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Blockchain Technology in Germany: An excerpt of real use cases in logistics industry

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Purpose: Due to the large number of intermediaries in logistics networks there is a variety of possible failures, frictions and waste of time and money among the logistics process chain. With the ability to provide data securely in near real-time, like track and tracing data of goods to every participant, the Blockchain-Technology (BCT) can help to solve these problems.
Methodology: A structured literature analysis has been executed by using the databases Web of Science and Science Direct to find out current intermediary´s functions and real use cases. In addition, available other sources, like manufacturer websites, blog entries or whitepapers are searched for specific blockchain-based applications invented and used by German companies. The identified use cases are then qualitatively analyzed.
Findings: The first results showed that most of the business cases are still in the concept phase or are merely ideas how the BCT could solve existing problems. Additionally, we got results on the distribution of applications and economic benefits along the logistics chain. Furthermore, important conclusions on implementation problems can be derived from this.
Originality: In order to maintain Germany´s top economic position, it is necessary to push ahead with the adaption of the BCT. Our analysis contains first results in the area of real blockchain use cases of German companies. Initial comparisons between currently used and blockchain-based logistics networks are also possible.

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1 Introduction

The complexity of logistics chains has increased with the growing number of intermediaries. They are used to organize, coordinate and perform actions and processes within the network and serve as enabler between the involved parties. This raising complexity makes the logistics chains slower and more expensive. This development can be regarded as independent of the market. However, there are changing customer demands, like cost reductions, shorter delivery times and improved traceability. In contrast, Loklindt et al. showed that a shipping container does not move half of the delivery time (Loklindt, Moeller and Kinra, 2018).Therefore, IBM and Maersk started a cooperation in 2016. They created a blockchain-based platform which unites all participants and intermediaries. The main target is supporting all parties with real-time information about every single cargo and its actual status in order to reduce costs, risks and lead time.

A blockchain is based on distributed ledger technology. That means all information are visible and spread throughout the whole network. Moreover, the blockchain is built as a peer-to-peer network, which enables new possibilities of storing and exchanging transaction data without the need of a trusted intermediary. Hence, a lot of roles within logistics networks will change and some participants as the customs officer will drop out by using the BCT with additional implementation of smart contracts (Dobrovnik et al., 2018). Smart contracts are protocols, which contain rules and logical connected terms of trade. Additionally, the smart contract implements individual trading rules between the parties. In practice it means conditions of payment, of forwarding goods or quality assurance can be described, e.g. the shipment container will just load in case the door lock is not damaged.

All of these information will recorded, analyzed and confirmed by both parties. The BCT in combination with smart contracts serves as a secure and immutable interface.

As part of the logistics networks the increasing complexity poses challenges to German companies. Currently a lot of human intermediaries are working along the logistics chain. They serve as important enablers between all other participants of the network in order to organize and coordinate all kinds of processes and actions within the network. Intermediaries come along in a big variety, from the customs officers, to the port manager, the logistics provider, to the chatter of the cargo ships, who transport the goods. On the other hand they are cost-casing and a point of failure. Due to the increasing spread of BCT, with its potential for disruptive change, the role of human intermediaries and the corresponding processes will change, e.g. no more paperwork for cross border shipments and therefore no need of any customs officers or more possibilities for effective routing by the distributer (Dickson, 2016).

The main target of our article is answering following research questions:

RQ1: Is the effect of disintermediation a possible factor for further adaptation of the Blockchain-Technology in German enterprises?

RQ2: What is the status quo of Blockchain-Technology adoption in German (logistics) companies by analyzing selected use cases?

To address the research questions we conduct a structured literature analysis on current functions of human intermediaries in logistics chains and real blockchain-based use cases in German logistics. The phenomenon of disintermediation is investigated in a separate research. Additionally we will execute a guided iterative screening of other available sources as the manufacturer's websites, whitepapers, blogs and websites focusing on

crypto currencies to gain more information. Furthermore we will analyze real use cases by employing Robert Stake´s approach for qualitative case study analysis, due to the lack of quantitative data (Stake, 1995).
The article is structured as follows. We will continue by first giving the theoretical background of the BCT as well as the phenomenon of disintermediation in logistics chains. In the methodology section we will present our framework for a multilevel literature research based on the tasks of human intermediaries in the logistics chain. Furthermore, we will explain why this is not appropriate for the identification of applications (Section 3.1) and give a brief description of the selected blockchain-based applications. The results sections starts with the cross-case analysis and leads to the within-case analysis, with our assumption of disintermediation probability, followed by a brief discussion of the results. Section 4.3 answers the question on the actual status quo of blockchain adoption in German companies. The last part contains conclusions and proposals for further research.

