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Logistics Management

Contributions of the Section Logistics of the German Academic Association for Business Research, 2021, Dresden, Germany

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Editors
Udo Buscher
Fakultät Wirtschaftswissenschaften
Technische Universität Dresden
Dresden, Sachsen, Germany

Rainer Lasch
Fakultät Wirtschaftswissenschaften
Technische Universität Dresden
Dresden, Sachsen, Germany

Jörn Schönberger
Institut für Wirtschaft und Verkehr
Technische Universität Dresden
Dresden, Sachsen, Germany

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Preface

This book contains selected papers presented at the 12th Logistics Management Conference (LM 2021) of the Scientific Commission for Logistics (WK-LOG) of the German Academic Association for Business Research (VHB). The LM conference series is continued every two years at different places in Germany. It aims at providing a forum for scientists and practitioners in business administration, IT, and industrial engineering to present and discuss new ideas and technical developments related to the management of logistic systems. LM 2021 was hosted by the Technische Universität Dresden. It took place from September 15–16, 2021, in a digital format. Previous LM conferences were held in Bremen (1999, 2013), Aachen (2001), Braunschweig (2003, 2015), Dresden (2005), Regensburg (2007), Hamburg (2009), Bamberg (2011), Stuttgart (2017), and Halle (Saale) (2019). The LM 2021 conference concerns itself with the current general dynamics and challenges in the field of logistics management. To give an insight into the field, LM 2021 has invited two keynote speakers to examine ongoing developments:

- Christian Bierwirth (Martin Luther University Halle-Wittenberg)
- Alexander Hohlfeld (Deutsche Bahn AG)

In addition to the keynote talks, around 34 presentations were given at LM 2021 out of which 15 are printed as full papers in this proceedings. These papers were selected through a careful review process. Each paper was reviewed by at least two reviewers and went through up to two rounds of revisions. The accepted full papers address a broad spectrum of facets of logistic systems with regard to digitalization, sustainability, and optimization. They divide this book into five parts, considering the digitalization of supply chains, supply management, supply chain operations, sustainable supply chain management, and supply chain risk management. We hope that it provides insights into the state of the art of logistics management and, thus, stimulates future research.

September 2021

Udo Buscher
Rainer Lasch
Jörn Schönberger

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Contents

Supply Chain Digitalization

The Roles of Small and Medium-Sized Enterprises in Blockchain Adoption

Sven Reimers[1(✉)], Thomas Twenhöven[2], Moritz Petersen[2], and Wolfgang Kersten[1]

[1] Institute of Business Logistics and General Management, Hamburg University of Technology (TUHH), Hamburg, Germany
{Sven.Reimers,logu}@tuhh.de
[2] Department of Operations and Technology, Kühne Logistics University (KLU), Hamburg, Germany
{Thomas.Twenhoeven,Moritz.Petersen}@the-klu.org

Abstract. Despite the growing maturity of Blockchain technology and an increasing deployment in Supply Chain and Logistics, many small and medium-sized enterprises (SMEs) struggle to use the technology for their benefit. Based on 27 expert interviews, we develop a typology of Blockchain adoption approaches for SMEs and discuss their implications. We find that SMEs can approach the technology as either an Observer, a Cooperator, or a Service Provider based on their technological expertise, the expected relevance of the technology for their organization, and their market power.

1 Introduction

Researchers and practitioners alike have high hopes of Blockchain technology improving Supply Chain and Logistics (SC&L) activities. Tracing goods, identifying counterfeit products, and coordinating with business partners are key activities for any modern business, but developing the necessary information infrastructure remains a challenge. Blockchain technology promises to fix this gap in trans-organizational communication through its distributed nature. Some large companies have already begun to deploy Blockchain technology for their operations, with what appears to be some success (Sternberg et al. 2020). While their small and medium-sized enterprise competitors have attempted to do the same, they do not have the same amount of know-how and financial resources. This is in stark contrast to those SMEs' need for information sharing infrastructure – their value-add relies on external relationships. Large corporations can more easily generate value-add in-house, and Blockchain may provide advantages for SMEs in this regard. However, there is little insight into potential adoption strategies for SMEs (Wong et al. 2020) and the organizational structure of Blockchain projects in general (Lumineau et al. 2020).

We approach this research gap with a qualitative, exploratory research design and Grounded Theory (GT). We conduct semi-structured interviews with 27 industry professionals and derive a typology of approaches. In particular, we gain insight into the criteria relevant for selecting an approach and the trade-offs associated with each approach. In doing so, we answer the following research questions:

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1. What approaches can SMEs take to adopt Blockchain in SC&L?
2. What considerations should drive the decision for a particular approach?

The rest of this paper is structured as follows. First, we describe the state of the art and existing research in the field. Then, we present our methodology, followed by the results of our study and a discussion of the implications. Finally, we consider limitations and conclude our findings.

