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# Blockchain Adoption at German Logistics Service Providers

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**Purpose:** The study provides a recent overview of the diffusion of blockchain technology in the logistics industry. It reveals the adoption of blockchain technology at German logistics service providers (LSPs) and their expectations regarding the future relevance of the technology. Based on the TOE Framework adoption supporting and inhibiting factors are identified.

**Methodology:** In a first step, LSPs listed in the “Die Top 100 der Logistik 2016/2017” were contacted and questioned about their blockchain activities. Based on the responses, qualitative interviews were conducted with seven participants as part of a three-stage Delphi study.

**Findings:** In particular small and medium-sized German LSPs are currently hardly involved in blockchain technology. Larger LSPs are beginning to define their own use cases and are trying to develop them further in joint projects with partners. A systematic use is currently not taking place.

**Originality:** The study reveals the current discrepancy between rapidly evolving theoretical approaches for the use of blockchain technology in logistics, on the one hand, and the absence of the technology in everyday operations on the other hand. It also reveals a reluctant attitude of the management towards the technology.

**Keywords:** Blockchain Adoption, German Logistics Service Providers, TOE Framework, Delphi Method

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## 1 Introduction

The blockchain technology is an emerging but also highly controversial innovation for the logistics industry that challenges LSPs (Hackius & Petersen, 2017). According to Tushman and Nadler (1986), innovations can create incremental, synthetic or discontinuous change. Incremental changes have a minor impact on an organization and involve only little risk. Synthetic changes result from existing ideas or technologies being reconstructed and combined in an innovative way. The highest impact on an organization with respect to change and risk arises from discontinuous change. Concerning the last-named category, in particular, the distinction between “competence-enhancing” and “competence-destroying” (Tushman & Anderson, 1986) innovations is crucial. Competence-enhancing innovations enlarge the expertise of companies and contribute to further development. Competence-destroying innovations may render existing technologies and expertise obsolete. As blockchain technology is in an early stage, the future will show which classification applies in the case of LSPs. However, even without a specific classification, it becomes clear that blockchain technology will influence logistics services anyway (Blossey, Eisenhardt, & Hahn, 2019; Dobrovnik, Herold, Fürst, & Kummer, 2018). LSPs that adopt blockchain technology will be able to exploit the benefits or to adjust their business models.

In consequence, this paper does not aim to evaluate the impact of blockchain on LSPs. Instead, the objective of this paper is to address a lack of research, pertinent to academics and practitioners by shedding light on the adoption of blockchain technology at LSPs. Thus, our research questions are:

RQ1: Which factors influence the adoption of blockchain technology at LSP?

RQ2: How advanced is the blockchain adoption at LSP?

By answering these questions, we respond to calls from Hughes et al. (2019) to research on the adoption of blockchain technology, especially on the benefit expectations. We also respond to Blossy et al. (2019) to identify success factors and challenges of implementing blockchain applications. Finally, we respond to Risius and Spohrer (2017) to research on how existing intermediary service providers position themselves towards blockchain technology.

The remainder of the paper is structured as follows. Section two lays the theoretical foundation for assessing the adoption of blockchain technology at German LSPs. Subsequently, in section three, the research methodology and the data sample are explained. The findings of our study are presented in section four. These are discussed and summarized in propositions in section five. In the final section, we summarize the contributions of our study and address implications for further research.

## **2 Theoretical Background**

### **2.1 Blockchain in Logistics**

The blockchain technology is a topic of steadily increasing interest for academics and practitioners (Li, Marier-Bienvenue, Perron-Brault, Wang, & Paré, 2018; Miao & Yang, 2018; Risius & Spohrer, 2017). A blockchain is a shared ledger that allows a decentralized verification and immutable storage of data and thus a trustworthy record of business activities (Nofer, Gomber, Hinz, & Schiereck, 2017). Because of its ability to create trust

within a decentralized system with participants that do not necessarily trust each other, the application of blockchains seems to facilitate the elimination of a trustful third-party intermediary (Swan, 2015). Besides the execution of rather simple transactions such as currency or token transactions, blockchains also allow for more complex transactions via the application of smart contracts (Szabo, 1997). Thus, because of the blockchain characteristics and the possibility to execute smart contracts, the term “disruption” has frequently been used in recent years for the blockchain technology, in order to describe an estimated radical change of business processes and even business models in many industries (Mettler, 2016; Nofer et al., 2017; Peters & Panayi, 2016).

