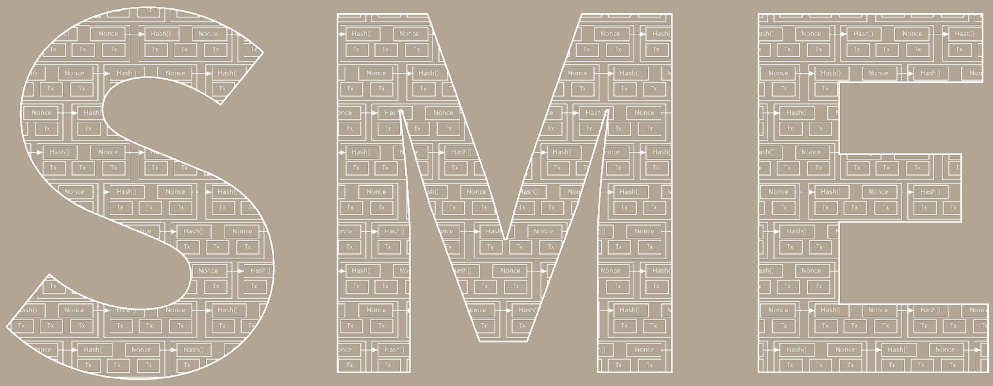
Sven Reimers

Blockchain Adoption Strategies of Small and Medium-sized Enterprises



Blockchain Adoption Strategies of Small and Medium-sized Enterprises

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Summary

The growth of digitalization is affecting virtually all Logistics and Supply Chain Management (L&SCM) processes, products, and business models. Key activities for any modern business include tracing goods, identifying counterfeit products, and coordinating with business partners, thus the development of an information infrastructure remains challenging. Researchers and practitioners have high hopes that Blockchain will enable improvements in these L&SCM activities. However, while some large companies have begun to deploy Blockchain solutions, their Small and medium-sized Enterprise (SME) competitors are struggling to use the technology for their benefit.

This dissertation addresses the Blockchain adoption strategies of SMEs in the context of L&SCM with two studies. In Study 1, practitioners' perceptions of the role of SMEs in Blockchain projects were surveyed. An online questionnaire yielded 80 responses regarding the respondents' experiences with SMEs in Blockchain projects. The findings show that SMEs are not the knowledge carriers in Blockchain projects – in neither technology nor business-model development. In the main study, a qualitative, exploratory research approach and Grounded Theory (GT) were applied to expand on the findings of Study 1. This (Study 2) involved 37 semi-structured interviews. The findings revealed a typology of SMEs' approaches to Blockchain adoption. For each project, an SME must choose one of these four approaches, which are not mutually exclusive. This choice of approach is determined by several internal and external conditions, most notably a company's digital capabilities (or lack thereof).

In conclusion, SMEs have a role to play in Blockchain projects and this needs to be defined. This finding emphasizes the need for further research. More case studies should be collected to clarify the role of SMEs in Blockchain projects, and the long-term consequences of passive participation in Blockchain solutions have to be identified. SMEs could work together to build their own system, though this might be challenging to adopt in the context of the existing supply chain structures and power relationships. SMEs could also collaborate to develop a logistics Blockchain solution. Though this might be challenging to achieve, the solution may be more accessible than a supply chain management option due to the fragmented nature of the market.

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List of Abbreviations

CEP Courier, express, parcel

CRM Customer-Relationship-Management

EKAM European Competence Center for Applied SME Research

ERP Enterprise Resource Planning

EU European Union

FTL Full-truckload

GDP Gross Domestic Product

IfM Institut für Mittelstandsforschung

KfW Kreditanstalt für Wiederaufbau

L&SCM Logistics and Supply Chain Management

LTL Less-than-truckload

OEM Original Equipment Manufacturer

PL Party Logistics

ROboB Release Order based on Blockchain

SCM Supply Chain Management

SME Small and medium-sized Enterprise

TMS Transport Management System

WMS Warehouse Management System

ZEW Leibniz Centre for European Economic Research

Chapter 1

Focus and Scope of this Thesis

1.1 Introduction

Few Information System (IS) generate as much attention as systems based on Blockchain technology (Sternberg et al. 2020). Since 2016, academic and practitioner literature has been overrun with potential use cases, the potential to disrupt business models, disintermediate trusted third parties, and the possibility of changing the entire economy. As Iansiti and Lakhani (2017) stated in their Harvard Business Review article, "Indeed, virtually everyone has heard the claim that Blockchain will revolutionize business and redefine companies and economies." Both researchers and practitioners have high hopes for Blockchain technology to improve the activities in Logistics and Supply Chain Management (L&SCM).

