood.

3. Method

3.1. Delphi study

To identify the challenges, we first conducted a Delphi study among experts from the payments industry who are knowledgeable on blockchain technology. The Delphi method has become a common tool for measuring and aiding forecasting and decision making [30]. It is especially appropriate for exploratory theory building on interdisciplinary issues involving new or future trends [2, 23], particularly since it enables discussion of a complex topic through a structured communication process [21]. Dakey and Helmer [10] define Delphi as a method that attempts to obtain the most reliable consensus of a group of anonymous experts. Hence, the method is highly recognized in research concerning technology forecasting [1, 38]. In the past, the Delphi method has been extensively used in IS research to identify and rank key issues for management action [32]. Given its characteristics, it represents a suitable technique for the objectives of our study, especially regarding the context of the early development stage of blockchain technology.

As suggested by Murry and Hammons [24], as well as Fan and Cheng [13], we chose to follow a three-round procedure. Round one (R1) aimed to derive panelists' insights and opinions. In round two (R2), panelists evaluated the results of R1. In round three (R3), panelists were asked to re-evaluate the results in light of the group feedback. The most important criterion when selecting panelists is that they have individual expertise on the issue under study [26]. Therefore, we took the requirements described by Hill and Fowles [16], as well as Adler and Ziglio [1], into account. Accordingly, we selected experts with a thorough understanding of blockchain technology to assess its implications on payments. In addition, a deep understanding of payments was needed to assess industry-specific aspects. Furthermore, we considered the panelists' professional position, as well as their role and the background of the firm they worked at. In total, we identified 45 experts: 16 (35%) from consulting, 11 (24%) from fintechs (start-up companies in the financial services sector that rely heavily on new technology), 6 (13%) from banks, 4 (9%) from academia, 3 (7%) from public institutions (e.g., regulatory authorities), 3 (7%) from payment service providers, and 2 (4%) from technology providers. The Delphi study started with R1 in April 2016 and ended with R3 in July 2016.

As per Linstone and Turoff [21], we designed R1 based on an open-ended format, suggesting starting points around blockchain technology in the payments field. The goal was to elicit individual perspectives, judgments, and opinions from each panelist [32]. In R1, we sent out 45 emails to the panelists and received 38 responses (84.4% response rate). All answers from the panelists were consolidated and transferred into distinct items. To this end, the input was reviewed and coded by three independent researchers, while a moderator coordinated the process and facilitated the sub-

sequent coordination between the researchers. Finally, the researchers translated each item of the coding process into a more readable and understandable statement for the subsequent rounds. Through the coding in R1, an initial set of 45 statements was produced, which described the implications of blockchain in payments.

In this paper, we analyze and discuss those statements that are relevant for the aim of our research – i.e., understanding challenges within the development of blockchain technology. Hence, 20 out of the overall 45 statements were identified as being relevant to the objective of this research. The statement selection was based on the following criteria: technical issues, missing factors, areas in which more effort is needed, and currently underdeveloped aspects that might hinder the dissemination of blockchain technology. To facilitate the evaluation, in R2 and R3 all statements were presented through the use of an online tool (Qualtrics).

In R2, we exclusively considered the 38 panelists who had completed R1. These experts were presented with the statements produced in R1 and asked to evaluate each on a six-point Likert scale ranging from "Strongly agree" to "Strongly disagree." At the end of R2, evaluations had been received from 36 out of 38 panelists (94.7% response rate).

The evaluations of the 36 experts were further considered in R3, where panelists were presented with the same statements, along with the group's responses from R2, combined with each panelist's own evaluation from R2. In R3, the panelists were asked to provide their individual evaluations in light of the group's evaluations. In total, 34 responses were collected from R3 (94.4% response rate). After completing R3 we checked the group stability, as advised by Dajani et al. [9] and Linstone and Turoff [21]. Across all statements, the average for agreement with the statements was 87%, with only 13% for disagreement. Next, we calculated the variance and variation in R2 and R3 to determine whether consensus had been achieved. The average variance was reduced from 1.23 in R2 to 0.96 in R3. Furthermore, average variation decreased from 47% in R2 to 43% in R3. Both values are in line with van der Gracht [15].