2 Literature Review

At its core, a Blockchain is a distributed database. A full copy of this database is stored on multiple independent but synchronized computer systems. This enables every network participant to instantly access any information needed from their copy of the database (Nakamoto 2008; Swan 2015; Pilkington 2016). Previous research has identified use cases in food traceability (Caro et al. 2018), pharmaceutical products (Bocek et al. 2017), and the digital bill of lading (Dobrovnik et al. 2018), among others. The technology has also made inroads into practice. For example, retail behemoth Walmart uses Blockchain to track the origin of food (Corkery and Popper 2018), and shipping giant Maersk has matured initial experiments for freight documentation into a powerful platform that is now part of their regular operations (Carlsen 2021).

Research has also shown that Blockchain technology extends beyond the above-mentioned SC&L use cases. The technical characteristics of Blockchain have profound business implications for the deployment of Blockchain technology. A trusted operator of the shared technical system is no longer required; instead, participants can interact directly. The consequences of this change are far-reaching and poorly understood; recent research even claims that the organizational implications outweigh the technical ones (Lacity and Van Hoek 2021). Lumineau et al. (2020) highlight the importance of understanding the characteristics of participants (the "who"), their circumstances (the "where"), and their motivations (the "why"). Sternberg et al. (2020) focus on the importance of corporate cultures, the interdependencies between different participants, and the tensions between them. Furthermore, they emphasize the tension between competition and collaboration in information sharing. In their analysis of some early Blockchain projects, Beck et al. (2018) emphasize the importance of power relationships ("decision rights" and "accountability") and the objectives driving the behavior of the actors ("incentives").

Such power relationships play an important role in Blockchain adoption for SMEs (Corkery and Popper 2018), and research by Ilbitz and Durst (2019) is hence of particular relevance for those enterprises. The authors discuss the appropriateness of Blockchain and outline major challenges to SMEs, such as network effects, internalization, and financing. Furthermore, a study of Malaysian SMEs' adoption of Blockchain has demonstrated that competitive pressure, market dynamics, and technology complexity are significant factors for SMEs (Wong et al. 2020). However, a study by Wang et al. (2019) revealed contradictory viewpoints in this regard: larger corporations can adopt the technology more easily due to their resources, but only smaller organizations have the agility needed to implement revolutionary technology. In addition, Clohessy and Acton (2019)

find that larger companies are more likely to adopt Blockchain technology than small companies. They outline that top management support and organizational readiness are particularly relevant in Blockchain adoption. Existing research also highlights these areas of interest, but it does not provide in-depth insights, and most importantly, it emphasizes problems instead of paths towards a solution. Practitioners appear to face a similar problem and focus their efforts on the operational consequences of Blockchain rather than the strategic implications (Nandi et al. 2020), highlighting the need for research into this space. In fact, previous research has explicitly shown that choosing the right approach to Blockchain is crucial, particularly for SMEs (Ilbiz and Durst 2019). We contribute to this research area by providing insight into the different approaches towards Blockchain adoption, particularly their requirements and implications.

3 Methodology

We used an exploratory, qualitative GT approach to determine how SMEs position themselves in dealing with this emerging technology. We chose the GT approach because it "seeks not only to uncover relevant conditions but also to determine how the actors respond to changing conditions and to the consequences of their actions" (Corbin and Strauss 1990).

To answer our research questions, we interviewed experts from the SC&L field. Our sample included logistics companies, manufacturers, software vendors, and Blockchain service providers. All companies involved in the study were asked the same questions from a three-part, semi-structured interview guide. First, we asked them what experience the companies have with Blockchain technology and what potential they see. Then, we discussed opportunities and barriers with the respondents, after which we focused on regulations and incentives for companies on the topic of Blockchain.

We conducted 27 in-depth, semi-structured interviews from March 2020 to January 2021, each of which lasted between 32 and 111 min (mean: 58 min, median: 54 min). Due to the current pandemic, all interviews were carried out via web calls or phone, in either German (22/27) or English (5/27). We began with an initial sample of six interviews to test the interview guide and gain insight into the topic. Based on this knowledge, we slightly adapted the interview guide to include emerging themes and topics. We returned to the interviewees in four cases to clarify statements, discuss new topics, and discuss the current results.

This study employs theoretical sampling (Corbin and Strauss 1990). The interviewed companies represent a cross-section of industries with different levels of experience. Notably, we aim to identify adoption strategies in an industry that has not yet adopted the technology on a larger scale. We conducted interviews with interested industry participants and participants who have either already adopted the technology or attempted to adopt it. The limited knowledge of our interviewees is ultimately a limitation for our study. Furthermore, the considered SMEs are not only operational companies looking to deploy Blockchain technology for their SC&L activities but also technical companies currently providing computer software to aid operational companies in their logistics and/or supply chain work. We found that IT solutions providers working with SMEs have a strong understanding of the challenges facing these SMEs. Table 1 contains an overview of the sample, including the level of Blockchain experience.