The logistics industry is expected to be one of the most impacted sectors. For example, Korpela et al. (2017) develop a concept for a blockchain-based digital supply chain that could enable an end-to-end data integration. Blosssey et al. (2019) offer the most recent overview of blockchain applications in the field of logistics and supply chain management. According to them, blockchains can be applied in the fields of a) supply chain visibility, b) supply chain integrity, c) supply chain orchestration, d) supply chain virtualization, and e) supply chain finance. In most of the existing studies, blockchain technology is described as a competence-enhancing innovation for logistics services. However, it can also be a competence-destroying one. For example, Subramanian (2017) argues for blockchain-based decentralized marketplaces, *inter alia* for transportation services. Such a market place could seriously harm the existing business models of forwarders. It becomes clear that especially LSPs are well-advised to deal with blockchains, either in order to develop their business models or to be prepared for emerging new competitors.

The aforementioned studies are rather conceptual than empirical and only a few studies have been conducted which describe the adoption of the blockchain technology in logistics until now. Dobrovnik et al. (2018) offer a conceptual approach to discuss the adoption of blockchain technology in the logistics industry. Based on Rogers' attributes of innovation (relative advantage, compatibility, complexity, trialability, and observability) (Rogers, 2003), they hypothesize potential blockchain applications in the logistics industry (Dobrovnik et al., 2018). An empirical proof of the propositions does not take place. Hackius and Petersen (2017) conducted an expert survey of logistics professionals to explore potential applications and future prospects of blockchain technology in supply chain management. According to them, there are significant differences in regards to the estimated benefits and adoption barriers of blockchains between logisticians on the one hand, and consultants as well as scientists on the other. Especially logistics experts "have difficulties getting a clear idea of the benefits and use cases" (Hackius & Petersen, 2017, p. 16) and make reservations regarding an anticipated high level of collaboration and commitment. Thus, Hackius and Petersen ask logisticians to "engage in experiments to find out if and how Blockchain [sic!] could be of use for their own company" (2017, p. 16). We distinguish to the aforementioned literature in so far that we offer profound details on the antecedents for blockchain adoption of LSPs on an organizational level. To the best of our knowledge, there has been no other study on this topic so far. Thus, we intend to fill this gap with this paper and build on the findings of Hackius and Petersen (2017).

## 2.2 Innovation Adoption

Adoption of innovations takes place on different levels, e.g. individuals, groups, organizations or industries. The different entities on each level adopt the innovation, based on their attitude towards innovations. The more entities adopt an innovation, the higher is the possibility that adoption spills over to other entities and levels (Valente, 1995). Thus, adoption is a sub-process of diffusion according to Rogers (2003). There are several approaches that conceptualize the adoption process, e.g. the technology acceptance model (Davis, Bagozzi, & Warshaw, 1989), the theory of planned behavior (Ajzen, 1991), and the unified theory of acceptance and use of technology (Venkatesh, Morris, Davis, & Davis, 2003). However, in this paper, we apply the concept of Rogers (2003) as his approach seems to be applicable not only for individuals but also for organizations. Rogers divides the adoption process into five different stages: a) knowledge, b) persuasion, c) decision, d) implementation and e) confirmation. In the knowledge stage, a decision-making unit gets the awareness of an innovation, reaches a basal understanding of the innovation, and apprehends the principles of the innovation. During the persuasion stage, the decision-making unit forms an attitude toward the innovation, based on the perceived characteristics of the innovation, e.g. relative advantage, compatibility, complexity, trialability, and observability (cf. section 2.1). In consequence, the decision-making unit decides to adopt or to reject the innovation in the decision stage. The implementation stage describes the application of the innovation in routine processes. This stage often comes along with a degree of uncertainty and adaptations of the innovation (Rogers, 2003). After a distinct time, the decision-making unit evaluates the outcome of the decision stage within the confirmation stage. At this point in time, discontinuance, which

Rogers describes as "a decision to reject an innovation after having previously adopted it" (Rogers, 2003, p. 182) can occur.

In order to explain adoption on an organizational level, the TOE framework turned out to be very fruitful, because of its general applicability (Baker, 2012). According to the TOE framework (DePietro, Wiarda, & Fleischer, 1990), the organizational adoption of technological innovation is influenced by the context's technology, organization, and environment, which can be "constraints and opportunities for technological innovation" (1990, p. 154). As the contexts are not exclusively, Zhu and Kramer (2005, p. 63) describe TOE as a "generic" framework.