2 The blockchain-technology

Satoshi Nakamoto presented the BCT in 2009 by introducing the cryptocurrency Bitcoin (Nakamoto, 2008). Up to now Bitcoin is the most popular use case for BCT. Modern logistics chains originating a huge amount of information, like transaction data, tracking protocols and contracts just to address some of them. All these information need to be recorded, protected, proofed and shared if necessary. Hence, all participants permanently exchange information, which are important from their individual point of view. By focusing on logistics, especially on international cargo freight, it is obviously that these kind of information exchange rises shipping costs and lowers the competitiveness. Eventually, the participants in the logistics branch need shift the way they work (Iansiti and Lakhani, 2017).

2.1 How blockchain principles solve logistics problems

Since the existence of logistics chains, there are various problems that need to be solved. Kudlac et al. are clustering all problems in three groups. Group one describes knock-out problems, i.e. can the logistics chain be realized or not, including safety aspects or the transportability with different means of transport. The second problem group describes problems that are quantifiable over a certain period of time, such as costs incurred, delivery times or delivery reliability. Group three summarizes all problems that are likely to occur, such as cost overruns, delivery delays or changing customer requirements (Kudlac, Stefancova and Majercak, 2017). BCT can possibly solve the mentioned logistics chain problems.

The name blockchain is derived from the way how the data and information were stored. A predefined set of transactions will be recorded on one block. In this connection it does not play any role which kind of data or information are in a single transaction. Depending on the sort of blockchain a single block has a determined size, which cuts the number of possible stored transactions for a several block. Through scientific cryptography and digital signatures the transactions are protected and secured in a block. A block contains a timestamp of creation, a block number and a unique value, called block hash. The preceding block is connected with next block in the chain through their block hash values. Therefore, no third party is necessary to confirm the transaction. Due to the decentralized character every participant has insight into the whole blockchain. This feature can cover the safety and trust issues, which is described concluded in group one. Nodes, a special group of clients, are connected to each block and responsible for confirmation through a consensus mechanism. For each transaction a private and a public key based on the calculated hash value is given to the user. Encrypting of data is just possible by having the right pair of public and private key. Further details of how the technology works can be found in (Christidis and Devetsikiotis, 2016). However, more important for the motivation of implementation of BCT into logistics systems are the blockchain-principles and their ability to solve current problems, e.g. high costs, trust and safety issues or inefficient processes along the logistics chain (Kudlac, Stefancova and Majercak, 2017).

Gupta and Iansiti/Lakthani summarize five principles of BCT. The most remarkable feature is the fact, that all blockchains are based on the distributed ledger technology. Particularly the availability of information increases, due to the fact that the whole ledger is completely shared, updated and replicated among all relevant participants. Based on the fact no central entity controls the blockchain all information are available in near real-time. There is no need for an intermediary for verification of transactions (Gupta, 2018; Iansiti and Lakhani, 2017).

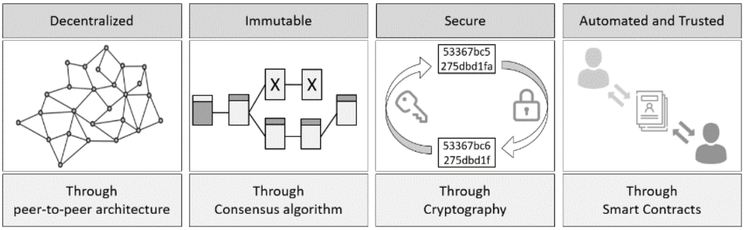

Figure 1: Basic blockchain principles (based on Hackius and Petersen, 2017)

Second, BCT offers the possibility to facilitate a peer-to-peer network, which underlines the decentralized character of the ledger. It means clients (nodes) communicate with each other directly within the network without a central node as found in classically organized business networks.

The blockchain is immutable. Therefore records cannot be altered after the transaction is verified and the blockchain is up to date. Every block is connected to the previous block. In order to close a block all participants have to find consensus through a defined consensus mechanism. In contrast to today´s status quo the BCT is absolutely transparent. To illustrate all associated clients of a transaction have access to the same database and therefore to the same records. Due to the high grade of transparency no trust is needed. Transactions can be verified within seconds without a trusted intermediary. As mentioned before every transaction is ordered by the time of verification and time-stamped.

One of the biggest problems in business is the need of trust or the need of a trusted intermediary, like a notary (Queiroz and Fosso Wamba, 2019). Both is time consuming and raises the costs for focused transaction. BCT is flexible and evolving. Moreover, BCT offers the possibility to implement smart contracts. The involved parties can implement one or more conditions to trigger the next step of their transaction. A new end-to-end solution is now available without the need of a trusted intermediary (Gupta, 2018; Iansiti and Lakhani, 2017).