Table 1. Sample of interview respondents

#	Company	Respondent Position	Employees	Experience
1	IT Solutions Provider	Founder & CEO	11–100	Very High
2	University	Researcher	>1,000	Very High
3	IT Solutions Provider	Engineer	101–1,000	High
4	Logistics Service Provider	CEO	11–100	Medium
5	IT Solutions Provider	Director of Development	101–1,000	High
6	Logistics Consulting Company	Founder & CEO	1–10	Very High
7	Blockchain Consulting Company	Founder & CEO	1–10	Very High
8	Blockchain Consulting Company	Consultant	1–10	Very High
9	Logistics Association	Project Leader	11–100	Medium
10	Waste Management	CEO	>1,000	Medium
11	IT Solutions Provider	Engineer	>1,000	Very High
12	IT Solutions Provider	Business Developer & Client Manager	11–100	Very High
13	Manufacturer	Head of Blockchain	>1,000	Very High
14	Blockchain Consulting Company	Consultant	11–100	Very High
15	Manufacturer	Head of IT	>1,000	Medium
16	Logistics Service Provider	Senior Developer	>1,000	High
17	IT Solutions Provider	Founder & CEO	1–10	Very High
18	IT Solutions Provider	Founder & CEO	11–100	Very High
19	IT Solutions Provider	Head Manager	11–100	Medium
20	Logistics Service Provider	Head Manager	11–100	Medium
21	IT Solutions Provider	Customer Success Manager	11–100	Very High
22	Logistics Authority	Head Manager	>1,000	Medium
23	IT Solutions Provider	Client Manager	11–100	Very High
24	Logistics Association	CEO	11–100	High
25	IT Solutions Provider	Client Manager	11–100	Very High
26	University	Researcher	>1,000	Very High
27	Manufacturer	Head of SCM	>1,000	Medium

We conducted data analysis in parallel with data collection using the iterative procedure developed by Corbin and Strauss (1990). Following the coding scheme of Charmaz

(2014), we analyzed the interviews with an open coding scheme in the initial coding phase. This resulted in 620 codes, each summarizing a fragment of the text. We reviewed the initial codes, generalized them, and merged frequently used codes into higher-level concepts during the subsequent focused coding. Finally, we used axial coding to create themes, marking larger common ideas related to the concepts (Charmaz 2014).

4 Findings

In our analysis, we were able to identify three ideal-typical roles that SMEs can assume to leverage Blockchain technology: Observers, who join existing solutions; Cooperators, who team up with other interested parties; and Service Providers, who offer Blockchain-based services to other companies. The typology is summarized in Fig. 1 and explained in more detail thereafter. In support of our typology, the participants' statements are incorporated into the text (Pratt 2009). Most importantly, the roles discussed here are not mutually exclusive – an SME may choose to adopt one role in one Blockchain project and another role in another project.

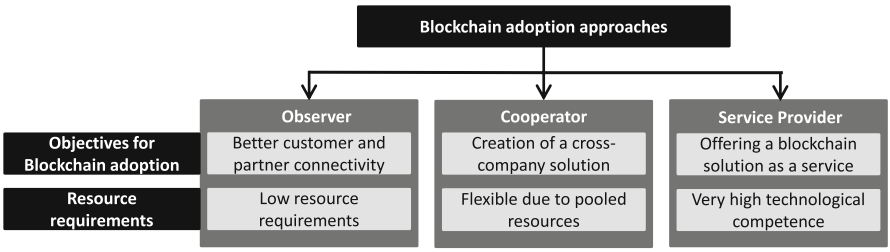

Fig. 1. Approaches to blockchain adoption for SMEs

4.1 Observers

Observers are operational companies that merely observe the development of Blockchain solutions and adopt finished systems. Once they discover a solution relevant to them, they deploy it as a turnkey solution. Other market participants provide "the entire onboarding process and connections to existing systems" for them (#12 IT Solutions Provider). In practice, these SMEs report being approached by "countless external providers, who naturally see the potential and propose something to [them]" (#10 Waste Management).

Two types of motivation can drive Observers. They can be motivated either intrinsically, by a desire to save costs or improve their product, or externally, by factors such as regulations or pressure from business partners. Organizations with substantial market power can force less powerful business partners into specific projects with an "if you don't do it, you are out" (#16 Logistics Service Provider) approach.

Due to their reliance on other developers, Observers do not require any technical competencies. They do not even need to "know what Blockchain really means" (#20 Logistics Service Provider). Their approach requires no market power and only limited internal resources; they simply "plug in somewhere" (#16 Logistics Service Provider).

4.2 Cooperators

Cooperators team up with other interested parties to jointly develop Blockchain solutions. One interviewee highlighted that companies "lose money together" in shared inefficient processes and that a "community spirit" is needed to resolve these issues (#6 Logistics Solutions Provider). Cooperators apply this community spirit and seek to actively shape developments in their industry. They design and create the solution together and shape it according to their ideas, and they can be both operational and technical companies.

Cooperators are motivated by their expectation of Blockchain adding value to their companies and their supply chains by saving costs or by improving their offerings (#4 Logistics Service Provider). Their goal can be to develop a productive system or evaluate the technology in general.

However, Blockchain may also provide some less-tangible benefits. For example, otherwise invisible SMEs may be able to gain "prestige" and "higher visibility" through technology development (#18 IT Solutions Provider). This can also work in reverse when a respected industry player pushes a project, "and through its pull, it brings part of the industry onto such a network" (#11 IT Solutions Provider). Well-known solutions can force others to follow or risk being left behind. The idea here is to use Blockchain adoption to signal innovativeness or other company characteristics and to use it directly due to its intrinsic properties.