The technological context of the TOE framework refers to all relevant technology for an organization, whether it is equipment or processes. This includes technology that is already applied in an organization (Collins, Hage, & Hull, 1988) but also technology that is generally available but not yet applied in an organization (Kuan & Chau, 2001). The adoption of new technology is restricted by the significance and embeddedness of the already applied technology with respect to its ecosystem (Adner & Kapoor, 2016).

The organizational context represents all organizational characteristics and resources available for the adoption and operationalization of technological innovation. Elements of the organizational context include financial readiness, slack resources, top management support, the involvement of the employees, the degree of centralization, technology competence and, to a lesser degree, the size of the organization. Large organizations are considered to be more successful in adopting innovations (Damanpour, 1992) mainly because of higher financial resources (Iacovou, Benbasat, & Dexter, 1995) and more slack resources (Rogers, 2003).

The environmental context describes the setting in which an organization acts. Characteristics of this context are the size and structure of the industry, the technology support infrastructure, and the regulatory environment (DePietro et al., 1990). Because of the endogenous competitive pressure, the size and structure of an industry have been identified as highly important characteristics of the environmental context (Iacovou et al., 1995). However, not only competitors influence the adoption but also customers and partners in the value chain, such as suppliers, retail partners or service providers (Kuan & Chau, 2001). Especially vertical relations in value chains accelerate the adoption of new technologies (Alipranti, Milliou, & Petrakis, 2015).

### **3 Research Process**

#### **3.1 Methodological Approach**

To be able to investigate the adoption behavior of LSPs, we conducted a three-stage Delphi study. Delphi studies use an iterative feedback technique with a group of experts (Dalkey & Helmer, 1963). In this study, we apply the procedure as proposed by Murry and Hammons (1995). According to them, a Delphi study consists of two main phases: a) Definition and selection of experts and b) multiple iterations of questionnaire rounds. In this study, we define experts as managers that are responsible for the technological or business development at German LSPs and have a job experience of at least three years. Based on these criteria, we contacted all companies listed in "Die Top 100 der Logistik 2016/2017" (Schwemmer, 2016) and asked for participation of relevant experts. A detailed description of the different experts follows in the next section.

In the first questionnaire round, we asked the participants for basic information about their companies and blockchain activities. Based on these results, we prepared a second round with guided qualitative interviews. The interviewees were informed about the intentions of the study before the start of the interviews and the guideline was made available to the interviewees one week before the interview. The interviews took place from June till August 2018. They were recorded on tape and later transcribed. Within the scope of qualitative content analysis, the statements of the interviewees were manually paraphrased and coded (Saldaña, 2009). The results of the qualitative interviews were condensed in a classification scheme with the help of the theory derived from the TOE framework (DePietro et al., 1990) and were used to create a survey to evaluate the blockchain efforts of the company. This helped to classify the companies even better within Rogers' adoption process (Rogers, 2003) and their assessment of blockchain. Finally, the findings were discussed with each participant. After the third stage, a consensus was reached among the participants and thus, the procedure came to an end (Murry & Hammons, 1995). In order to eliminate problems associated with face-to-face meetings, the names of the participating managers and companies were treated confidentially during the entire procedure (Murry & Hammons, 1995).

### **3.2 Sample Description**

In total seven interviews with German LSPs were conducted. In the following, we name the seven cases A to G for the sake of anonymization. Company E is partly a logistics service provider. The investigated companies employ between 750 and 35,600 employees and their turnover was between 130 million and 15 billion in 2018. The interviewees job positions can

be defined as follows: Site manager (A), CEO (B), CIO/Head of Global IT (C), Manager of Corporate Development/Head of Innovation (D), Blockchain-representative/employee in the field of digitalization (E), CIO (F) and Team-leader Innovation (G). The share of turnover in contract logistics referring to the full turnover of each company ranges from 18-97%.

## **4 Findings**

### **4.1 Classification of Blockchain Engagement**

The first questionnaire round revealed that all interviewees know the blockchain technology and attribute benefits to the technology. Cases A and B reached an awareness of the technology but in contrast to the cases C and D, they have not started to engage profoundly and deepen their knowledge on the technology yet. The cases E, F and G have done so and also developed blockchain use cases in order to gain specific knowledge and be able to evaluate the technology for their purposes. The procedure differs in so far as case F carries out an individual project, while cases E and G each cooperate with other companies. Figure 1 gives an overview of the companies' blockchain engagement