2.2 Disintermediation as consequence of blockchain-technology

Due to the complexity of globally interlinked logistics networks with their involved intermediaries, inefficiencies and frictions increase. Under these conditions, certain business models are not possible, especially when many small transactions and very broad customer requirements are involved (Nowinski and Kozma, 2017). According to Allen, the original meaning of disintermediation is to invest money without the mediation of a bank or other controlling factors (Allen, 1996). A more recent definition, very appropriate for this article, is provided by Atkinson. He describes disintermediation as "the reduction or elimination of the role of retailers, distributers, brokers, and other middlemen in transactions between the producer and the costumer" (Atkinson, 2001). Another definition that applies to the technological properties of blockchain is provided by (Sampson and Fawcett, 2001). They describe disintermediation as a direct business relationship with the manufacturer without a middleman. Taking into account the different definitions of disintermediation, some conclusions can already be anticipated. There may be an increase in the number of contracts concluded between consumers using smart contracts (Jacquemin, 2019). Disintermediation of human intermediaries will lead to a disintermediation of processes and to the emergence of new and more efficient processes. Logistics networks will thus act more sustainably and become more competitive. Customers can be offered new services, such as an extended quality guarantee (Chang, Chen and Lu, 2019). The final consequence will be a re-engineering of the entire logistics chain with significantly fewer intermediaries than the current status quo. The first transformations of logistics chains through BCT can be observed worldwide. We use definitions provided by Atkinson and Samson & Fawcett to analyze these first re-engineering phenomena in logistics chains of German companies.

3 Methodology

To answer the first research question, we begin with a literature review of the tasks of human intermediaries currently used in logistics chains (section 3.1). The identified functions will later be used for the analysis (section 4.2) of the found blockchain-based applications in the following case study research. The results from section 3.1 are the functions of human intermediaries in logistic chains. The results on disintermediation (section 2.2) and from 3.1, serve for the analysis of the use cases found in section 3.2. Using the results of the within-case and cross-case analysis, RQ1 is then named. RQ2 is then answered in Section 4.3 (see figure 2).

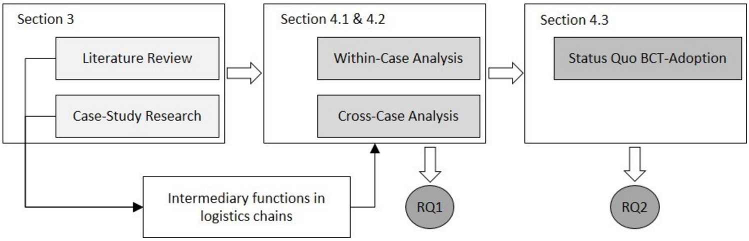

Figure 2: Process of research questions answering

3.1 Structured literature review

According to Webster and Watson (Webster and Watson, 2002), it is necessary to conduct a structured literature analysis in order to be able to answer the research questions. Usually the literature analysis is divided into different steps, which can be defined differently depending on the author. Nonetheless, the analysis proceeds from problem formulation, literature search, literature analysis and the subsequent interpretation of the sources (Moher et al., 2009). To obtain the necessary information, the scientific databases Web of Science and Science Direct were used for section 3.1. We got a total of 58 hits with the search algorithms used (asterisk symbol corresponds to a placeholder for the rest of the string to take into account different spellings; see Table 1). After removing the duplicates, 50 sources remained. The found references were transferred into literature management software Zotero, ranked and analyzed according to their usability for finding out the current functions of human intermediaries in logistics chains.

Table 1: Distribution of identified references for intermediary´s functions

Source	Algorithm	Hits	Hits (%)
Web of Science	Logistic* AND intermediar* AND funcion*	49	85,0
Science Direct	Logistics AND (intermediary OR intermediaries) AND (function or role)	9	15,0

We now present the results of the structured literature research as shown in Figure 2, with the aim of identifying the tasks of intermediaries in logistics chains as a basis for further analysis of the real use cases. As far as possible we also tried to find first starting points for the guided iterative search with regard to blockchain-based applications. The next part will have a closer look to the most common human intermediaries in logistics networks and which frictions and failures could cause through them. The distributed nature of data and information management enables the possibility of performing transactions between network parties without an intermediary (Underwood, 2016; Turban et al., 2015). However, most of the intermediaries are still needed, due to scalability issues, which makes high frequency use inappropriate at the moment. Most of today's networks, which are used in German companies, use human intermediaries who have to accomplish many tasks at the same time. Turban et al. postulates that central intermediaries take over tasks that can be automated and tasks that require the experience of the intermediary. So it is assumed that the focus by blockchain adoption is on tasks of the first category. Often manual, automatable tasks are providing information on supply and demands, prices and trading requirements. The wider focus lies on matching sellers and buyers (Turban et al., 2015). In doing so, the intermediary appears as a trustworthy agent for enabling business relationships between strangers (Zheng et al., 2019). In modern multilayer logistics chains there are also third and fourth party logistics provider (4PL), which offer value added services such as consulting, payment arrangements and transport of the physical goods (Turban et al., 2015). A 4PL can be seen as a neutral business partner and offers several services in order to increase the efficiency along the logistics chain. Figure 3 shows how the 4PL is implemented in the logistics chain as cross section function (Mehmann and Teuteberg, 2016). Therefore the 4PL as intermediary incorporates with a lot of participants of the logistics chain and seems to be a good point to start with BCT implementation. German companies facing a lot of uncertainties concerning import regulations, therefore some intermediaries have a regulatory function in order to avoid trade law violence and high contractual penalties.