Becoming a Cooperator has some preconditions. For instance, Cooperators' active involvement requires them to deploy resources, and together with their co-cooperators, they create a shared pool of resources. The type and extent of contribution can vary across the different Cooperators; however, their shared project ultimately needs to receive sufficient resources. From the perspective of an individual Cooperator, access to reliable project partners is itself a resource. In smaller projects, all participants "have some sort of connection to everyone else" (#18 IT Solutions Provider), and more often than not, reliable partners looking to work on the same problem are competitors of the Cooperator. Hence, Cooperators must be willing to work with these competitors and "make certain data available" (#16 Logistics Service Provider), although many hesitate to do so.

4.3 Service Providers

Service providers are true believers in Blockchain solutions and build their business model around the technology. Service Providers provide various services going all the way to a "carefree package" for customers (#12 IT Solutions Provider). They essentially offer to connect their customers to the Blockchain in a Software-as-a-Service model, providing services based on the Blockchain or selling the Blockchain itself as an infrastructure for others to build on. They also serve as evangelists that spread information about the technology to as-yet uninvolved companies through their business development – technical companies usually take on this role.

Service Providers enable other companies to benefit from Blockchain technology but do not use the potential themselves. Therefore, they are driven by their customers' motivations – when their customers seek to resolve regulatory problems, so do the Service Providers, for example. Considered in isolation, Service Providers themselves represent a new business model enabled by Blockchain technology.

As for prerequisites, Service Providers need a large technical competency because they offer a digital product. Conversely, they also require other companies that do not possess technical competencies themselves and outsource them to the Service Providers instead. In this regard, Service Providers need not hold substantial market power; their business model revolves around providing an attractive service at a competitive price. One Service Provider insinuated that it has "a special technology […] at a very good price" (#21 IT Solutions Provider). To develop these technologies, the Service Provider may need to invest its own resources.

5 Discussion

The first research question concerns the possible approaches to Blockchain technology adoption that SMEs can take. We tackled the second research question by discussing the factors involved in such a decision. The following sections discuss the implications of our findings. Crucially, however, our research only covers SMEs, although SMEs frequently interact with large corporations in the open market. Therefore, we also discuss the interaction between large corporations and the adoption approaches.

Interestingly, SMEs do not need to select only one approach. In one project, they may become an Observer to foster a better connection to a big company, whereas in another project, they may cooperate to ensure that solutions align with the company's requirements. This can also provide them with options if either approach turns out to be inappropriate, as maintaining flexibility may be crucial when exploring new technology.

The approaches presented here quintessentially differ in the depth of involvement with the technology. Interested companies need to weigh not only the advantages and disadvantages but also the feasibility for their organization. An organization can only take on a certain role if the required competencies are available. Perhaps the most important criterion in this regard is the presence (or lack) of digital capabilities. A company already providing IT solutions to other companies is likely well equipped to become a Blockchain Service Provider or work on Blockchain solutions cooperatively. However, it would struggle to become an Observer – even if it chooses to connect its software product to an existing system, its role ultimately lies in connecting its (preexisting) customers to the Blockchain system. Conversely, an operational company can choose between acting as an Observer and a Cooperator. It may also decide to act as a Service Provider but likely lacks the experience and organizational setup to provide software services to other companies. Operational companies looking to deploy Blockchain technology and technical companies looking to make the Blockchain itself part of their business model have different options. Figure 2 provides an overview of the proposed decision opportunities.

As suggested in our literature review, some companies adopt Blockchain systems due to a requirement from a more powerful business partner (Hald and Kinra 2019; Ilbiz and Durst 2019). This forces them into the Observer role because that partner has already determined the characteristics of the system. Although they may still benefit from using the system, the system's creator has ultimately extended its supply chain power into the digital realm, which can have negative consequences for SMEs in the long term.

On the plus side, Observers face a complete system to which they merely need to connect – the organization responsible for onboarding connects the Observer's legacy

infrastructure to the new system. From the more powerful partner's perspective, it is beneficial to offer a turnkey solution to lower the hurdle for adoption. Furthermore, we imagine the Observer as a company – or part of a larger company – that excels within its particular niche of the supply chain. Observers succeed precisely because they focus on their strengths rather than dabbling in their weaknesses, and they extend this same approach to Blockchain adoption.

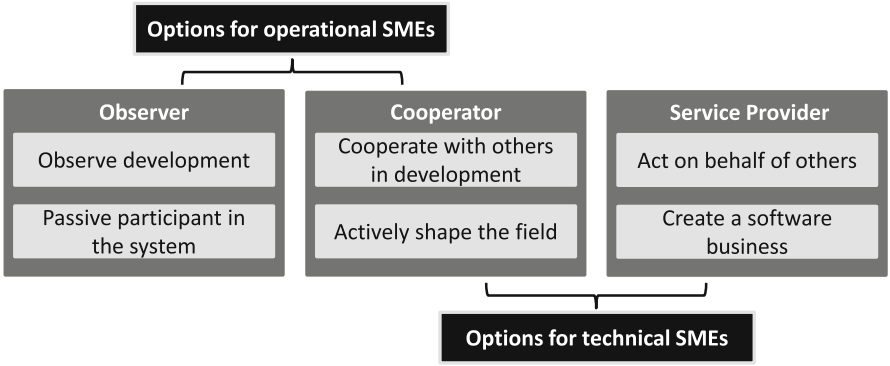

Fig. 2. Options for operational and technical SMEs

Companies that want to shape the industry may find themselves as members of a consortium rather than being Observers. Indeed, this goes back to the motivation for adopting Blockchain technology. Interviewees from all company types are motivated by ideas on solving large logistics or supply chain problems, such as the paper-based Bill of Lading, with Blockchain technology. This precludes being an Observer - observing is only an option when a project with the desired characteristics already exists and is open for new members. If no such project exists, then a new project needs to be developed.

