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Conference Paper

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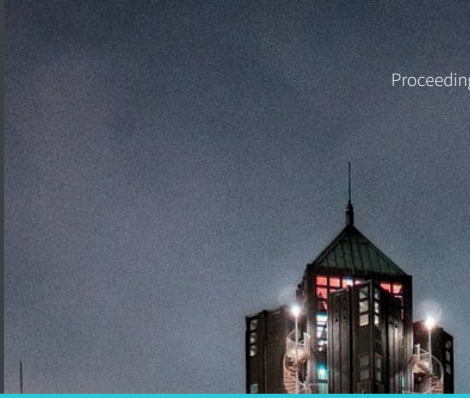

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Impact and Beneficiaries of Blockchain in Logistics

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Impact and Beneficiaries of Blockchain in Logistics

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Purpose: Blockchain in logistics is slowly moving beyond the hype. Against this background, we investigate the current expectations concerning the impact and possible beneficiaries of Blockchain applications in the logistics services industry.

Methodology: We conduct an online survey among logistics professionals to understand their expectations regarding specific use cases, potential issues, and general developments. Specifically, we ask the respondents to evaluate impacts and beneficiaries of three actual Blockchain projects from the logistics domain.

Findings: We find that industry professionals are still optimistic about Blockchain and expect it to make an impact on both communication effectiveness and costs in the industry. However, we also find that the expected impact and beneficiaries strongly depend on the underlying use case.

Originality: While there is a fast-growing body of research on Blockchain in the logistics industry, the specific impacts and beneficiaries of Blockchain usage as they relate to different use cases have received little attention to date.

Keywords: Blockchain, Logistics, Survey, Use Cases

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1 Introduction

As an emerging technology, Blockchain has received an increasing amount of attention in recent years. After being brought into the general consciousness by the cryptocurrency Bitcoin, the technology was initially perceived as a phenomenon in the financial industry. However, a Blockchain is a general-purpose decentralized database with cryptographic assurances about integrity and write access. Monetary systems such as Bitcoin are only one possible application of this structure (Tapscott and Tapscott, 2018). Several sectors could benefit from this technology (e.g., Carson et al., 2018; Gentemann, 2019). One industry in the spotlight of Blockchain considerations is logistics, characterized by a large number of interacting organizations without efficient information exchange processes (Dobrovnik et al., 2018). The Blockchain as a distributed data structure is uniquely suited for this purpose. Consequently, it is widely believed that Blockchain will have a profound transformational effect on the industry as a whole (e.g., Hackius and Petersen, 2017; Treiblmaier, 2018).

Digitally enabled technologies, in general, are increasingly used to improve logistics processes. Additive manufacturing, artificial intelligence, and autonomous driving are just three examples of technologies that promise to change how logistics is done today (Hoberg et al., 2019). Blockchain is also one of these technologies, raising hope and fear at the same time. After a period of inflated expectations with little substance, the industry is slowly figuring out how Blockchain could be utilized for its logistics processes (e.g., Dobrovnik et al., 2018; Groenfeldt, 2017; Petersen et al., 2018). Also, companies increasingly scrutinize the actual value Blockchain can bring beyond a technology savviness signaling effect. To further illuminate the

value proposition of Blockchain for logistics, we seek to provide insights into the impact that Blockchain might have on the logistics process as a whole and the role of different actors. Two research questions emerge from this perspective: (1) “Which positive impacts might Blockchain in logistics entail?" and (2) "Who might benefit from Blockchain in logistics?" The subsequent sections of this paper have the following structure: We begin with a theoretical analysis of Blockchain with a focus on logistics. Following this, we introduce three projects as examples of the emerging Blockchain logistics industry. Then, we present the setup and results of an expert survey that we conducted among industry professionals. We discuss the results in the subsequent section, followed by limitations and further research, and a conclusion.

2 Theoretical Background

In this section, we introduce the theoretical underpinnings of Blockchain and provide a short overview of recent research in the emerging subfield of Blockchain application for the benefit of logistics.

A Blockchain is a decentralized, verified, and immutable ledger for the storage of information (Figure 1). To implement these key characteristics, the data is fully replicated across all nodes in a peer-to-peer network. By storing this data itself, each node can verify that the rest of the network is storing the data correctly and not tampering with the database. Moreover, all transactions must be signed with a private key cryptographically linked to the sending account. This allows the access management to be verified across the network as well. Through a consensus algorithm, the nodes can

then establish a common understanding of the current state of the database, making it immutable (Tapscott and Tapscott, 2018).