In the end, based on the initial 20 statements we selected those with the highest consensus measures. To do so, we applied a three-step measurement. First, we used a predefined level of agreement of 75% on our six-point Likert scale. This seems reasonable as other researchers have used percentages between 60% [36] and 80% on a five-point Likert scale [27]. Second, we required a variation score below 50%, as suggested by English and Keran [12]. Third, statements were excluded when the variance was above 1.0, following von der Gracht [15]. As a result, we were able to identify six statements that met the aforementioned criteria. These six statements represent the key challenges blockchain technology faces, as identified by the experts in our Delphi study (see Figure 1).

3.2. Interview series

In order to deepen our understanding of the key challenges and the rationale behind them, we started an interview series. Hence, we conducted four in-depth interviews in order to understand how experts from both financial institutions and fintech startup companies are approaching challenges toward the establishment of blockchain technology in the payments industry. We followed the recommendations outlined by Eisenhardt [11] and Yin [40] and designed semi-structured guidelines for the interviews. The questions were open-ended to ensure the examination of all perspectives and assessments expressed by the interviewees. Table 1 provides an overview of the interviewees, including their position and the length of the interviews. The interviewees were selected to provide a solid foundation, which covers the whole payment process. Moreover, we aimed for an equal mix of fintechs (I2 and I4) and established banks (I1 and I3).

Table 1 List of interviewees and professional position

ID	Interviewee's Position	Length (min)
I1	Bank: Director, Market Infrastructure and Initiatives	59
I2	Fintech: Founder, Manager, and Developer	77
I3	Bank: Chief Digital Officer, Transaction Banking	61
I4	Fintech: Business Unit Manager	57

All interviews took place in person to ensure adequate data collection. They were conducted in German, since all participants indicated that they were fluent and most comfortable in German. The interviews were recorded in full and transcribed. The same interview guideline was used throughout to ensure comparability. The interviews took place in Q4 2016 and Q1 2017. Coding of the transcripts was performed using MaxQDA v.12.2. The data analysis started with descriptive codes according to the six challenges identified by means of the Delphi study. This stage led to the identification of 84 descriptive code statements grouped around six different key challenges. At this point, our focus was to "organize and make sense of the qualitative data" [3, p. 152] to understand how the six challenges were perceived and understood by the experts in the payments industry. This process was highly iterative and involved studying each interview individually as well as in combination with the other interviews. As a result, we were able to derive a more

nuanced and refined analysis of the key challenges as identified by our Delphi study.

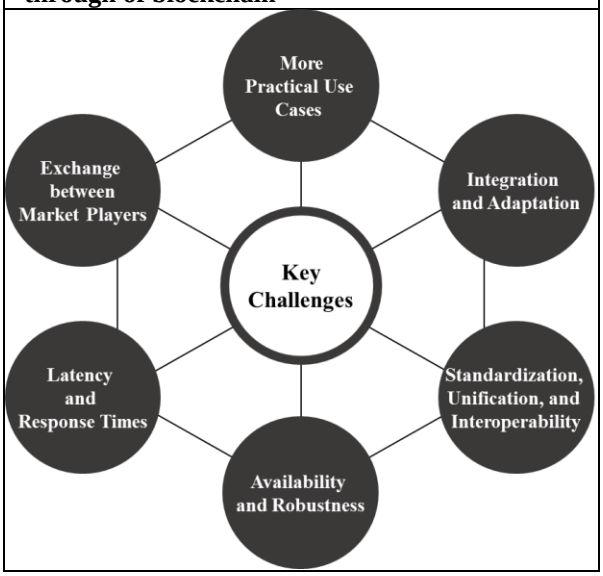
4. Findings

The findings of our analysis are presented in two steps. First, the key challenges resulting from the Delphi study are introduced (corresponding to RQ1). Second, the findings from the Delphi study are combined with key insights from the interviews to further explore each challenge and to explain the rationale behind it (corresponding to RQ2).