Companies could come to the conclusion that the primary goal of blockchain implementation should be the reduction of the number of intermediaries in their supply chains. This phenomena is called disintermediation (Giaglis et al., 1999) (see section 2.2).

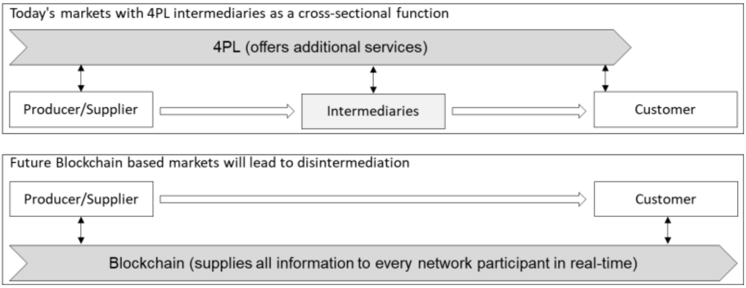

Figure 3: 4PL as cross section function intermediary (based on Giaglis et al., 1999)

3.2 Case study research

The second part of the research aims at identifying suitable use cases. Case study analysis is the most popular form of qualitative research (Recker, 2013), as it provides insights that other research methods do not allow (Rowley, 2002). For this article, the choice also falls on qualitative analysis, because the status quo of BCT adaptation is to be captured. This goal can only be achieved by examining use cases that are already in use in the real world. Thus, the transfer of laboratory results into the real world can be analyzed (Recker, 2013). However, there is criticism of this type of research methodology because it is not subjected to a codified design (Yin, 2009).

The use cases should only come from the logistics sector and be used by companies located in Germany. They should also be in real use and no longer have laboratory status to ensure of investigating a real world phenomenon. Furthermore, the number of cases is important to ensure sufficient scientific reliability. Pare postulates that the number of cases investigated depends on the object of investigation (Pare, 2004). Whereas Rowley gives a defined range of 6-10 cases with different designs that have proven to be practicable (Rowley, 2002).

In order to find as many references as possible for use case identification, only the keywords "blockchain" and "Logist*" were used for the first research turn. After removing duplicates we got 248 hits in total, including all scientific areas. The second run additionally contained the search term "German*", which leads to 178 hits in total. After first screening of the abstracts 41 sources seemed to be relevant to the topic. A more detailed analysis showed that they are either theoretical concepts or the real case of application does not allow any conclusions for Germany. It also turned out that the Science Direct database in the advanced search mode also displays those publications for which the keyword "german" can only be found in the reference list. The second step in finding use cases is a Google search with the following search algorithm: ("blockchain and logistics") and german -supply chain, which returns 5,610 results. Attention was paid to the focus on logistics and not on the entire supply chain. After analyzing headlines, company websites, abstracts and articles, it turned out that this method has brought some use cases, but is very ineffective. The last step to find appropriate use cases was the iterative guided screening of various sources. The starting points were on the one hand the websites of the companies, whereby these hardly provide any further information. The second point of search are forums, blogs or relevant sites about crypto currencies, like BTC-Echo. These sites often provide various search options, where "snowballing" leads more effective to new sources with new content

(Brings et al., 2018). At this point the we use the analysis approach according to Stake, where the data analysis is "a matter of giving meaning to first impressions as well as to final compilations" (Stake, 1995), (see table 2).
To answer the research questions, 10 concrete use cases are analyzed in more detail. Most use cases come from medium to large enterprises. According to our research, we assume that this new technology requires significant financial resources for its implementation, which only a small number of companies have in their budget. They cover various fields of logistics in industries such as drug trade, chemicals, shipping, and transport in general, automotive, food trade and services (see Table 3 and 4). The tables show the respective blockchain application in the table header. The applications are numbered for a better overview (square brackets). The left column contains four clusters, which focusing on several features of the application.

Table 2: Distribution of identified references for real use cases

Source	Algorithm	Hits	Hits (%)
Web of Science	blockchain AND logist* AND german*	1	0,5
Science Direct	blockchain AND logistics AND german	178	91,3
Manufacturer websites		7	3,6
Blog entries		5	2,6
Crypto-web-sites		2	1,0
Whitepapers		2	1,0

The analysis of the areas "Intermediary functions", "Type of blockchain" and "Business model" is discussed in section 4.2. The cluster "Value proposition" is dealt with in section 4.1.