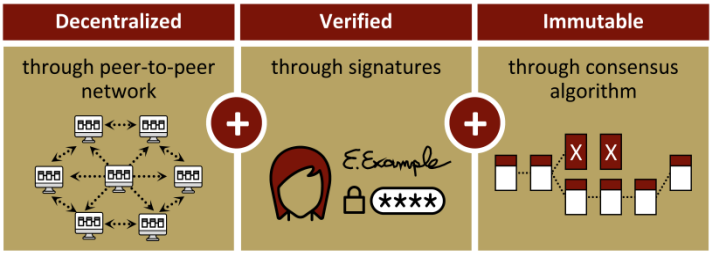

Figure 1: Characteristics of Blockchain (Hackius and Petersen, 2017)

What this mechanism allows for is the creation of a database without the central authority that is usually required to run that database. The most obvious consequence would be the development of databases that store information important to multiple stakeholders in a business process. However, the previous requirement for a central database operator has traditionally enabled the business models of intermediaries and other third parties seeking to insert themselves between business partners and extract revenue from their role in the process. Removing the need for these intermediaries potentially has dire consequences for their business models and potentially positive implications for the industry as a whole (Avital et al., 2016). This close link to the structure of the industry also means that any analysis of the implications of Blockchain must consider the affected industry and not just general characteristics of the technology (Nowiński and Kozma, 2017).

A key characteristic of the distributed database is that all nodes in the network have access to all transaction data. This is a fundamental aspect of Blockchain because it is necessary for them to verify the correctness of the

transactions. It also enables the nodes to conduct data analysis to draw conclusions on the real-world business associated with the stored data (Kalodner et al., 2017). Therefore, the Blockchain poses challenges regarding the privacy of people associated with the data and regarding confidential internal information by the involved organizations.

Regarding the state of research on Blockchain in logistics, we survey some of the existing literature in the following. Note that most of these contributions discuss Blockchain in both logistics and supply chain management, suggesting that the fields are closely related. Since our focus on Blockchain in logistics is indeed on its impact on the whole supply chain, such papers are well-suited to shed light on our research area. In an early practitioner survey, Hackius & Petersen (2017) found that while high hopes are on Blockchain in logistics and supply chain, scientific publications on the subject are still scarce. This no longer holds. In their more recent literature review, Queiroz et al. (2019) and Wang et al. (2019) found an increasing number of relevant publications. However, despite this increase, the number of peer-reviewed publications is found to be still below 30 papers in total, possibly illustrating a misfit of long review cycles and fast technological developments.

Wang et al. (2019) distinguish between enhancements of transparency and associated characteristics and the associated gains in efficiency. The first aspects relate to tracking information on the Blockchain. This way, the information is authentic and can no longer be altered, and since it is visible to all participants in the network, it makes the process transparent. This is useful for information about the contracting, the state of the transport process itself (which would essentially replace Bills of Lading and other forms of paper-based documentation), and other metrics about the freight such

as location information or temperature (Poszler et al., 2019). The immutability also means that unauthorized movement of freight (such as theft) cannot be represented on the Blockchain, potentially easing the recovery of stolen merchandise (Queiroz et al., 2019). Utilizing this information can help increase the efficiency of the overall network. Since the information is available in digital form, it can be processed automatically and the paper form is no longer required. This also means it is instantly available to all interested parties without handling physical documents (Wang, Singgih, et al., 2019). Dobrovnik et al. (2018) propose that a critical mass of users is necessary to make applications viable through the network effect. Thus, coordination between many parties is required. However, they focus on diffusion within the industry without considering external parties, such as the customers of the industry. Wang et al. (2019) follow a similar approach to analyze the diffusion of Blockchain in Supply Chain Management. Gallay et al. (2017) additionally highlight the importance of decentralization – if a central party has influence over or even control of the network, other organizations are unlikely to adopt it.

Overall, the focus of the Blockchain logistics literature is set to improving efficiency. Thus, it is in stark contrast to publications like Flint et al. (2005), who find that customer value drives successful innovation in the field of logistics. Perboli et al. (2018) also propose that Blockchain projects in the industry should focus on understanding business processes to be able to deliver customer value.

3 Industry Analysis

In this section, we present industry projects to highlight the potential of Blockchain for logistics. In their analysis, Poszler et al. (2019) determine the value-add of different Blockchain startups in logistics. They list use cases, partners, revenue, and cost structure of the startups, illustrating the breadth of the industry. Our overview also includes projects undertaken by established companies. The Blockchain in logistics industry consists of a large number of diverse organizations with different backgrounds and approaches (e.g., Bita, 2019). Thus, this section is not intended to be an exhaustive list, but rather a sample of well-known projects selected by the authors. The intent is to capture projects that have already moved beyond the conceptualization stage and have developed real applications and to capture different use cases and implementation mechanisms.