We derived six key challenges from the data analysis of the Delphi study. These provide a better understanding of what is hindering further development of blockchain technology in the payments industry. The challenges can be abstracted from the specific industry (namely the payments industry) and eventually considered relevant for the dissemination of blockchain in other industries and sectors.

The six key challenges (as depicted in Figure 1) are: (1) need for more practical use cases rather than theoretical concepts; (2) integration within and adaptation to legacy systems; (3) need for standardization, unification, and interoperability; (4) high availability and high level of robustness; (5) low latency and short response times; and (6) closer collaboration between market players, including regulators.

Figure 1 Key challenges to achieve the breakthrough of blockchain



The insights presented in the following sections are drawn from the input provided by the panelists of our Delphi study, as well as from comments registered during the subsequent interviews. All direct citations in this section are taken from the comments provided by participants in our Delphi research, and are shown in italic font. Individual opinions from the interviewees are marked by I1, I2, I3, and I4 (cf. Table 1).

4.1. More practical use cases

The panelists identified the lack of practical use cases that can clearly prove the advantages of blockchain as one of the main challenges. As mentioned by one of the Delphi participants, "*to be accepted on a wider range, blockchain technology should prove that it can do better than the existing infrastructure in terms of speed, efficiency, and costs."* This perspective is driven by the currently strong focus on applications in theory, rather than on actual use cases. One aspect panelists criticized is that "*use cases to date have not tested the scale and configuration of the blockchain"* actually needed in financial services. Hence, further development is hindered as the extent to which the new technology can fulfill the high requirements of the payments industry is unclear [37]. The panelists believe that use cases could trigger a *"positive helix of application,"* where even regulators would join the movement as they favor features of blockchain technology such as transparency and increased control.

Further insights gained during the interviews suggest that the current lack of use cases is due to limited availability of "*manpower*." The more use cases built, "*the more can be tested*" (I2). Currently, it is primarily "*proposals*" and "*demo showcases*" that exist (I4). However, the skills needed to build cases are rare and, in turn, the development of new cases is slow. Some actors in the financial services sector have proposed pure testing of "*marketing or advertisement materials of the providers*" (I3), which is far from the "*real application in the environment of a bank with certain boundary conditions*" (I3). The "*question is, which use cases are reasonable*" (I3) for financial services purposes? In a subsequent step, each "*use case has to be analyzed as to whether it fits*" (I4) the desired application area, and whether it has sufficient substance to be realized.

4.2. Integration and adoption

The second challenge resulting from the Delphi study is related to the limited integration of new technologies within legacy systems of banks and other financial services institutions. The main reason was identified as pertaining to the outdated infrastructure, which makes "*interfacing legacy systems with blockchain an ongoing challenge*." At this stage, there is an open question as to how the *"implementation of blockchain connections to existing IT"* should happen. In effect, applications of blockchain technology have

mostly been tested outside the current infrastructure. The panelists agreed that there should be a shift to where "*companies are required to adopt new technology more strongly and integrate new blockchain technology in existing systems*." However, the "*challenge of incorporating blockchain into the existing infrastructure"* remains.

Some of the interviewees stressed this aspect by stating that "*integration is the biggest challenge*" (I1). This issue becomes even more apparent when solutions are based on a greenfield approach. As a possible solution, the adoption of an "*integration layer*" (I1) was suggested, since it could serve to connect new technologies to existing systems. The main obstacle to integration, however, is believed to lie in the outdated focus of financial institutions. While in the past the application owners of these systems were traditionally thought to be at the center of attention, the digitalization of financial services has shifted the view towards decentralized and automated services that could eventually even occur via blockchain. It is then the responsibility of managers to lead this transition and guide their employees. In an example provided during one of the interviews, a parallel was drawn with what happened in another industry, i.e. the publishing sector: "*where the biggest challenge was to explain to a well-trained journalist why he should suddenly receive less attention and love than some blogger who has had great growth online. I believe we [the financial services sector] are going through the same transition*" (I1).