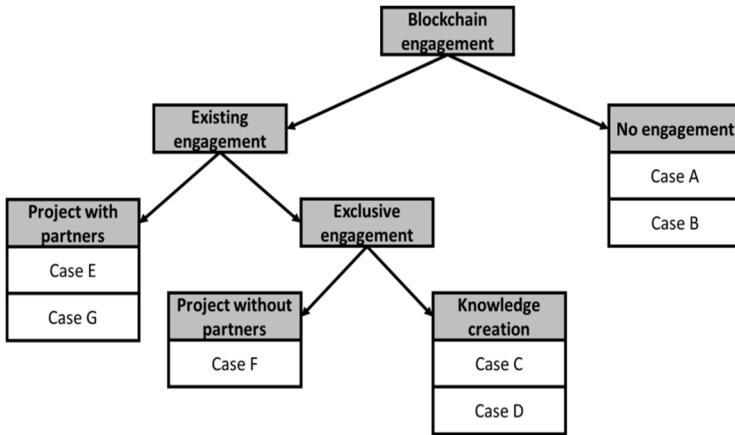


Figure 1: Classification of companies' blockchain engagements

## 4.2 Factors of Influence for Blockchain Adoption

During the qualitative interviews in the second stage of the Delphi procedure, factors, according to the TOE framework were identified that facilitate or inhibit blockchain adoption. The technological context comprises a high number of influencing factors in the categories perceived characteristics of the blockchain technology, existing IT infrastructure and data as well as IT knowledge. General perceived benefits of blockchain technology are more predictive supply chains, general optimization, and savings based on an end-to-end digitalization and a high level of privacy based on the applied encryption. The most mentioned perceived benefits of the blockchain technology are high data security based on the distributed ledger and transparency. In contrast, some interviewees expressed the fear of insufficient privacy and sharing data with all blockchain participants. Further perceived

shortcomings are technological immaturity (i.e. performance, speed, scalability, and power consumption), the complexity of the technology and missing blockchain standards. Besides the perceived characteristics of the blockchain technology, the data quality and the maturity of the existing IT infrastructure and its compatibility with blockchain technology were named as adoption impediments. Likewise, the interviewees attributed to their companies a lack of relevant IT knowledge, especially in the fields of interface control and blockchain infrastructure.

The influencing factors of the organizational context were all considered to inhibit blockchain adoption. The main factors are the culture of the organization and financial considerations. The different cultures of the organizations were described as reluctant in most of the cases. The interviewees were apprehensive of the “curse of the first mover” (Rayna, and Striukova, 2009), called existing use cases “lobbying” and stated missing trust towards blockchain in general. The financial considerations represent anticipated high investments, sunk costs through a partial replacement of existing systems and in consequence an unclear cost-benefit ratio. Further organizational factors include strict IT governance rules and a high need for process harmonization.

Similar to the organizational context, the environmental context was predominantly described as inhibiting by the interviewees. The pressure from the customers as well as from competitors and other closely related industry partners seems to be low. The interviewees expected other companies are not willing to share data via blockchains and only very few customers asked for blockchain solutions. In addition, short contract periods impede investments into blockchain technology. Likewise, legal uncertainties in

general, especially referring to smart contracts depict impediments. A facilitating factor is represented by the estimated ongoing technological development of the logistics industry.

Figure 2 gives an overview of the influencing factors for blockchain adoption based on the TOE framework.

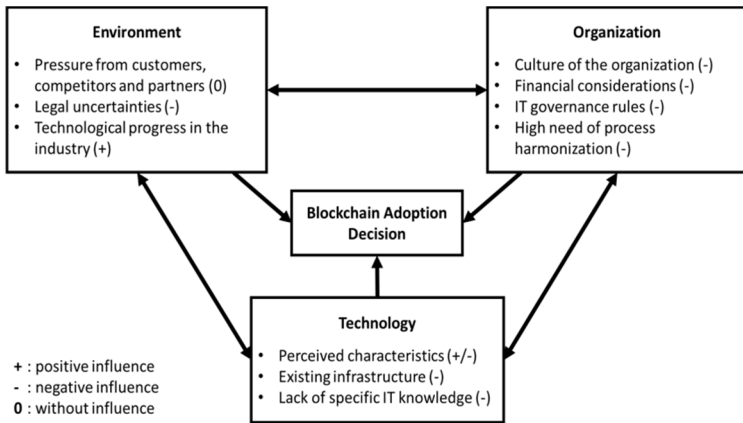


Figure 2: Factors that influence blockchain adoption at LSPs

### 4.3 Assessment of the Blockchain Adoption Process

During the third stage of our Delphi procedure, we conducted a second survey based on the blockchain and innovation adoption literature as well as the results of the qualitative interviews. The purpose of the survey was to determine the statuses of the different companies with regards to the adoption of blockchain technology. Thus, the interviewees first assessed their company's blockchain efforts. Based on the answers and the results

of the analysis of the qualitative interviews, we determined the adoption statuses of the companies according to the adoption process of Rogers (Rogers, 2003). The results of our classification were discussed with the interviewees until consensus was reached. Table 1 depicts the final results of our classification.