3.1 CargoX

Our first example is CargoX, a Slovenian startup that has developed a Blockchain-based Bill of Lading for containerized ocean freight. The startup is focused on the Bill of Lading but intends to include all other freight documentation in their product as well through an iterative development process. In a trial with just the Bill of Lading, they claim to have reduced processing costs by 85% (Wee, 2018). The startup partners with external logistics companies for the deployment of the technology, but it aims to be a neutral platform for all actors in the market instead of a venture by any particular market participant (such as the TradeLens platform headed by Maersk and IBM). CargoX believes that an open platform is necessary for succeeding in the marketplace (Rajamanickam, 2018).

3.2 dexFreight

dexFreight is a startup building a freight exchange on the Blockchain that allows shippers and carriers to negotiate directly. dexFreight is also looking to provide an open platform and partners with established logistics companies. Trucking companies can store various company-related documents on the platform to speed up the onboarding process of subcontractors. Thus, the focus for the shippers can be on negotiating terms related to the specific freight rather than administrative tasks. The negotiation of specifics such as rates, delivery and pickup times, and other stipulations also occurs on the platform. Ultimately, the entire contracting part of freight transportation is both handled and documented on the Blockchain (Prevost, 2018). dexFreight has recently partnered with CargoX to provide documentation for both contracting and the actual transportation process within one platform and remove paper from the entire process (Rajamanickam, 2019).

3.3 GS1

A specific part of the logistics process is the target of a pilot project for the digitization of pallet notes. Most companies that require pallets for the movement of freight already participate in a pallet-sharing program in which pallets trade flexibly among all involved parties. This requires an accounting structure for the ownership, state, and flow of the pallets. The systems currently rely on paper-based pallet notes, but the project aims to bring Blockchain to this field. Through a smartphone application, the operators can access a Blockchain backend to store information about the

transfer of pallets between the different parties. Since there is no single pallet owner who could operate a traditional digital ownership-tracking infrastructure, Blockchain has enabled the digitization of this process (Uhde, 2018). After the trial period, the project partners consider the project to be a success and intend to continue developing this system (Nallinger, 2018).

4 Survey about the Impacts and Beneficiaries of Block-chain in Logistics

The three project exemplars introduced above illustrate that the market for Blockchain in logistics extends across multiple use cases and organizational backgrounds. The projects' impacts and beneficiaries are likely depending on the use case - warranting a more diversified approach to evaluating Blockchain's potential benefits for logistics. We decided to run an expert survey to shed light on these issues. Parts of the survey update the findings from a similar study we ran in 2017 (i.e., Hackius and Petersen, 2017). This section describes the survey's setup and its most relevant findings.

4.1 Setup and Data Collection

We conducted a four-section survey using Typeform. First, we asked about the general industry role of the participant and their general opinion and knowledge of IT in logistics and Blockchain in general. Secondly, we introduced the three projects as described in the previous section, and inquired about the participants' opinion of them. Following, we asked more specific questions about Blockchain as a technology. We then concluded the survey with some more questions about the background of the participants.

For the evaluation of the projects, we adopted the approach proposed by Bienstock et al. (1997) and added dimensions recommended by Qureshi et al. (2008) and Yeung (2006). Hence, we used the criteria reliability, timeliness, cost, sustainability, and information sharing to evaluate how the logistics process might benefit from each of the three projects.

Data collection started April 10th and ran until May 1st, 2019. The study was distributed among respondents of the previous survey, known industry partners, and various social media channels (Twitter, Xing, and Reddit) related to the topic of supply chain and logistics. The survey link was also included in email newsletters by two industry associations in Hamburg and three online bulletin boards. We incentivized participation through small donations. After data collection was concluded, we donated 50 Euro to "Zeit für Zukunft" (Hamburg-based mentoring program) and to "Ingenieure ohne Grenzen" (Berlin-based aid organization) on behalf of our participants. In total, we received 81 qualified responses.

Especially for anonymous internet surveys, it is recommended to identify and exclude potentially careless responses (Meade and Craig, 2012). However, none of the data sets exhibited any unusual answer pattern. All 81 collected data sets were prepared for statistical analysis following the guidelines of Hair et al. (2009). We used the software jamovi for data analysis.

4.2 Findings

In the following, we present the results of our survey. In addition to looking at the descriptive statistics, we ran statistical analyses (ANOVA) to explore differences between respondent groups. Such differences are presented only if they are found to be statistically significant at the 5%-level.

Figure 2 gives an overview of the 81 respondents: A clear plurality works in logistics services, with consulting and manufacturing being the other large groups of respondents. German participants represent the majority, followed by individuals from the USA, India, and a large number of countries with a small number of participants. In total, 70% of the participants are from Europe. As expected, company headcount and company turnover yielded similar overall distributions. A slight majority of respondents work in small organizations and about a quarter in medium-sized companies.

Figure 3 summarizes the results pertaining to the company's stance towards Block-chain. 20% of the respondents indicate to not be involved with Blockchain in any fashion. Together with respondents observing the development from a distance, they represent the majority of companies.