4.3. Standardization, unification, and interoperability

By means of the Delphi study, we also identified standardization, unification, and interoperability as a key challenge, as there is consensus that "*standards, unification, and interoperability (across companies, industries, and borders) are needed to boost blockchain technology*." Currently, different applications rely on various unstandardized implementations of blockchain. Thus, "*the lack of common industry standards is seen as a great bottleneck for mainstream acceptance of blockchain technology."* Hence, the development of "*consequent, and ideally global, standards is required*." Standards are important to enable "*interoperability of different infrastructures*" and enable better assessment of how to apply certain technological features. The panelists stated that they do not expect blockchain technology to be suitable for large applications on entire transaction systems without standards.

The interviewees further stressed that standards are decisive as "*different areas [in financial services] will use different blockchains*" (I1). Furthermore, the definition of standards is difficult regarding blockchain, as it is not a technology that is owned by a particular firm or standardized by a dominating coalition. The development of blockchain is currently driven not only by large corporations, but especially by individual developers who are following an approach similar to this statement: "*I published a new version of the blockchain. You can decide if you want to use it or not. But there is nobody really standing behind this implementation of blockchain*" (I2). Regarding this point, the formation of consortia was mentioned, which could "*ensure that people are communicating with each other because of the necessity to solve a common problem*" (I1) within the industry.

4.4. Availability and robustness

In our Delphi study, we found consensus on technical requirements for blockchain in terms of high availability with no downtime, a high level of robustness, and 24/7 service in order to be used for payment transactions. Panelists consistently stressed that "*payments must be processed around the clock and on every day of the year*." Absolutely no amount of downtime is acceptable, and even "*maintenance should not be connected with downtime*." Additionally, the international efforts toward instant payments require that blockchain technology ensures solidity in a "*real-time environment and, connected with that, constant accessibility to the clearing systems*."

When analyzed from a different perspective, the high requirements of the payments industry may also represent an opportunity for this new technology. As one of the interviewees mentioned, "*blockchain as a decentralized system is better suited to support*" (I2) the needs of the payments industry. In fact, the "*higher reliability and availability*" (I3) of blockchain as opposed "*to traditional systems*" (I3) was mentioned as a point of superiority. Furthermore, traditional payment systems were never designed for current requirements of the industry such as instant processing and 24/7 service. Their initial development started way before the emergence of the Internet; while over time the requirements have massively increased, the systems in use have not developed at the same pace. In banking, it is common opinion that the requirements cannot be met by conventional technology and existing database systems. Instead, this could represent an opportunity for blockchain technology as it uses a different design and aims to be "*constantly available and constantly online, even if some of the nodes are offline*" (I3). Specifically, "*blockchain is actually properly suited as it builds on decentralized systems. […], hence, the single point of failure can be eliminated*" (I2). As a result, the "*configurations of blockchain are an advantage with regard to existing problems*" (I3). Ultimately, firms

have to evaluate which is the "*best, most efficient, and cheapest, implementation of the requirements*" (I3) and "*if banks and Visa are able to manage it for their systems without blockchain, then they should also be able to realize it with blockchain*" (I2).

4.5. Latency and response time

High technical requirements are not only reflected in terms of high availability. In that direction, panelists in our Delphi study highlighted that low latency is needed to allow short response times and fast acceptance of transactions via blockchain technology. The status of blockchain currently seems to entail a tradeoff between the "*development of a ledger protocol that will enable high-volume/low-latency real-time transaction processing […] [and] processing capacity saturation challenges*." Moreover, the panelists expect the capacity requirement to significantly increase the closer the technology gets to market maturity. In the near future, the scaling issue of the technology has to be tackled. As with most new technologies, however, scalability is a particular problem in this early stage.