Modern businesses are confronted with topics such as the tracing of goods, identification of counterfeits, coordination with business partners, and secure data exchange. Blockchain seems to solve these problems with its distributed nature (Swan 2015; Dobrovnik et al. 2018) and the possibility of transorganizational communication. Large companies have already begun to deploy Blockchain for their operations, in some cases with a high level of success (Sternberg et al. 2020; Tan et al. 2018). For example, two of the most prominent Blockchain-enabled solutions in production are TradeLens, started by A. P. Møller-Mærsk, and IBM Food Trust, started at Walmart, but neither of them began as a Blockchain project. Both started with industry-specific problems: A. P. Møller-Mærsk wanted to reduce the administrative costs of shipping and digitalize shipping documents for paperless trade.

Walmart sought a better way to trace fresh products through its supply chain. Both intentions developed into Blockchain projects with global impact (Carlsen 2021; Nash 2018; Lacity and van Hoek 2021b).

All integrated companies must share data to achieve these potentials along the supply chain. As Lacity and van Hoek (2021b) wrote, "Early IBM Food Trust adopters then had to persuade their trading partners to join in order to achieve end-to-end traceability." While large corporations such as A. P. Møller-Mærsk and Walmart have the resources to set up a Blockchain, smaller companies are restricted by limited resources. They often even need assistance to onboard into these Blockchain infrastructures. Moreover, small and medium-sized enterprises (SMEs) have attempted to mimic the industry giants, but with less know-how and resources. Some SMEs team up to set up their Blockchain infrastructure and generate value in their external relationships. However, there is little insight into the approaches of SMEs toward Blockchain adoption (Wong et al. 2020a) and the organizational structure of Blockchain projects (Lumineau et al. 2020).

1.2 Research Objective and Research Questions

Aside from the mentioned examples of Walmart and A. P. Møller-Mærsk, other companies also attempt to optimize their supply chains or logistics processes with Blockchain. These trends and opportunities are also evidenced by the number of scientific publications investigating the potential of Blockchain technology since 2017. This sound body of literature on the potential of Blockchain technology mainly focuses on incumbents and whole supply chains in diverse industries, such as pharmacy, healthcare, food, and general logistics (Wamba and Queiroz 2020; Treiblmaier 2018; Dujak and Sajter 2019; Dobrovnik et al. 2018; Koens et al. 2020). In contrast to the incumbents and whole supply chains, which have received much attention, the area of SMEs has surprisingly been scarcely researched, although these companies must also be integrated into the value creation process. Only a few insights exist regarding the barriers to and challenges of Blockchain adoption for SMEs. Scientific and practitioner literature contains almost no documentation on relevant factors for SMEs. This dissertation hence pursues the following research goal:

Research Goal: Gaining a better understanding of small and medium-sized enterprises' roles and approaches in adopting Blockchain.

Although Blockchain scholars have yielded a significant body of research on the possibilities of Blockchain and their adoption factors for incumbents or the whole supply chain, only a few scholars have focused on Blockchain adoption among SMEs. Therefore, this dissertation aims to provide insight into the possibilities of SMEs with Blockchain technology. Since SMEs are included in almost every supply chain and Blockchain project currently being implemented, the role of SMEs in these types of projects warrants investigation. To this end, project participants' experiences are surveyed. The first research question addresses these experiences directly:

Research Question 1: How do companies perceive the role of SMEs in Blockchain projects?

Based on the results from research question 1, the question of how SMEs approach Blockchain arises. Therefore, the second research question identifies and describes different strategic approaches to SMEs' Blockchain technology adoption:

Research Question 2: What approaches do SMEs take toward the adoption of Blockchain technology?

Building on the survey results and the four identified approaches, the third research question aims to identify SMEs' considerations when deciding on a specific approach. It reads as follows:

Research Question 3: What should SMEs consider when choosing a particular approach?