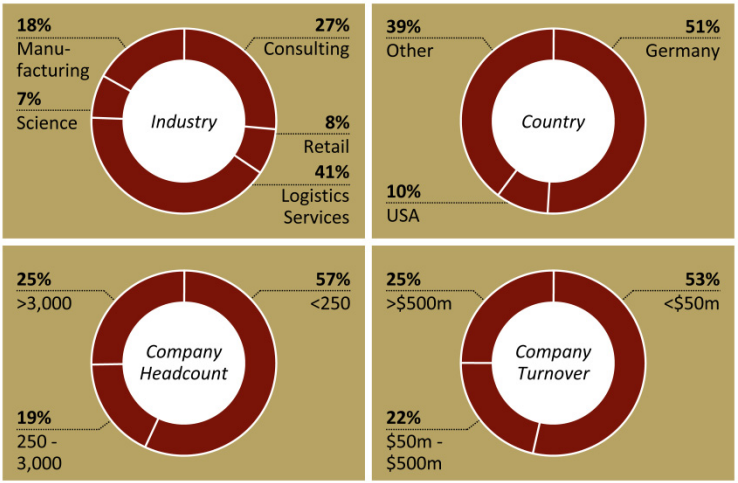

Figure 2: Industry and Organizational Background

Only 14% are actively working with Blockchain, around 30% state to be investigating use cases. Overall, these results indicate a hesitant approach to the technology. We also found that big companies are significantly more likely to be implementing Blockchain solutions than small companies (as measured by company turnover).

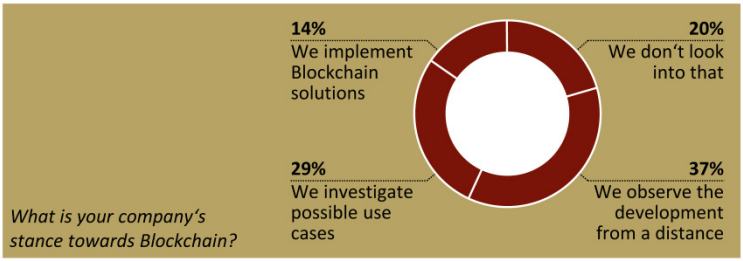

Figure 3: Stance towards Blockchain

As shown in Figure 4, we asked our respondents for their opinion on two statements on Blockchain. They show a tendency to believe that Blockchain has real use cases and offers tangible benefits for business (average rating of 6.68). This is particularly true for the executives among them, who have given an average response of 8.4, a significantly higher value than the one provided by both middle management (5.95) and operational personnel (6.43). Also, we asked about the maturity of the technology and got mixed results (average rating of 5.48). Again, the executives in the sample show a significantly more positive attitude towards the technology (with a score of 7.2) than their fellow respondents (4.80 and 5.22).

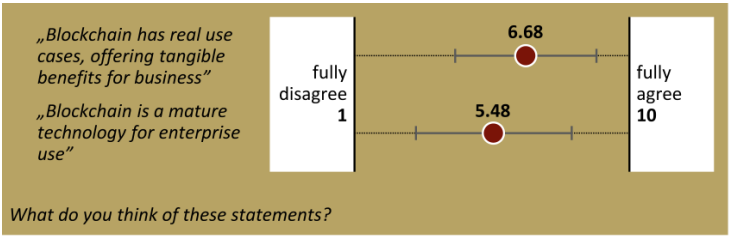

Figure 4: Statements on Blockchain

Respondents working in logistics services have rated the maturity of the technology more than 1.5 points lower than their colleagues in other sectors. For both statements, it has to be kept in mind that the standard deviations are high. Thus, our respondents are far from agreeing on these issues.

Next, we inquired about the potential beneficiaries of Blockchain usage. Figure 5 shows that multiple groups have received a large percentage of votes. 84% of respondents believe that Blockchain would benefit logistics service providers, followed by 77% for technology providers and similar responses of slightly above 60% for both senders and receivers. In the 2017 survey, we asked the same question and got a more positive result for senders and receivers. Thus, the customers received ratings similar to those of logistics service providers and technology providers. This may be indicative of a shift in the perception of Blockchain in the industry. However, the 2017

sample size and structure differ from this survey and, thus, this inter-temporal relationship cannot be established reliably. Still, we consider it noteworthy.