As one of the first applications of blockchain technology, "*transaction throughput of Bitcoin is referenced at seven transactions per second*," while "*retail payment networks do thousands of [transactions] per second*." Moreover, size and bandwidth could represent a related challenge considering that "*Bitcoin blockchain, for instance, is over 50 GB and is growing by 15 GB per year*," which implies that the "*data volume can become an issue considering the high transaction rates in payments*." Finally, network latency is currently high, given that, in the case of Bitcoin, the "*confirmation times for a block are very slow – quoted at 10 minutes per block – whereas verification for credit card transactions only requires seconds*."

A huge potential for blockchain technology lies within the distributed system, which, spread across the globe, and can reduce response times as the "*end user only needs to cover the distance to the next server*" (I2) to confirm a transaction. However, this depends on the implemented software and hardware infrastructure. Furthermore, different implementations of blockchain could further decrease response times, for instance by utilizing it "*on the basis of single transactions*" (I3). In this scenario, there would be almost no batch transactions, which usually slow down confirmations.

4.6. Exchange between market players

The key challenges identified as findings of the Delphi study do not solely focus on technical aspects. Consensus was reached that a closer exchange between market players is needed to further develop regulatory standards. Regulation is one of the main determinants when it comes to new technology in financial services, especially in payments. Consequently, "*significant legal and regulatory work will be required and common standards need to be agreed (inclusive regulators and non-financial competitive players), before blockchain technology can be broadly adopted*." On the regulatory side, parties such as "*banks, regulatory agencies, and central banks have to be integrated*" into the discussions to start "*regulatory discourse to allow the wide application of blockchain*." In essence, "*collaboration between all parties involved, including regulators and tech firms*" is necessary, especially since the rationale behind the challenge is that "*the regulatory framework is in principle agnostic to the underlying technology*" of blockchain, while the ultimate hope is "*that regulation should not stifle innovation*."

The development of new technology in financial services is always connected with "*regulatory hurdles that are standing in the way*" (I2). In order to overcome these hurdles, either "*external help or partners are needed*" (I2). The gathering of all market players "*is organized in industry forums with clear goals*" (I1); but, as one of the interviewees indicated, what remains problematic is the lack of visionary power and transformative momentum in such meetings. Both seem to be completely missing as these meetings are staffed with "*employees with very few visions*" (I1) and the working groups are not led by visionary leaders but by "*chairmen who are already three years retired*" (I1).

5. Discussion

The previously explained six key challenges are currently hindering the breakthrough of blockchain in the payments industry. They appear to be interrelated and seem to converge to a final aspect, which is, once again, the need for the technology to concretely prove its added value compared to existing technologies. This is not only true in the payments industry or the financial services sector, but applies to all other sectors as well. Moreover, this challenge becomes evident also with other new technologies, and with IT in general [7]. Proven use cases are a convincing way to show cost savings or increased efficiency, which might speak in favor of blockchain. As such, prototypes and experiments are still needed, and while the technology has attracted significant attention, it continues to face expectations that may even be inflated cases [22]. It should not be surprising, then, that blockchain has been recently positioned at the peak of Gartner's hype cycle of emerging technologies [8]. This is partly in line with some criticisms raised in the literature [31]. However, the position in the hype cycle represents only a temporary stage, as the technology is expected to further de-

velop and move along the curve. In the short term, the lack of human resources could exacerbate the currently existing challenges, leading to a slowdown of the evolution of blockchain. Eventually, the attention that the technology is currently receiving could contribute to attracting more talent, which would lead to overcoming this issue over time.