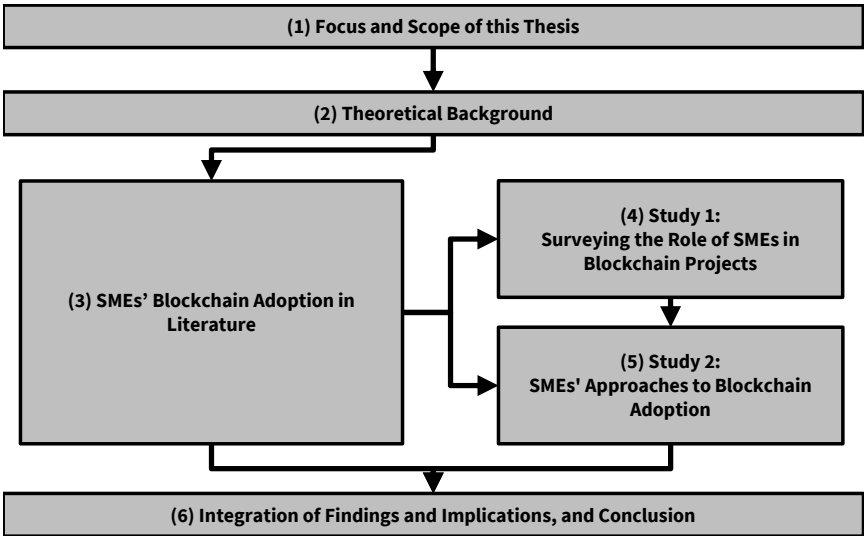

Figure 1.1: The Structure of this Dissertation

1.3 Research Structure

As depicted in Figure 1.1, this dissertation has six consecutive sections and is structured along two empirical studies. Chapter 2 on the next page introduces the terminology and concepts relevant to supply chain management, logistics, SMEs, innovation adoption, and Blockchain technology. Chapter 3 on page 31 reviews the relevant literature regarding SMEs' Blockchain adoption and deepens the actual state of research on SMEs. Chapter 4 on page 63 presents the first empirical study based on a web-based survey approach. This study presents the perception of the role of SMEs among companies with Blockchain project experience. Based on these findings, Chapter 5 on page 81 presents SMEs' approaches to Blockchain adoption, and the results of a qualitative Grounded Theory (GT) study are presented. Finally, in Chapter 6 on page 173, the research questions are answered, and all findings are integrated into the overall context of innovation management.

Chapter 2

Theoretical Background

This chapter outlines the terminology used regarding logistics and supply chain management, small and medium-sized enterprises and innovation adoption, and it briefly introduces Blockchain technology and its key terms. For further specification and confirmation of the relevant aspects, Section 2.1 describes the fundamentals and core components of the research areas. Notably, the literature contains numerous definitions of each term, but since the fundamentals are explained in this chapter, only particularly relevant topics will be examined.

2.1 Logistics and Supply Chain Management

First, it is necessary to establish the understanding of Logistics and Supply Chain Management (L&SCM) and the theory concerning SMEs that underlie this dissertation. To this end, this section first explains how L&SCM are defined. Thereafter, a general understanding of logistics and supply chain management research is presented.

2.1.1 Scope of Logistics and Supply Chain Management

Differences in interpretation often arise when the terms logistics and supply chain management are used since they often refer to the same topic and are often not differentiated in scientific works (Richey et al. 2022).

Since the first use of the term "supply chain" in 1982, discussion has ensued on the correct delineation of "logistics." Depending on the author, these terms have different scopes, from synonymous use to concretely defined terms (Swanson et al. 2018). The term "supply chain management" is more recent than "logistics," with the latter often viewed as a broader concept. In 1998, logistics and supply chain management were distinctly defined – logistics was a subset of supply chain management – but they are frequently integrated as a single discipline (Lambert et al. 1998). Scholars have made substantial efforts to create consensus regarding the definitions of these terms (Mentzer et al. 2001; Larson et al. 2007; Frankel et al. 2008; Mentzer et al. 2008; Lambert et al. 2008; Stock and Boyer 2009; Zinn and Goldsby 2014; Carter et al. 2015; Ellram and Cooper 2014; LeMay et al. 2017; Richey et al. 2022; Swanson et al. 2018). According to Christopher (2011, p. 2), supply chain management is a broader concept than logistics: "Logistics is essentially a planning orientation and framework that seeks to create a single plan for the flow of products and information through a business. Supply chain management builds upon this framework and seeks to achieve linkage and coordination between the processes of other entities in the pipeline, i.e. suppliers and customers, and the organization itself." This differentiation between the two terms is adopted in this dissertation.