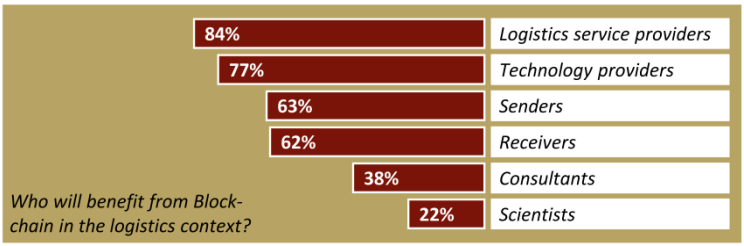

Figure 5: Beneficiaries of Blockchain in Logistics

In the question depicted in Figure 6, we asked how our respondents expect Blockchain to change the logistics industry. All options presented in this multi-option question have been reasonably popular with the respondents, with even the least popular option being selected 41% of the time. The most frequently selected option at 85% was the stronger IT integration with customers, suggesting that customers can also benefit from Blockchain in the logistics context.

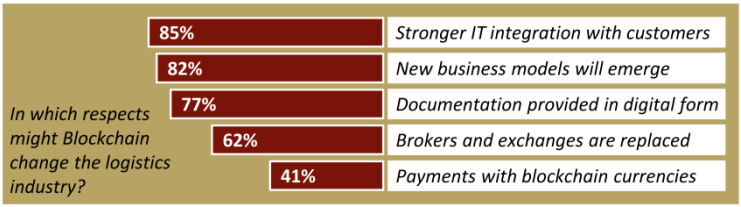

Figure 6: Blockchain-induced Industry Changes

The emergence of new business models came in a close second, followed by digital documentation. The replacement of brokers and exchanges and

Blockchain payments received fewer votes than the leading group of options.

We found that respondents from companies with more Blockchain implementation experience anticipate more different kinds of change than their less experienced counterparts. We measured experience through the responses shown in Figure 3; to achieve this, we created a binary "less experience/more experience" measure by splitting the four response options into two groups of two options each.

To enable a more detailed analysis of the expected impacts and beneficiaries of the technology, we asked participants to evaluate the three projects presented previously (Figure 7). Our participants received a short introduction to each project, based on the information in Chapter 3, to allow them to respond meaningfully.

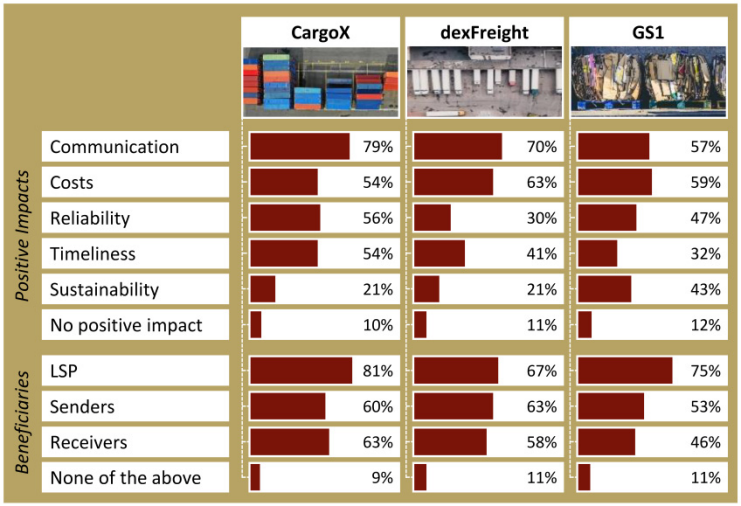

Figure 7: Evaluation of Specific Blockchain Projects

Overall, the results show that Blockchain is expected to make the strongest impact on communication between stakeholders, followed by an impact on cost. For the GS1 project, cost is slightly ahead of communication. The technology is also expected to have an impact on reliability and timeliness. For the CargoX project, the two have received almost the same percentage of votes. However, timeliness leads for dexFreight, and reliability leads for GS1. Sustainability is the least popular potential impact area with just above 20% of the respondents expecting an improvement for CargoX and dexFreight. However, this figure jumps to 43% for GS1. In general, the evaluation of GS1 has yielded different results than the evaluation of CargoX and dexFreight. The impact areas of the latter two are similar in their order and overall values (except for a large difference in reliability impact), and the large spread between the impact areas. For GS1, costs rank ahead of communication due to a big drop in communication impact, and sustainability beats timeliness due to a significant increase in sustainability impact. Additionally, the spread between the biggest and the smallest impact areas is much smaller.

Regarding the beneficiaries of these projects, the logistics service providers themselves rank ahead of their customers (senders and receivers). However, there is a difference between the projects – CargoX benefits the logistics service providers significantly more than dexFreight. Overall, senders and receivers have received similar responses, with senders ahead of receivers for dexFreight and GS1, but a slight lead for the receivers with CargoX. Both have received values between 60% and 70% for CargoX and dexFreight, but only around 50% for GS1. For both CargoX and GS1, the logistics service providers rank about 20 percentage points ahead of their customers as potential beneficiaries. Only the dexFreight project is expected

to benefit the customers on a similar (but still lower) level. Overall, the technology is expected to have a strong impact on all participants, with only one value dropping slightly below 50%, and most far above.