More difficult to overcome is the need to integrate and adapt the technology with respect to legacy systems, which could also represent one of the main reasons why current use cases of blockchain do not appear to be convincing. This is true partly because financial institutions are unable to completely redesign their infrastructures anytime soon, especially given the current economic circumstances. New regulations are already requiring the implementation of additional compliance standards, as well as industry-specific changes, while at the same time increased competition and changing customer behavior are draining required resources. A possible solution to this standstill could be the adoption of a modular architecture, where the different components are loosely coupled [20]. If this were to happen, the integration of blockchain might no longer represent a problem, and blockchain could adequately be docked on via defined standards. However, as stated above, this cannot be expected under the current circumstances.

Recent developments have indicated that global financial institutions are already allocating substantial investments to finance internal, as well as external, projects dedicated to exploring implementations of blockchain [28]. This trend, though, is currently not followed by small or mid-sized institutions, which should raise concerns about the possibility of impacting competition in the sector. Ways to facilitate more agile development of the technology could be offered by start-ups providing financial services based on blockchain, since their current systems might have a head start as these companies are less, or even not at all, dependent on old infrastructures. As a result, the development of so-called white-label solutions might be promising. In this case, small firms would sell their novel applications of blockchain technology to extant financial institutions. These institutions could then label the chosen application according to their requirements, though they would still need to deal with the integration challenges discussed above.

The emergence of new technologies is characterized by industry-wide standards or agreed upon quasi-standards, but the setting of standards can be a double-edged sword for new technologies [18]. On the one hand, standards can foster the development of technologies, as more market players can build on those technologies given a clear definition of the requirements [14]. Moreover, standards are specifically important for the payments industry, as it builds on a worldwide network with many interconnected players [5]. On the other hand, standards can limit the dissemination of new technologies if imposed in a very early stage, because then more promising deviations of the technology would be rejected. Consequently, while standards are necessary, they bear the risk of being premature and restrictive. It is possible that developments comparable to what has occurred with other technologies, such as databases, will happen, where an initially large number of standards slowly converge to a few that eventually prevail [18]. Furthermore, given the flexible use of blockchain for different purposes and by various actors, it would be wrong to limit certain blockchain applications due to standards that are too restrictive.

The requirements regarding new technology in financial services are exceptionally high [37]. A recurring concept since the last financial market crisis has been the reduction of risks in the sector, for which new technologies make no exception. Technologies adopted in financial services represent the skeleton sustaining all activities taking place within a developed economy, and when deployed they must constantly assure a reliable and adequate standard of service. As such, this might result in delayed implementation of blockchain in the payments industry until complete assurance of its reliability is provided. At the same time, though, the technology might profit from the strict requirements of the industry. Given its peculiarity of being a ledger that is distributed among the parties in the system, blockchain has already overcome one of the most important risks for the industry, which is that of representing a single point of failure [29]. Furthermore, it is interesting to note that although in the payment industry security plays a superior role, security has not emerged here among the key challenges. This is mainly due to a low consensus regarding experts' evaluation of the security feature of blockchain. The individual perceptions of the security features of blockchain are very diverse. Moreover, security comprises a broad spectrum of financial services, and a number of aspects are included in the availability and robustness challenge.

Despite the lack of an established, clear definition of response time and latency, the current implementations of blockchain still reveal doubts about its scalability in terms of the number of transactions in a given timeframe [5]. Currently, it is unclear as to the exact number of transactions that can be handled in a given period of time. Various solutions, such as the transaction of micro-payments "off the chain," have been proposed to solve this issue. Off-the-chain transactions are not directly integrated into the chain of blocks and would therefore reduce the burden imposed on the chain. However, a clear path to this point is far from being realized, because it may require the need to co-

ordinate the efforts of various institutions, and agreement on a specific standard.