However, one party cannot build such a system alone, because Blockchain serves to connect multiple partners. To build such a consortium, Cooperators must find partners looking to solve the same problems. This problem can result from a shared process, a similar product, or a regulation affecting multiple companies. Finding the right partners and distributing power across them is crucial for any new business venture, particularly for Blockchain projects, since the much sought-after network effects always require many participants (Ilbiz and Durst 2019; Wang et al. 2019; Koens et al. 2020).

Furthermore, some technical companies act as Service Providers, selling their solutions (or simply their efforts) directly. This allows them to focus on technological aspects, while their customers can focus on business aspects. For a technical company, the key difference between cooperation and service provision lies in the relationship with its partner. Service Providers offer a paid service, while Cooperators invest their own resources in shared projects in return for ownership and a seat at the table.

6 Implications

Choosing a particular role (or being forced into one) has implications for companies. It determines the learnings, the risk, the organizational complexity, and the design opportunities afforded by project participation. Figure 3 displays an overview of these implications.

	Observer	Cooperator	Service Provider
Project Learnings	Few learnings, only how to connect to a Blockchain	Many learnings on governance, technology and organizational structure	Many learnings on technology, limited on governance and acquisition
Risk of Project Failure	Low risk, because Observer will only be integrated	Medium risk, only the resources used are affected	Low risk on project level, but existential on a larger level
Organizational Complexity	Low complexity, has to set up a business relationship	High complexity, whereby it can also contradict the technology principle	Medium complexity, but a possible mismatch with technology
Design Opportunities	Low influence, cannot shape the existing system	High influence on the design of the Blockchain solution and the participants of a project	Medium influence on the design of the solution, but limited on the participants of a project

Fig. 3. Implications of choosing any particular approach

Since the different approaches cause companies to take on different responsibilities within a project, they will generate different learnings, and although the learnings may not be relevant within that particular project, they can be applied in later projects. Observers learn the least from a project, as they merely connect to the system once it is finished, while Cooperators learn about both the technical and the organizational sides of setting up the project. Crucially, the distribution of work among the different Cooperators may enable an inexperienced Cooperator to gradually deepen its involvement in the project as it learns more about the inner workings of the new technology. Meanwhile, Service Providers will learn mostly about the technical implementation, which is arguably the most important aspect for a technology company. Depending on the extent of their work, Cooperators and particularly Service Providers may go beyond learnings to build a capability for future projects.

The depth of involvement also dictates the risk that individual companies take in the project. An Observer takes on little risk, while a Cooperator risks a negative return on its resource investments. Service Providers also take on a smaller risk – they get paid for their services and usually receive payment even if the project does not succeed. However, their business model ultimately hinges on the success of Blockchain technology; if the technology fails, then they are forced to abandon their business model.

From an organizational perspective, Observers again face little complexity – they merely connect to the system once it is completed, which requires them to build some type of business relationship. In contrast, Cooperators face the full organizational complexity

of Blockchain technology. Managers must coordinate all project partners' competing interests, distribute rights and responsibilities, and ensure that these considerations do not hamper technological development. This is of particular importance for managers because, unlike other technology developments, Blockchain adoption cannot be delegated to the IT department. Therefore, management attention is an important success factor for Blockchain projects.

These organizational problems worsen as project size increases due to the number of participants (Filippi and Loveluck 2016; Casino et al. 2019; Wang et al. 2019). However, Blockchain technology is said to require many participants to succeed and generate so-called network effects. Thus, Cooperators must create a scalable organizational setup for their system and determine how others can access their system. A Service Provider is also hired by Cooperators and enjoys a rather simple organizational situation (even though the Cooperators may draw on their experience in this regard as well).

In this vein, it is important to consider the design opportunities available when choosing any particular approach. When Observers adopt preexisting systems, their ability to influence the system structure is limited. Observers end up conforming to the newly set standard, which may or may not fit their needs; even if they cover their use case, they may have preferred to approach it differently to match their existing processes. Cooperators can influence the project in this regard. Service Providers also have some leeway, depending on the specific project.

By using this leeway, technical companies – as either Cooperators or Service Providers – may end up in a situation where they hold substantial technical power over the Blockchain system. Such influence defeats the purpose of using Blockchain. Technical companies need to limit their role, despite the obvious appeal of such a strong position.

The key question in terms of design opportunities is whether they are needed for a particular company in a particular project. A small industry participant has no interest in or resources for setting industry standards. Consequently, it has no need for design opportunities in a Blockchain project. An ambitious mid-sized company may need such opportunities. Managers should also consider the implications of running multiple projects at the same time or in succession. They may need to prioritize projects based on their importance for their business model and their probability of success. Moreover, a group of SMEs looking to shape the world around them may invest substantial resources in developing an operational Blockchain system, only to be forced into another system developed by a more powerful peer. If they lack meaningful power in the target market, they may end up as Observers regardless of their decisions.