The beneficiaries of the CargoX project have received very similar percentages to the beneficiaries of the overall technology (Figure 5), while both dexFreight and GS1 deviate from the result. This might suggest that the value proposition of CargoX is the use case most commonly associated with the technology, while the other projects implement solutions that are not as well-known to the respondents.

The specific use case associated with each project is paramount when comparing the results between the projects. It is noticeable that while senders and receivers are expected to benefit similarly from CargoX and dexFreight, the freight exchange has scored worse for the logistics service providers themselves. One may expect that easier negotiations between customers and logistics service providers would make it easier for customers to receive multiple offers for each item of freight. Thus, competition between logistics service providers might increase, ultimately hurting their ability to maintain profit margins. For the GS1 project, logistics service providers receive a higher result again, but senders and receivers fare lower. This would be expected for innovation in the logistics process itself, but the sender usually provides the pallets along with the freight. One may speculate that

respondents wrongly assumed the pallet notes to be a logistics process innovation not relevant to the customers.

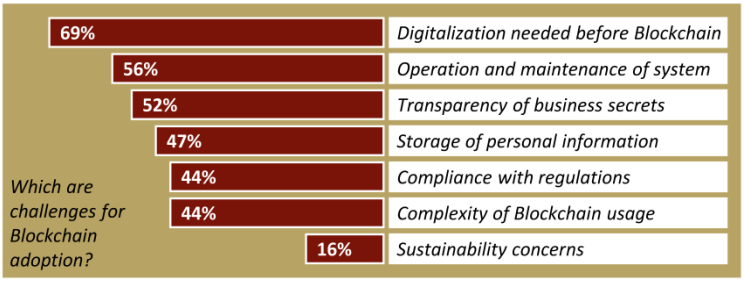

Figure 8: Challenges for Blockchain Adoption

Finally, regarding barriers to the adoption of Blockchain, 69% of respondents believe that digitalization is necessary before Blockchain can be introduced, as shown in Figure 8. This option has received the most votes by a large margin. This means that most respondents agree that many companies still have to do their homework concerning digitalization - a fact that can act as a decisive roadblock for any digital technology. The three options of storage of personal information, usage complexity, and regulatory compliance have received almost the same amount of votes at close to 50%. Sustainability, however, has merely received 16%, suggesting that such concerns are not perceived as a significant barrier to adoption. Similar to what has been found for the impacts of the technology, more experienced respondents anticipate significantly fewer different challenges than their less experienced counterparts.

5 Discussion and Implications

Our study reveals that most respondents and their companies are still cautious about implementing Blockchain even though they expect many benefits in different areas of the logistics industry. Overall, general questions about the technology have received more positive responses than those asking about the current state. This may indicate that the technology has not yet reached its expected potential.

Remarkably, respondents working in companies with more Blockchain experience tend to see more positive impact areas and fewer challenges. One may expect that more experienced companies possess better information about the technology than their less experienced peers. Interestingly, this may point to a positive relationship between past decisions to conduct Blockchain projects (which we use to measure technology experience) and future Blockchain projects (which we expect to be based on the general attitude towards the technology by people within the company). This may lead to the emergence of a divide between companies which keep on adding to their experience with the technology, and other companies stagnating at a low level of experience.

While this is an assumption, it highlights that companies should seek to develop an understanding of Blockchain and use it according to their findings, not based on general skepticism towards an unknown technology. This is an important finding from a managerial perspective. However, the positive attitude by executives suggests that management is well-equipped to utilize this effect.

Due to its background in cryptocurrencies such as Bitcoin, these currencies are still a major theme in the industry. Our study confirms that this holds

for the logistics industry as well, with 41% of respondents expecting cryptocurrencies to be used for payments.

Regarding problems for Blockchain, the biggest one appears to be the lack of digitalization in the industry. This is a positive result for Blockchain, but it also presents a valuable lesson to both technology providers and logistics services providers – Blockchain projects cannot just move digitized assets to a different kind of database, but they must digitize the physical world first. Therefore, they have to understand the real-world logistics processes, interactions, and paperwork in order to be successful, as previous research has suggested. However, technology-related problems also rank high, highlighting the lack of maturity.

This may be viewed as a statement regarding the difference between startups and Blockchain projects started within the logistics industry. Indeed, of our three example projects, the two startups were rated differently compared to the industry project. Overall, the number of selected impact areas is similar, but for the industry project, the spread between the different impact areas is much smaller. However, at a sample size of three, we cannot make any reliable statement comparing startups and projects by established companies.