Table 1: Adoption statuses according to Rogers (2003)

<b>Case/Company</b>	<b>Phase of the adoption process</b>
A	Knowledge phase (awareness knowledge)
B	Knowledge phase (how-to-knowledge)
C	Knowledge phase (how-to-knowledge)
D	Knowledge phase (principles-knowledge)
E	Begin of persuasion phase
F	End of persuasion phase
G	Decision phase

## 5 Discussion

### 5.1 On the Adoption of Blockchain Technology

Our research reveals the practitioners' perception of blockchain technology. Although more inhibiting than facilitating factors were mentioned, the interest in blockchains is rather high. Nevertheless, the reviewed LSPs act

differently. Our results show that companies with solely theoretical blockchain knowledge have a positive attitude towards the technology. These companies acknowledged the future importance and advantages of the technology. For example, the interviewee in case D explained, if it is possible to conclude contracts soon without the parties knowing each other, the market will be very efficient through smart contract logistics operators. Cases C and D assume that in future automatic contract negotiations and conclusions will be possible through interlinked transport management systems and supply chain management systems. These estimated use cases correspond with the work of Blossey et al. (2019) who name the supply chain orchestration an emerging blockchain-driven innovation.

Companies with practical blockchain experience also highlighted the future relevance of blockchain technology, but in the same way, they learned about the difficulties of the technology. For example, the company of case F conducted various use cases but is still doubtful, which processes should be performed with the help of blockchains in the future. The company of case G initiated a blockchain consortium in which several companies are involved. The target of the consortium was to develop a standardized blockchain protocol for a specific tracking and tracing system that incorporates sensor data to initiate smart contracts for payments. However, the implementation is unclear, because of the uncertain stability of cryptocurrencies (Catania, Grassi, & Ravazzolo, 2019). The company of case E works on a use case in cooperation with a number other companies and investigates the application of blockchains for financial transactions, billing methods within the company, processes of order processing as well as track and trace of materials from production to consumption. Additionally, the company is a member of an international network of different companies that

shares knowledge on blockchains and smart contracts e.g. for price determination and flexible adaption. These results add to the research of Hackius and Petersen (2017) who attested logisticians in 2017 difficulties in getting a clear idea of use cases. Two years later, several LSPs are able to identify and conduct first use cases but they have not made a final adoption decision so far. Furthermore, it confirms the practical utility of the so far hypothesized application of blockchain in logistics (Dobrovnik et al., 2018; Korpela et al., 2017).

The companies A and B, which had not engaged in blockchain technology behaved critically towards the technology. They observed the technology and market and found themselves mainly in a waiting position. Company A supposed benefits in the area of tracking and tracing, a transparent supply chain with live status messages and billing processes with the help of smart contracts. Company B assumed the same advantages. Additionally, it named predictive maintenance and network coordination with other companies as further prolific application areas.

## 5.2 Implications

Our research on the adoption of blockchain technology at LSPs has theoretical and practical implications, which will be summarized in this section. In general, we suggest that German LSPs should focus more on blockchain technology and define their own use cases. Companies should also cooperate more intensively to define certain blockchain rules and standards, e.g. for emerging networks.

**Implication 1: The theory about blockchains in logistics is far more advanced than the practice.** A lot of research has been conducted to conceptualize blockchain applications for logistics (Blossey et al., 2019; Dobrovnik

et al., 2018; Korpela et al., 2017). However, our research reveals a gap between the existing literature and use cases in the reality of German LSPs. We identified facilitating and inhibiting factors according to the TOE framework (DePietro et al., 1990) that help to understand this development. In addition to these factors, the nature of the blockchain technology seems to impede its diffusion in practice. Blockchains can create trust in decentralized environments where the participants do not necessarily trust each other (Swan, 2015). However, this constellation makes it difficult for companies to set up comprehensive projects in order to gain experience, as they normally would prefer trustful partners for such kind of projects. This impediment should be addressed by researchers. For example, the game theory (Aumann & Hart, 1992) could be a prolific source for ideas. Moreover, future blockchain research in the field of logistics should apply more practice-oriented methodologies, e.g. action research (Lewin, 1946).