7 Conclusion and Further Research

In conclusion, our research suggests that SMEs should consider the implications of following any particular path towards Blockchain adoption. From an academic perspective, we find that the situation for SMEs is complex, and further research is required. Previous conceptual work on the topic falls short when it comes to SMEs' decision-making. As for managerial insights, we find that managers should consider several factors before working with Blockchain technology. In particular, they should assess the extent of their resources, technical capabilities, and position in the supply chain.

Following the GT approach, we cannot claim the generalizability of our results. Future research could attempt similar studies in different settings to determine the validity of our findings there. Furthermore, in a field as young as Blockchain, the approaches are still prone to change. Therefore, in the future, we seek to investigate which company incentives lead to which approach, particularly regarding the supply chain position. In addition, examining the decision criteria employed by companies to decide on an approach to Blockchain would also be valuable.

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References

Beck, R,. Müller-Bloch, C., King, J.L.: Governance in the blockchain economy: a framework and research agenda. J. Assoc. Informat. Syst. **19**(10), 1 (2018). https://doi.org/10.17705/1jais.00518

Bocek, T., Rodrigues, B.B., Strasser, T., Stiller, B.: Blockchains everywhere - a use-case of blockchains in the pharma supply-chain. In: 2017 IFIP/IEEE Symposium on Integrated Network and Service Management (IM). Lisbon, Portugal, pp. 772–777 (2017)

Carlsen, C.: Coronavirus crisis gives boost to Tradelens (2021). https://shippingwatch.com/suppliers/article12695211.ece. Accessed 18 Jan 2021

Caro, M.P., Ali, M.S., Vecchio, M., Giaffreda, R.: Blockchain-based traceability in agri-food supply chain management: A practical implementation. In: 2018 IoT vertical and topical summit on agriculture - Tuscany (IOT Tuscany) (2018)

Casino, F., Dasaklis, T.K., Patsakis, C.: A systematic literature review of blockchain-based applications: current status, classification and open issues. Telematics Inform. **36**, 55–81 (2019). https://doi.org/10.1016/j.tele.2018.11.006

Charmaz, K.: Constructing Grounded Theory, 2nd edn. SAGE Publications Ltd, Los Angeles (2014)

Clohessy, T., Acton, T.: Investigating the influence of organizational factors on blockchain adoption. IMDS **119**(7), 1457–1491 (2019). https://doi.org/10.1108/IMDS-08-2018-0365

Corbin, J.M., Strauss, A.: Grounded theory research: procedures, canons, and evaluative criteria. Qual. Sociol. **13**(1), 3–21 (1990). https://doi.org/10.1007/BF00988593

Corkery, M., Popper, N.: From farm to blockchain: walmart tracks its lettuce. In: The New York Times (2018). https://www.nytimes.com/2018/09/24/business/walmart-blockchain-lettuce.html

Dobrovnik, M., Herold, D.M., Fürst, E., Kummer, S.: Blockchain for and in logistics: what to adopt and where to start. Logistics **2**(3) (2018). https://doi.org/10.3390/logistics2030018

Filippi, P., Loveluck, B.: The invisible politics of bitcoin: governance crisis of a decentralised infrastructure. Int. Policy Rev. **5**(3), (2016). https://doi.org/10.14763/2016.3.427

Hald, K.S., Kinra, A.: How the blockchain enables and constrains supply chain performance. Int. J. Phys. Distrib. Logist. Manag. (2019). https://doi.org/10.1108/IJPDLM-02-2019-0063

Ilbiz, E., Durst, S.: The appropriation of blockchain for small and medium-sized enterprises. JIM **7**(1), 26–45 (2019). https://doi.org/10.24840/2183-0606_007.001_0004

Koens, T., van Aubel, P., Poll, E.: Blockchain adoption drivers: the rationality of irrational choices. Concurrency Comput. Pract. Exper. (2020). https://doi.org/10.1002/cpe.5843

Lacity, M., Van Hoek, R.: What we've learned so far about blockchain for business. MIT Sloan Management Review (2021)

Lumineau, F., Wang, W., Schilke, O.: Blockchain governance—a new way of organizing collaborations? Organ. Sci. (2020). https://doi.org/10.1287/orsc.2020.1379

Nakamoto, S.: Bitcoin: a peer-to-peer electronic cash system (2008). https://www.bitcoin.org/bitcoin.pdf

Nandi, M.L., Nandi, S., Moya, H., Kaynak, H.: Blockchain technology-enabled supply chain systems and supply chain performance: a resource-based view. SCM **25**(6), 841–862 (2020). https://doi.org/10.1108/SCM-12-2019-0444

Pilkington, M.: Handbook on digital transformations. In: Blockchain Technology: Principles and Applications. pp. 1–39 (2016)

Pratt, M.G.: From the editors: for the lack of a boilerplate: Tips on writing up (and reviewing) qualitative research. Acad. Manag. J. **52**(5), 856–862 (2009). https://doi.org/10.5465/AMJ.2009.44632557