The functions of intermediaries have already been described in section 3.1 by employing the within-case analysis (see section 4.2) these functions are assigned to the respective blockchain-based application, e.g. taking over the trust building function of the human intermediary. The "Type of blockchain" and the "Business model" are also derived from the within-case analysis. For both clusters it is necessary to use several sources for the same application, which the structured literature analysis in the databases could not provide. If the blockchain is permissioned or permissionless depends on, which information are shared among the network partners. The "Business model" describes how the blockchain will act in each use case. The blockchain can act as an "Infrastructure provider", which only provides the blockchain to be used without further functionality. In case of a "Platform provider", a platform with additional functions will offered to the users. If the blockchain acts as an "Integrator", it connects legacy systems. The "Applications provider" provides the blockchain itself and a complete useable application as frontend.

Accenture and DHL [1] have established a blockchain solution that enables the pharmaceuticals to be tracked from the manufacturer to the end customer. This includes all necessary participants and thus prevents counterfeiting (Kückelhaus et al., 2018). The chemical manufacturer BASF and the two start-ups Ahrma and Quantoz [2] want to make the entire logistics chain more transparent for all parties involved. This is achieved by using sensor data and making the data available in the blockchain in almost real-time. The sensors are located on a pallet and record movement data and temperatures that are important for the chemical industry (Lacefield, 2017; Petersen, Hackius and See, 2018). Various players based in the port of Hamburg [3] and having different tasks have implemented a blockchain solution that serves as a common data platform. This is intended to improve the handling process from unloading the sea freight carrier to the transport of the containers by truck. Other participants like port terminals, truck companies and freight forwarders are also included (Hackius, Reimers and Kersten, 2019). Mosolf [4] is an automotive logistics service provider. It creates waybills and other documents in a blockchain solution and validates them with the help of smart contracts. The consulting company Etecture GmbH is responsible for the infrastructure conception. Lawa Solutions GmbH provides the necessary programming work (MOSOLF, 2019). Deutsche Bahn AG, in cooperation with IBM [5], wants to investigate into a blockchain-based traffic control solution. For this purpose a 57km long test field with 1 to 4 tracks will be used (Herrnberger, 2019; Wirminghaus, 2019). Two German automobile manufacturers are simultaneously trying to set up a blockchain, which primarily pursues the purpose of tracing where the cobalt for the accumulators of their electric cars comes from. The first manufacturer is BMW in cooperation with Circulor [6]. The cobalt needed for the new electric vehicles will be imported from Australia. It will first be chemically marked there. From this point on, counterfeiting is no longer possible (Lewis, 2018; Luckow, 2018; Scheider, 2019). Second, Mercedes Benz and Circulor [7] want to implement a blockchain to trace the route of its cobalt from recycling facilities entering the supply chain. In addition, working conditions and greenhouse gas emissions are to be monitored (Daimler, 2020; Pollok, 2020). Commerzbank, in cooperation with Daimler Truck [8], was the first bank in Germany to test a blockchain application, which serves to process fully automated machine-to-machine payments without the need for a trusted intermediary. The main focus is on payments at e-charging points and a truck (Commerzbank, 2019; Pollock, 2019). The MindSphere application is Siemens' [9] own cloud-based Internet of Things (IoT) software solution for monitoring the food and beverage supply chain. MindSphere offer users ready-made blockchain applications for registration and participation. Due to the given infrastructure it is possible to provide only the necessary data to the participant (Siemens, 2019). The Telekom subsidiary T-Systems [10] offers "Blockchain as a Service" on an independent marketplace. The services range from fully digital blockchain based monitoring of the entire logistics chain to the validation of cross-company business processes. The services can be purchased by interested companies at the relevant Telekom offices (Telekom, 2019).

Table 3: Assumption of possible features and benefits by shifting Status Quo to blockchain-based logistics solutions (based on Tönnissen and Teuteberg, 2020)

Blockchain-based application or leading companies	Accenture & DHL [1]	BASF, Quantoz & Ahrma [2]	Seaport Hamburg [3]	Mosolf & Etecture & Lawa Solutions [4]	Deutsche Bahn & IBM [5]
Intermediary functions					
Platform provider	X	X	X	X	X
Relevant information	X	X	X		X
Matching buyer/seller					
Trust	X		X	X	
Added value					
Complience/Governance	X			X	
Value proposition					
Cost reduction	X	X	X	X	X
Increased Transparency	X	X	X	X	
Process safety		X	X		X
Process efficiency		X	X	X	X
Tracebility	X	X	X	X	
Real-time processing	X	X	X		X
Type of Blockchain					
Permissioned	X	X	X	X	X
Permissionless					
Business model					
Infrastructure provider				X	
Platform provider	X				
Integrator		X			
Applications provider			X		X

Table 4: Assumption of possible features and benefits by shifting Status Quo to blockchain-based logistics solutions (based on Tönnissen and Teuteberg, 2020)