One key stakeholder of the logistics process is the customer that benefits from the freight being moved. Our results show that the logistics companies themselves, rather than their customers, are seen as the primary beneficiaries in Blockchain projects. The technology providers as the secondary beneficiary also rank ahead of senders and receivers. However, the logistics process as a whole is ultimately undertaken for the benefit of senders and receivers of freight. A technology that primarily benefits the logistics service providers and technology providers might not be a good fit for

such a market. As a technology is expected to benefit mostly the logistics service providers, Blockchain may generate a positive impact on their customers through cost savings, but this impact area only ranks second. The primary impact area is customer communication. It is surprising to see that this impact area ranks higher than the customer as a beneficiary, highlighting that customer communication does benefit the logistics service providers as well as the customer.

6 Limitations and Further Research

The survey underlying this publication is subjected to some limitations. The sample is relatively small, not demographically representative, and concentrated in the geographic area of Germany. Additionally, we expect our sample to be biased towards those who actively network in social media channels and those who are part of the industry groups contacted by the authors. These limitations represent a starting point for future research, as others may conduct similar surveys within other subgroups.

Regarding the differences between the three Blockchain projects, a larger sample of projects would be necessary to conclude the differences between the associated company structures or use cases. Further research may also focus on the disruption of the established industry by new players, which is a common expectation in our study. Our conjecture of a divide between users and non-users may also be a starting point for future research.

7 Conclusion

In this contribution, we present the results of our study regarding the state of Block-chain in logistics and its impact on the supply chain. We find that the technology may have a large impact on the industry in the future, but for now, companies are rather cautious about implementations. We find that those who have implementation experience it are significantly more optimistic about it – a cautious approach may be associated with unwarranted caution in the future. We also find that a lack of digitalization is the biggest hurdle for Blockchain adoption in the industry, ahead of any technical problems related to Blockchain technology itself.

While our research shows that Blockchain in logistics is expected to have the strongest impact on logistics services itself, its customers (i.e., senders and receivers of freight) have also received strong results regarding a potential impact. In terms of impact areas, communication and costs dominate. Further research is required to understand the precise nature of this impact on the logistics process and the value chain as a whole, and the differences between startups and projects by established companies. While our results in this area are ultimately inconclusive, they suggest that differences exist.

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References

Avital, M., Beck, R., King, J., Rossi, M. and Teigland, R., 2016. Jumping on the Blockchain Bandwagon: Lessons of the Past and Outlook to the Future. The 37th International Conference on Information Systems ICIS 2016, AIS Electronic Library, Dublin.

Bienstock, C.C., Mentzer, J.T. and Bird, M.M., 1997. Measuring Physical Distribution Service Quality. Journal of the Academy of Marketing Science, Vol. 25 No. 1, pp. 25–31.

Bita., 2019. Members of BiTA. BiTA: Blockchain in Transport Alliance, available at: https://www.bita.studio/members (accessed 6 June 2019).

Carson, B., Romanelli, G., Walsh, P. and Zhumaev, A., 2018. Blockchain Beyond the Hype: What is the Strategic Business Value? June, available at: https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/blockchain-beyond-the-hype-what-is-the-strategic-business-value (accessed 24 May 2019).

Dobrovnik, M., Herold, D.M., Fürst, E. and Kummer, S., 2018. Blockchain for and in Logistics: What to Adopt and Where to Start. Logistics, Vol. 2 No. 3.

Flint, D.J., Larsson, E., Gammelgaard, B. and Mentzer, J.T., 2005. Logistics Innovation: A Customer Value-oriented Social Process. Journal of Business Logistics, Vol. 26 No. 1, pp. 113–147.

Gallay, O., Korpela, K., Tapio, N. and Nurminen, J.K., 2017. A Peer-to-Peer Platform for Decentralized Logistics. in Kersten, W., Blecker, T. and Ringle, C.M. (Eds.), Digitalization in Supply Chain Management and Logistics, epubli, Hamburg, pp. 19–34.

Gentemann, L., 2019. Blockchain in Deutschland – Einsatz, Potenziale, Herausforderungen. Bitkom e.V., available at: https://www.bitkom.org/sites/default/files/2019-04/190423_bitkom_studie_blockchain_2019.pdf (accessed 13 May 2019).

Groenfeldt, T., 2017. IBM And Maersk Apply Blockchain To Container Shipping. Forbes.Com, March, available at: https://www.forbes.com/sites/tomgroenfeldt/2017/03/05/ibm-and-maersk-apply-blockchain-to-container-shipping/#7d43507a3f05 (accessed 8 February 2019).

Hackius, N. and Petersen, M., 2017. Blockchain in Logistics and Supply Chain: Trick or Treat?. in Kersten, W., Blecker, T. and Ringle, C.M. (Eds.), Digitalization in Supply Chain Management and Logistics, epubli, Hamburg, pp. 3–18.

Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E., 2009), Multivariate Data Analysis, Prentice Hall, Upper Saddle River.