Sternberg, H.S., Hofmann, E., Roeck, D.: The struggle is real: insights from a supply chain blockchain case. J. Bus. Logist. (2020). https://doi.org/10.1111/jbl.12240

Swan, M.: Blockchain: Blueprint for a New Economy, 1st edn.. O'Reilly, Beijing (2015)

Wang, Y., Han, J.H., Beynon-Davies, P.: Understanding blockchain technology for future supply chains: a systematic literature review and research agenda. SCM **24**(1), 62–84 (2019). https://doi.org/10.1108/SCM-03-2018-0148

Wong, L.-W., Leong, L.-Y., Hew, J.-J., Tan, G.W.-H., Ooi, K.-B.: Time to seize the digital evolution: adoption of blockchain in operations and supply chain management among Malaysian SMEs. Int. J. Inf. Manage. **52**, 101997 (2020). https://doi.org/10.1016/j.ijinfomgt.2019.08

Preconditions and Challenges in the Digital Transformation of Supply Chains: Findings from Academia and Practice

Frauke Hellweg(✉), Luis Meierkort, Tim Severin, and Bernd Hellingrath

Westfälische Wilhelms-Universität Münster, Münster, Germany
{frauke.hellweg,bernd.hellingrath}@wi.uni-muenster.de,
{luis.meierkort,tseverin}@uni-muenster.de

Abstract. Digital technologies are omnipresent in today's world, and successful involvement in the digital transformation becomes increasingly important to companies from all industries. To stay competitive, companies are pressured to rethink their supply chains and adapt. However, the topic of digital supply chains is still in its infancy. The goal of this paper is to shed light on the preconditions and challenges regarding the transformation. The different areas of the digital transformation of supply chains, namely the strategic, organizational, process & method, and technological area are considered. Preconditions and challenges for companies in the digital transformation of their supply chain are extracted from literature with literature reviews and followingly discussed with practitioners to capture the magnitude of the transformation process. Furthermore, differences between academia and practice are revealed, and future research opportunities are identified.

1 Introduction

The digital transformation of supply chains is driven by the latest advancements in technology. Companies are being pressured to adopt emerging technologies to stay competitive and to satisfy changing customer requirements (Agrawal and Narain 2018; Bienhaus and Haddud 2018). Furthermore, companies start such transformation initiatives to capitalize on the gains of improving supply chain processes, increasing their resilience, and minimizing risks, while also improving operational excellence and revenues (Ivanov et al. 2019). Besides the evolutionary side, new business models emerge, partly having the potential to disrupt.

While digital transformation is expected to mitigate some challenges in today's supply chain management and bring many benefits and opportunities, it can also be seen as a complex and expensive undertaking (Agrawal and Narain 2018). Supply chains involve several functional areas on an intra-organizational level as well as interconnections between multiple actors on an inter-organizational level, thus requiring several preconditions to be successfully transformed. However, the adoption of digital technologies in supply chains is not very advanced, hinting towards obstacles and barriers

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associated with this process (Lammers et al. 2019). Supply chain disruptions are identified as one of the most severe risks and challenges in 2020 (Greg Dobie et al. 2020). The resulting loss of revenue can threaten the existence of both small and large enterprises.

The understanding of what a Digital Supply Chain (DSC) is (Büyüközkan and Göçer 2018) is still in its beginning, and the potentials are not fully explored. Previous research mainly focuses on single technological drivers or concepts like Industry 4.0, underlining the complexity and novelty of this topic. The process of digital transformation involves various challenges and must be well thought out. It can be daunting not having an overview and understanding of possible challenges and not knowing which ones to focus on. This can hinder the process of innovation and prevent companies from accessing the promising opportunities of new technologies.

Thus, in this paper, all areas of the digital transformation are considered: from strategic to organizational, process & method, and technological aspects. This paper aims to identify the preconditions and challenges for companies in the digital transformation of their supply chain. Literature but also practitioner's knowledge is taken into account to shed light on the following research questions discussed:

- Which preconditions and challenges regarding the digital transformation of supply chains can be identified in the literature regarding the different transformation areas?
- What are the insights from discussing the literature results with practitioners and their experience in expert interviews?

The remainder of this paper is structured as follows: In Sect. 2, the theoretical background is briefly outlined. In Sect. 3, the methodologies of literature reviews and semi-structured interviews are introduced. Afterward, the results of the conducted literature reviews are presented (Sect. 4) and reviewed with experts (Sect. 5). Finally, the findings are discussed in Sect. 6, and the paper concludes with a brief recap, limitations, and further research opportunities in Sect. 7.

2 Theoretical Background

To create a common understanding of terms and concepts referred to, the theoretical background of this paper is outlined in the following.

While digitization can be defined as "the action to convert analog information into digital information" (Verhoef et al. 2019: 3), digitalization is about changing tasks and processes in an organization, as its objective is a "reconfiguration of assets to develop new business models" (Verhoef et al. 2019: 3 f.). Digital transformation goes one step further. It can be seen as a process that is "concerned with the adoption and use of emerging technologies" (Morakanyane et al., 2017: 438). The emphasis is on major changes to an entire enterprise (Cichosz et al. 2020).