Blockchain-based application or leading companies	BMW & Circulor [6]	Mercedes Benz & Circulor [7]	Daimler Truck & Commerz-bank [8]	Siemens „MindSphere“ [9]	Telekom AG [10]
Intermediary functions					
Platform provider	X	X	X	X	X
Relevant information	X	X		X	X
Matching buyer/seller					X
Trust	X	X		X	
Added value	X	X			
Complience/Governance		X		X	
Value proposition					
Cost reduction	X	X	X	X	X
Increased Transparency	X	X	X	X	
Process safety					
Process efficiency			X		
Tracebility	X	X		X	
Real-time processing	X	X	X		
Type of Blockchain					
Permissioned	X	X	X	X	
Permissionless					X
Business model					
Infrastructure provider	X			X	X
Platform provider			X		X
Integrator					X
Applications provider		X			X

4 Results

For the analysis of the presented use cases, the websites of the participating companies, articles from journals, blog entries and relevant websites for crypto currencies were analyzed. Special focus was placed on the target figures summarized in tables 3 and 4: the possible functions as an intermediary of the blockchain application, the value proposition for the customer, the type of blockchain and which business model will be adopted with it. The analysis shows which of the respective use cases has the potential to eliminate human intermediaries from the logistics chain.

4.1 Cross-case analysis

In order to find out meaningful value propositions we use Stake's analysis approach, which is based on the intuition of the researcher on the one hand and on the assumption that there is no concrete point in time from which data are collected on the other (Stake, 1995). The aim of the cross-case analysis is to identify the value proposition by adopting BCT. First, all applications were roughly analyzed for their properties according to Stake. Then, their obvious value propositions were identified. This was followed by a second analysis run with reference to the work of Tönnissen and Teuteberg (Tönnissen and Teuteberg, 2020). Thus similar value propositions could be identified. Despite the multi-stage analysis, no new value propositions could be identified that could not be subsumed under the six already identified value propositions (see Table 3 and 4). The whole analyzing process is illustrated in figure 4.

The most important value propositions are cost reduction, increased transparency and traceability. The value proposition that occurs in every case examined is cost reduction through the elimination of human intermediaries and the associated errors and frictions. The increasing transparency value proposition is based on the permanent availability of all relevant, immutable data in real-time. The increased traceability is based on the same blockchain properties, extended by the peer-to-peer network and integrated smart contracts.

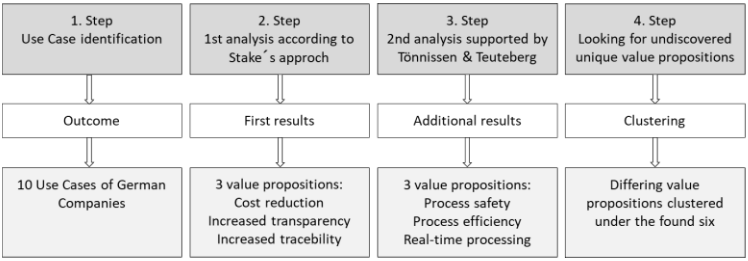

Figure 4: Analyzing process for value proposition identification

4.2 Within-case analysis

Accenture & DHL [1]: Primarily this application is a permissioned blockchain. However, the analysis is not quite clear, since the end customer can also be part of the network to check the authenticity of his pharmaceuticals. As an intermediary, it can be spoken here primarily of a platform provider, since additional functions are made available, thus human intermediaries become superfluous. Its value proposition is an increased transparency and high traceability of the pharmaceuticals. Cost reduction can also be mentioned, as the proportion of drugs to be replaced is decreasing. This application is a platform provider business model, since in addition to the blockchain, the service of authentication is offered to the end customer and user management to the distributors (Kückelhaus et al., 2018).

BASF, Quantoz & Ahrma [2]: Here the blockchain serves as an intermediary in the form of a platform provider. Due to the objectives of the three partners, this goal becomes clear. In addition, the solution should provide relevant information on the state of the load. This information is collected by the sensors attached to the pallets. With regard to the value proposition, cost savings are expected through better use of the pallets. In addition, the traceability of stolen and damaged pallets is significantly simplified. At the time of the analysis, access to blockchain is limited to the three project partners, who probably designed this blockchain as an integrator solution (Petersen, Hackius and See, 2018; Lacefield, 2017).

Seaport Hamburg [3]: The use case in the port of Hamburg is very complex due to the multitude of different participants. The blockchain is used here as a central intermediary that supplies all participants with information. This results in new functions that are directly reflected in the value proposition. Since all information are available completely and in real-time, the loading and unloading process can be made much more efficient. Cost and significant time savings have already been evaluated. In addition, it is clear at all times where the freight container being sought is located. The blockchain is only accessible for participating companies. Since there are some deficits among the logistics providers, the application has to be created from scratch. The blockchain is therefore designed here as an application provider (Hackius, Reimers and Kersten, 2019).