The need for collaboration between market parties is being partly addressed via the formation of consortia or work groups that have emerged recently (e.g., the banking consortium R3, B3i initiative for insurance companies). This could ensure that stakeholders are communicating with each other, and may even mean that the possible outcome of such collaborations lead to new directions, unifications, and standards for the industry (hence addressing two challenges simultaneously). A further example of collaboration is the conversation that European regulators are having with experts to discuss the application of blockchain technology, and the workshops organized, for example, by the German Bundesbank. Still, the decision of some large banks to leave the R3 consortium just before publication of the source code behind blockchain that was developed by the consortium indicates how fragile the equilibrium within such collaborations is.

6. Conclusion

For decades, the payments industry, and more generally the financial services sector, has been dependent on solid IT systems. With new technologies in financial services appearing rapidly, the convergence between technology and financial services is also progressing further. One of the most promising examples is blockchain technology, whose implications have been discussed far beyond financial services [39]. Nonetheless, the road towards deployment of this technology on a large scale is not believed to be immediate, and despite the benefits of blockchain, which have often been outlined, only little has been said about the challenges that it faces prior to breakthrough [5]. Our paper contributes to the literature on blockchain by investigating the key challenges of blockchain to achieve breakthrough via insights from the payments industry. However, we believe that the findings of the paper are applicable to other industries as well.

The analysis was based on a comprehensive Delphi study conducted among experts with a solid background in blockchain and payments. This analysis was then complemented by four in-depth interviews with experts of the payments industry, as well as experts of blockchain technology companies. The findings indicate that blockchain is currently expected to face six major challenges. These are: (1) need for more practical use cases rather than theoretical concepts; (2) integration within and adaptation to legacy systems; (3) need for standardization, unification, and interoperability; (4) high availability and high level of robustness; (5) low latency and short response times; and (6) closer collaboration between the market players.

These challenges are a double-edged sword. On the one side, they represent the very high requirements of the payments industry, which will increase the burden until suitable and best-designed implementation of blockchain is realized [37]. On the other side, these high requirements also represent the huge potential of blockchain technology, as legacy systems are approaching their limits [29]. This issue will eventually require a complete redesign of the financial technology infrastructure, which, in the future, might be built on blockchain. Nevertheless, this is not expected to occur soon, and, as such, the development of blockchain technology within the payments industry also depends on the possibility to actually overcoming challenges and prejudices with concrete proof of value added.

Our research builds on preliminary discussions and initial scholarly attention in the literature around blockchain technology. By providing a new perspective on the adoption of a new technology in a specific industry, the study offers evidence surrounding the usually long and convoluted adoption process. Furthermore, it provides insights on the challenges that blockchain technology, specifically, is believed to be facing. This research further carries important practical implications, as it uncovers challenges occurring in financial services. It can be expected that adequately addressing these challenges will eventually contribute to boosting the development of blockchain technology.

Limitations of our research include the reporting of aspects that may reflect only the current status of the technology, since it is still in an early stage of development. Furthermore, the level of expertise in the industry on this technology is still low, and uncertainty remains. The coding of items during the data analysis was conducted by three independent researchers, but was not verified with the panelists in order to keep the number of Delphi rounds manageable. In addition, we did not consider the example of Bitcoin or other cryptocurrencies. These currencies stand independently and in separate to the underlying blockchain technology. Hence, they are not integrated into the current, traditional payments systems, as underlined by the decision by the majority of central banks not to recognize Bitcoin as a currency. The coherences between the challenges were not studied here, and the challenges are not free of overlaps; hence, further research should look at the relationships among them (e.g., via interaction effects analysis).

Blockchain technology is at a young age, and research on the matter is still scarce. Future research should advance the findings of this paper by addressing the challenges under the various points of view of different stakeholders in the industry. In addition, more research should be dedicated to analyzing the advancement of blockchain over time, and factors affect-

ing the development of financial technology. Finally, there would be great value in future research examining how to tackle these challenges by, for example, analyzing industry-wide initiatives or putting greater emphasis on the changes in organizations to foster the dissemination and adoption of blockchain.

7. References

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