In this paper, Büyüközkan and Göçers' frequently cited definition of a DSC is used (Büyüközkan and Göçer 2018). They define the concept as an agile, customer-driven, productive way to develop different forms of returns for companies and to leverage efficient approaches with emerging technologies. Researchers emphasize that it is crucial to take advantage of new technologies in traditional supply chains to be successful in

global markets (Agrawal et al. 2019). Frequently mentioned emerging technologies of a DSC in academia are, for example, big data analytics, internet of things, cloud computing, cyber-physical systems, or blockchain (Ivanov et al. 2019; Queiroz et al. 2019). However, besides the technological aspects, also other areas have to be taken into account to succeed in the digital transformation (Kane et al. 2015; Kohnke 2017).

Different authors have proposed structures and frameworks of DSC to obtain a deeper understanding of the concept (Büyüközkan and Göçer 2018; Farahani et al. 2017). Merging the frameworks and further digital transformation-related literature, we suggest a working definition of a DSC framework with four areas, namely Strategic Digitalization, Organizational Digitalization, Process & Method Digitalization, and Technological Digitalization. The areas are briefly presented and examined separately to create a structured overview. However, strong interrelations exist. The area of business digitalization has an external steering focus and covers aspects like strategy, governance, value offering, and more. The second area, organizational digitalization, focuses on the internal digitalization of the supply chain, covering aspects like employees, culture, and structure. The third area, process & methods, concerns itself with aspects such as the digital transformation of business and supply chain-related processes, as well as supply chain collaboration and networks. Lastly, the area of technological digitalization relates to the implementation of smart objects and autonomous systems, the integration of data, information-related processes, technological infrastructure, architecture, as well as IT security aspects. The two areas, strategic and organizational digitalization, are closely related, and therefore the identified preconditions stem from the same stream of literature. The same holds for the technological and process & method areas examined regarding the challenges (cf. Fig. 1). We acknowledge that it would be beneficial to include all four areas in the review with preconditions and challenges, which we propose for future research.

Digitalization Areas / Subject of Study	Strategic	Organizational	Process & Method	Technological
Preconditions	Considered in this study	Considered in this study	Future research	Future research
Challenges	Future research	Future research	Considered in this study	Considered in this study

Fig. 1. Transformation areas in digital supply chains and scope of study

3 Methodology

In this chapter, the methodologies are briefly described to ensure a transparent and clear structure of the research process. First, for information gathering, literature reviews are conducted to answer the first research question. Second, the results from the literature are discussed with and evaluated by experts from the industry. The methodology of semi-structured expert interviews is applied to answer the second research question.

3.1 Structured Literature Review

The applied procedure for the literature reviews is based on the recommendations of Vom Brocke et al. (2009). A conceptualization of the topic follows the definition of the scope of the search. This conceptualization corresponds to the four areas of the digital transformation presented in Sect. 2. The database Scopus is selected as the primary source, as it is one of the most extensive abstracts and citation databases of peer-reviewed literature regarding science and technology, and widely used. Further, Web of Science is used (in snowball search) as a complementary source due to its reputation and multidisciplinary nature. The literature reviews took place in November and December 2020. The applied search strings are separated and results are depicted in Table 1. Firstly, for the preconditions, a more general string is applied to identify relevant literature because literature pointing out only preconditions is absent. "TITLE-ABS-KEY (supply AND chain AND digital AND transformation)". Secondly, regarding the challenges, the following term is applied: "TITLE-ABS-KEY ("Supply Chain" AND ("Digital Transformation" OR "Digitization") AND ("Challenges OR "Challenging" OR "Obstacles" OR "Barriers"))".

The inclusion and exclusion criteria in the first review ("preconditions") focus on papers naming or discussing preconditions for a successful digital transformation of supply chains in the strategical and organizational area. The criteria of exclusion are mainly related to the content, many papers only focus on technological aspects. A number of case studies specifically describe the implementation of single technologies, failing to analyze the required preconditions. In the second review ("challenges"), the focus lies on barriers of digital transformation in supply chains related to the areas of processes & methods, and technology. Insights regarding digital supply chains, industry 4.0, as well as digitization and digitalization in supply chains are considered as relevant. A high number of papers is rejected because they focus on challenges regarding other areas (e.g., organizational digitalization, only considered in the preconditions part) or on obstacles of companies in general and not especially on the supply chain. Papers and identified preconditions/challenges are sorted following a concept-centric approach by Webster and Watson (2002). Therefore, if a precondition or challenge is identified, the corresponding authors are added. The data analysis is an iterative process during which the concepts are re-structured and re-grouped. In this paper, we only present the final allocation of preconditions and challenges. Collection of identified preconditions/challenges and analysis, are presented next.

3.2 Semi-Structured Interviews

To gain further insights into the preconditions and challenges and their perceived importance in industry, the results of the literature analysis are discussed in semi-structured interviews with industry experts. This type of interview is chosen as it promotes a sociable and informal atmosphere, in which the interviewee can be more forthright and rather respond in his or her own words (Longhurst 2003). The interviewees should be able to raise their own ideas, thoughts, and questions in an open conversation, while certain guiding questions and issues must still be addressed for the objective of the work.