Mosolf, Etecture & Lawa Solutions [4]: With the introduction of BCT, a new intermediary is created, which opens up new functions and makes human personnel obsolete at some points in the logistics chain. There is always a high time pressure in the automotive industry and information on the delivery status must be available quickly. The customer can now call up the desired information himself. He no longer has to trust the statements of the employee. The value proposition is expressed in various dimensions, such as cost reduction or process reliability. As in the automotive sector, the analyzed blockchain is also access restricted. It is no information available on the business model, but it appears that the legacy software solutions will continue to be successful, it can be assumed that the blockchain has an integrator function (Pieringer, 2019; MOSOLF, 2019).

Deutsche Bahn & IBM [5]: This permissioned blockchain solution serves as a platform provider over which the traffic control should run autonomously. For this purpose, all information concerning to driving services must be available in real-time. The autonomously managed driving services offer high potential for cost reduction through personnel reduction and thus a high potential for increasing the efficiency of the entire railway operations. Until 2017 most of the scheduling activities were processed via Excel, fax and telephone, therefore it can be assumed that the blockchain solution will have to be created from scratch and can therefore only be an applications provider solution (Herrnberger, 2019).

BMW & Circulor [6]: BMW and Circular provide very little information for analysis. However, it is clear that the blockchain application will be structured as a platform provider according to the definition used here. New functionalities must be made available in order to be able to trace the path of the cobalt without any gaps. In addition, trust should be created across all participants in the logistics chain. Due to the complexity of this multi-layer logistics chain, many cost-intensive and more or less trustworthy intermediaries are involved. The value proposition consists on the one hand in the reduction of intermediaries and thus cost savings and on the other hand in an increase in process efficiency. It can be assumed that due to a lack of IT standards, the blockchain is designed as an infrastructure provider (Pollock, 2019; Lewis, 2018).

Mercedes Benz & Circulor [7]: The approach of Mercedes Benz and Circulor is to implement a platform provider through the blockchain. In the role of a central intermediary, the blockchain also takes on the tasks of providing relevant information to all parties involved, generating trust, maintaining and controlling compliance and legal standards. Mercedes Benz pursues the goal of closed material cycles and CO2 neutral production. The traceability of the origin and quantity of recycled cobalt as well as the measurement and storage of the quantities of greenhouse gases produced are to be solved with the blockchain application. The blockchain is permissioned. Due to the large number and complexity of the objectives pursued, it will probably be an application provider. Mercedes Benz does not give any further details (Daimler, 2020; Pollock, 2019).

Daimler Truck & Commerzbank [8]: The need for human intermediaries to initiate payments lowers process efficiency along the entire logistics chain. With the new "Cash on Ledger" function, the blockchain application can be identified as a platform provider that eliminates the need for human intermediaries. This makes the entire logistics process more efficient and secure. Currently the blockchain is permissioned. With the further expansion of capacities, access for additional participants will be made possible. The blockchain, in the sense of the business model, acts here as a platform provider (Commerzbank, 2019).

Siemens [9]: Through the integration of blockchain application into the MindSphere frontend, the user is provided with new functions in the form of a new platform provider. In addition, the blockchain forms a non-human intermediary that builds trust throughout the entire logistics chain, all the way to the end customer. The value proposition for the customer is increased transparency, traceability and process reliability. Secondary benefits include cost savings and a more efficient process. The blockchain is access restricted. Since MindSphere already exists as an application, the blockchain serves as an infrastructure provider (Siemens, 2019).

Telekom [10]: This blockchain application differs from the others examined in that, Telekom offers the “Blockchain as a service" tailored to the customer. Accordingly, the blockchain, as a new intermediary, can take over all the tasks of the existing intermediaries. However, it can be assumed that it will be implemented at least as a platform provider with new services and functions at the customer's premises. The value proposition depends on which project the customer is pursuing, as well as whether there will be access restrictions. The business model that the blockchain adopts remains variable (Telekom, 2019).

Based on the analysis, the first research question: "Is the effect of disintermediation a possible factor for further adaptation of the blockchain-Technology in German enterprises?" can be answered. The implementation of the BCT leads to the emergence of a new type of intermediary - here described as a platform provider, which provides new functions and services to the user, which did not exist before. The elimination of human intermediaries can be seen as a major consequence on the logistics chain by introducing blockchain-based solutions. Each of the analysed applications removes human intermediaries in the corresponding area of the company or logistics chain. It is possible that the intermediaries either change their role or take over other tasks as intermediaries (Giaglis et al., 1999). These effects will not be discussed in detail here. The within-case analysis and tables 3 and 4 show which tasks the BCT can take over and replace human intermediaries (see Table 5 and 6). Especially the possible cost savings and the reduction of human intermediaries make a further adaptation of the BCT interesting for German companies. Since the business model of most German companies requires cross-border, multidimensional logistics chains, BCT can help to make processes more efficient and secure, fight against counterfeiting of raw materials and products, and sustainably increase the trust of business partners among themselves and of end customers.