Hoberg, K., Petersen, M. and Heinen, J., 2019. Die Implikationen digitaler Technologien für die Supply Chain 4.0. In Obermaier, R. (Ed.), Handbuch Industrie 4.0 Und Digitale Transformation: Betriebswirtschaftliche, Technische Und Rechtliche Herausforderungen, Springer Gabler, Wiesbaden.

Kalodner, H., Goldfeder, S., Chator, A., Möser, M. and Narayanan, A., 2017. BlockSci: Design and Applications of a Blockchain Analysis Platform. ArXiv.

Meade, A.W. and Craig, S.B., 2012. Identifying Careless Responses in Survey Data. Psychological Methods, Vol. 17 No. 3, pp. 437–455.

Nallinger, C., 2018. Hat der Palettenschein ausgedient? 17 December, available at: https://www.eurotransport.de/artikel/palettentausch-mithilfe-der-blockchain-hat-der-palettenschein-ausgedient-10634469.html (accessed 3 April 2019).

Nowiński, W. and Kozma, M., 2017. How can Blockchain Technology Disrupt the Existing Business Models?. Entrepreneurial Business and Economics Review, Vol. 5 No. 3, pp. 173–188.

Perboli, G., Musso, S. and Rosano, M., 2018. Blockchain in Logistics and Supply Chain: A Lean Approach for Designing Real-world Use Cases. IEEE Access, Vol. 6, pp. 62018–62028.

Petersen, M., Hackius, N. and von See, B., 2018. Mapping the Sea of Opportunities: Blockchain in Supply Chain and Logistics. It - Information Technology, Vol. 60 No. 5–6, pp. 263–271.

Poszler, F., Ritter, A.-C. and Welpe, I., 2019. Blockchain Startups in the Logistics Industry: The Technology's Potential to Disrupt Business Models and Supply Chains. In Schröder, M. and Wegner, K. (Eds.), Logistik Im Wandel Der Zeit, Springer, Wiesbaden, pp. 567–584.

Prevost, C., 2018. dexFreight Completes First Truckload Shipment Using Blockchain. 24 October, available at: https://www.freightwaves.com/news/blockchain/technology/dexfreight-completes-first-truckload-shipment-using-blockchain (accessed 25 March 2019).

Queiroz, M.M., Telles, R. and Bonilla, S.H., 2019. Blockchain and Supply Chain Management Integration: A Systematic Review of the Literature. Supply Chain Management: An International Journal.

Qureshi, M., Kumar, D. and Kumar, P., 2008. An Integrated Model to Identify and Classify the Key Criteria and their Role in the Assessment of 3PL Services Providers. Asia Pacific Journal of Marketing and Logistics, Vol. 20 No. 2, pp. 227–249.

Rajamanickam, V., 2018. CargoX Introduces an Open and Neutral Blockchain Platform for the Maritime Industry. November, available at: https://www.freightwaves.com/news/technology/cargox-blockchain-smart-open-neutral-platform (accessed 22 March 2019).

Rajamanickam, V., 2019. CargoX's Blockchain-based Smart Bill of Lading Solution is now on dexFreight's Platform. March, available at: https://www.freightwaves.com/news/blockchain/cargoxs-blockchain-based-smart-bill-of-lading-solution-is-now-on-dexfreights-platform (accessed 13 May 2019).

Tapscott, D. and Tapscott, A., 2018), Blockchain Revolution: How the Technology behind Bitcoin and Other Cryptocurrencies Is Changing the World, Penguin, New York et al.

Treiblmaier, H., 2018. The Impact of the Blockchain on the Supply Chain : A Theory-Based Research Framework and a Call for Action. Supply Chain Management: An International Journal, Vol. 23 No. 6, pp. 545–559.

Uhde, T., 2018. Blockchain-Technologie und Architektur im Pilot-Projekt. December, available at: https://www.gs1-germany.de/innovation/blockchain-blog/das-passende-system-blockchain-technologie-und-architek/ (accessed 25 March 2019).

Wang, Y., Han, J.H. and Beynon-Davies, P., 2019. Understanding Blockchain Technology for Future Supply Chains: A Systematic Literature Review and Research Agenda. Supply Chain Management: An International Journal, Vol. 24 No. 1, pp. 62–84.

Wang, Y., Singgih, M., Wang, J. and Rit, M., 2019. Making Sense of Blockchain Technology: How Will it Transform Supply Chains? International Journal of Production Economics, Vol. 211, pp. 221–236.

Wee, V., 2018. CargoX Runs First Successful Electronic Bill of Lading Shipment. August, available at: http://www.seatrade-maritime.com/news/europe/cargox-runs-first-successful-electronic-bill-of-lading-shipment.html (accessed 22 March 2019).

Yeung, A.C., 2006. The Impact of Third-party Logistics Performance on the Logistics and Export Performance of Users: An Empirical Study. Maritime Economics & Logistics, Vol. 8 No. 2, pp. 121–139.