**Implication 2: The size of the LSPs strongly influences the adoption of blockchain technology.** All reviewed companies perceive the blockchain technology to be more positive than negative. Nevertheless, the willingness to change differs between larger and smaller LSPs. In our study, the larger LSPs are more engaged in the adoption of blockchain technology. They defined own use cases and developed them further in cooperative projects with partners. According to Rogers, this positive adoption behavior is the result of existing slack resources, which usually go along with a large size of an organization (Rogers, 2003). In contrast, we found also evidence that most of the companies do not want to change their (IT) structures, processes and work routines, Hannan and Freeman (1984) call this unwillingness to change structures and rejection of innovation “inertia”, which is normally more likely to occur at large organizations. In our cases, inertia

was more likely to occur at smaller companies. A possibility to overcome this inertia is the contact to external networks (Gilbert, 2005). However, in the case of German LSPs, external networks do not seem to positively influence the blockchain adoption behavior of smaller LSPs. The perceived pressure in the logistics industry as well as in partner companies was rated low and medium by the interviewees. Future research could focus on differences in the adoption behavior of smaller and larger LSPs.

**Implication 3: The management, especially at small LSPs, is in torpor.**

Our study also reveals a reluctant attitude of the management towards the technology. All interviewees acknowledged the future importance of blockchain technology. Nevertheless, no one of the interviewees – even not in the cases A and B – felt threatened by the blockchain technology. Although numerous research revealed potential threats to LSPs (e.g. Subramanian, 2017), the management does not perceive the blockchain technology as a discontinuous change and competence-destroying technology in the sense of Tushman and Nadler (Tushman & Nadler, 1986). Especially small LSPs have not engaged in the technology so far. The managers of the small LSPs refer to technical issues of blockchain technology, problems with the own IT infrastructure, little slack resources, organizational inertia and no pressure from the stakeholders in order to justify the low engagement. We argue that most of the named inhibiting factors are under the control of the management and the management has not attempted to change these factors. In fact, the management seems to be as much affected by the organizational inertia as other members of the companies. However, this implication is limited as we only reviewed a few companies. Further research is necessary to prove this implication. Future research should also address

the question, which kind of LSPs will be most affected by the blockchain technology.

**Implication 4: LSPs fear transparency because it reveals weaknesses in their work processes.** One interviewee mentioned that blockchain technology could make their company too transparent (De Cremer, 2016). Customers or competitors could become aware of failures or weaknesses and use this information against the company. However, this apprehension fades the more experiences were made with the blockchain technology. For example, all interviewees of companies with blockchain engagement evaluated the data disclosure in a blockchain positively. Future research could elaborate on this effect of the adoption of blockchain technology in logistics but also in general.

## 6 Conclusions, Limitations and Future Research

This study sheds light on the adoption of blockchain technology at German LSPs. Against the background of the rising importance of blockchain technology, we offer significant theoretical and practical implications for the further application of the blockchain technology in the logistics service industry. With the help of a Delphi study and the TOE framework (DePietro et al., 1990), we identified facilitating and inhibiting factors for the adoption of the blockchain industry from the perspective of managers at German LSPs. Furthermore, we evaluated the status of the blockchain adoption process according to Rogers (Rogers, 2003). Our results show that especially larger LSPs engage in the blockchain technology by deepening their knowledge or conducting projects. Nevertheless, none of the companies that we reviewed uses blockchains in their business processes. Smaller

LSPs are very reluctant adopters of the technology and remain in a waiting position.

However, our study as presented in this paper has certain limitations. The significance of our study is limited insofar as the sample size is rather small with only seven participants. Furthermore, it is conceivable that mainly companies participated in the interviews that expressed interest in the technology and tend to appraise it too positively. As a result, the real adoption engagement of LSPs may be lower. Although desktop research supports the findings, additional quantitative studies seem necessary.

Additionally to the directions for future research, which we already described in the implications, further research could also address the adoption behavior in different countries and cultural settings, because the entrepreneurial culture in other countries is different and thus could result in different findings. We also advocate for further research on the environmental factors of the TOE framework (DePietro et al., 1990) as we only focused on the evaluation from the viewpoint of the LSPs. It would be interesting to know if this perception also applies to the viewpoint of the different stakeholders.

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