Table 5: Disintermediation probability of analyzed use cases

Probability of disintermediation of human intermediaries	Accenture & DHL	BASF, Quantoz & Ahrma	Seaport Hamburg	Mosolf, Etecture & Lawa Solutions	Deutschte Bahn & IBM
	[1]	[2]	[3]	[4]	[5]
High			X	X	X
Medium	X				
Low		X			

Table 6: Disintermediation probability of analyzed use cases

Probability of disintermediation of human intermediaries	BMW & Circulor	Mercedes Benz & Circulor	Daimler Truck & Commerz Bank	Siemens "MindSpehre"	Telekom AG
	[6]	[7]	[8]	[9]	[10]
High			X		X
Medium	X	X		X	X
Low					X

4.3 Blockchain adoption at the beginning

In contrast to RQ1, the second research question: "What is the status quo of Blockchain-Technology adoption in German (logistics) companies by analyzing selected use cases?" cannot be answered quite so clearly. It is clear that the potential of BCT has now been recognized and is gaining in importance beyond the financial sector (Shermin, 2017). The results so far imply a further increase of blockchain-based applications in German companies in the logistics sector. The analysis of the search results from the scientific databases Web of Science and Science Direct only provided initial clues to real use cases in Germany, but did not name them specifically. Further research in alternative sources and on the websites of the companies led to evaluable results. Surprisingly, most of the projects are only available as concepts and that there are no real applications. Some projects that have already taken shape are still in the laboratory stage and therefore not representative. Some of the applications identified in the first research did not stand up to further analysis (see Section 4.2) and had to be replaced. Finding and replacing them is very time-consuming. Considering all the real use cases found and the enormous effort for identification, it can be assumed that the status of blockchain adaptation of German companies in the logistics sector is still in its infancy. This can also be interpreted on the basis of the unavailable quantitative data for individual applications.

5 Discussion

Blockchain-Technology can cause a paradigm shift in the logistics industry. First of all, the BCT must gain more acceptance in order to prevail (Kückelhaus et al., 2018). The basis for a breakthrough is, among other things, the analyzed first use cases and the quantitative data they will provide in the future. The Port of Hamburg in particular is a prime example of the advantages and disadvantages of BCT. Here, the loading and unloading process becomes much more efficient and secure, but some stakeholders see problems in maintaining business privacy. Since all information are available for each participant, competitors can draw conclusions about business relationships and trading volumes (Hackius, Reimers and Kersten, 2019). The BCT is only accepted when a critical mass of stakeholders recognizes the predominant advantages (Dobrovnik et al., 2018; Shermin, 2017).

The use cases already show that there will not be a comprehensive blockchain solution, but a multitude of permissioned blockchains depending on which cooperation partners have joined. In some cases the blockchain is used as an integrator to connect legacy systems. From this the necessity of a uniform industry standard can be derived. Even more, this is necessary in order to be able to work across company's borders and thus use the full potential of BCT (Kückelhaus et al., 2018). Mosolf [4] has already recognized the potential of BCT in conjunction with smart contracts and has integrated them into their process. This has considerably reduced the need for administrative tasks and paperwork (MOSOLF, 2019). In particular, the value proposition of reducing costs and avoiding errors by human intermediaries is significantly reduced or practically eliminated, if the contract is logically programmed and properly implemented on the chain (Christidis and Devetsikiotis, 2016). Not only freight documents but also payments can be made without delay and a trusted intermediary, as Daimler Truck & Commerzbank [8] have already tested (Commerzbank, 2019). The application is remarkable against the background that companies wait on average of 42 days for the receipt of an invoice. The use of BCT with smart contracts leads to an increase in profits of between 2% and 4% while reducing costs simultaneously (Nelson et al., n.d.).

6 Conclusion and further investigations

This article has taken a closer look at two aspects of BCT. Firstly, it should be analyzed to what extent disintermediation is seen as the driving force behind the implementation of BCT. It was found that the blockchain itself acts as a new intermediary. On the other hand, the status quo of blockchain adaptation in Germany was examined on the basis of the search methodology and real use cases. Due to the data situation, a final answer is not possible, but it can be stated that the adaptation is still in an early stage.

Future research should concentrate on two topics. First continue on the identification of real cases of application and, once a critical number of cases has been reached, draw an international comparison. Based on the relative development of real applications in Germany compared to other economies, a more comprehensive answer to the status quo of Block-chain adaptation in Germany can be given. Second, the role of BCT as a new intermediary should be exposed with a focus on value propositions for the user as well as on technical characteristics that can change process chains and business models.

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