2.1.2 Supply Chain Management

With evolving technology and increased digitalization, conscious interest in the discipline of supply chain management has grown (Stevens and Johnson 2016, p. 22). Numerous definitions and frameworks in this area have thus developed over time. An extensive overview of these definitions and frameworks can be found in Vahrenkamp et al. (2012, p. 22), Wolf (2008, p. 11), and von See (2019, 10ff.). Moreover, comprehensive reviews of the actual state of research can be found in Min et al. (2019), Stevens and Johnson (2016), and Swanson et al. (2018).

Since 1982, the term "supply chain" has been the subject of scientific works and is used in science and practice (Vahrenkamp et al. 2012, p. 25). Due to its frequent use and practical relevance, many efforts have been made to define the term uniformly. According to Mentzer et al. (2001, p. 4), "a

supply chain is defined as a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer." Like this characterization, Chopra and Meindl (2016, p. 1) capture all parties involved, direct or indirect, fulfilling a customer request under this term. This characterization includes not only the manufacturer and suppliers but also the transporters, warehouses, retailers, and even customers themselves. Customers' needs, in particular, drive this flow of materials, which connects a network of companies through a stream of materials, goods, and products (Council of Supply Chain Management Professionals 2013, p. 187; Chopra and Meindl 2016, pp. 13–16).

According to Bozarth and Handfield (2013, p. 6), the following is a simple example of a supply chain: Consider ordering a single cup of coffee at Starbucks. Before the coffee beans can be brewed at the Starbucks location, they must be roasted, packed and shipped, among other steps. In the case of Starbucks, eight roasting plants in North America roast coffee for all US stores (Garthwaite et al. 2017). The roasting plant in South California alone roasts 680,000 tons of coffee a week, which must be distributed to the stores (Warnick 2020). The coffee beans arrive as green beans from coffee farms worldwide – mainly Brazil, Vietnam, Colombia, and Indonesia. Depending on the type of coffee a customer orders, the different beans are roasted and mixed together (Deshmukh 2020; Hoffmann 2018). To provide a cup of coffee to the customer, transportation firms organize the right amount of materials at the right time – without harming the beans through suboptimal temperature, humidity, and long shipping times. Coffee is generally transported in shipping containers, which hold up to 300 bags of coffee at once (Hoffmann 2018, p. 40). In addition, software companies must support the information flow between these companies, thereby coordinating the flow of physical goods[1].

This simple example demonstrates that supply chains are highly complex and involve more than the conversion of raw material into a product (Fisher 1997). Supply chain management is needed to optimize and coordinate the processes within a supply chain (i.e., the entire network (Lambert et al. 1998, p. 4)).

1 The coffee example was chosen because Starbucks has a Blockchain-based traceability service for the origin of their coffee (Warnick 2019).

Many authors have criticized the term "supply chain" for its outdated suggestion that units are connected linearly. Chopra and Meindl (2016) suggest that the new typology of a supply chain is more a supply chain network than a linear structure (Lambert et al. 2008). Furthermore, Carter et al. (2015) take the previously mentioned foundations of a supply chain and add six basic premises to the structure and boundary of a supply chain:

- the supply chain is a network consisting of nodes and links;
- the supply chain as a network operates as a complex adaptive system, where every agent grapples with the tension between control and emergence;
- the supply chain is relative to a particular product and agent;
- the supply chain consists of both a physical supply chain and a support supply chain;
- the supply chain is bounded by the visible horizon of the focal agent; and
- the visible horizon of the focal agent is subject to attenuation, where distance is based on factors including physical distance, cultural distance, and closeness centrality (ibid.).

To illustrate the complexity of a supply chain network structure, mainly focusing on the dynamics and links between companies, an example according to Carter et al. (ibid.) is visualized in Figure 2.1 on the next page. Carter et al. (ibid.) argue that aside from the physical supply chain – often mentioned in the literature (Lambert et al. 1998; Cox et al. 2005; Mentzer et al. 2001) – a support supply chain exists. This support supply chain (see configuration 1) consists of financial institutions, brokers, truckload transportation, and IT service providers. The physical product does not flow through these institutions, but they enable the normal process (see configuration 2).

Figure 2.1 on the facing page shows that the Original Equipment Manufacturer (OEM), like in the previous Starbucks example, is the focal company that orders downstream from different suppliers, which also order from different suppliers. These different suppliers, in turn, order their goods from suppliers behind them, meaning that, depending on the supply chain,

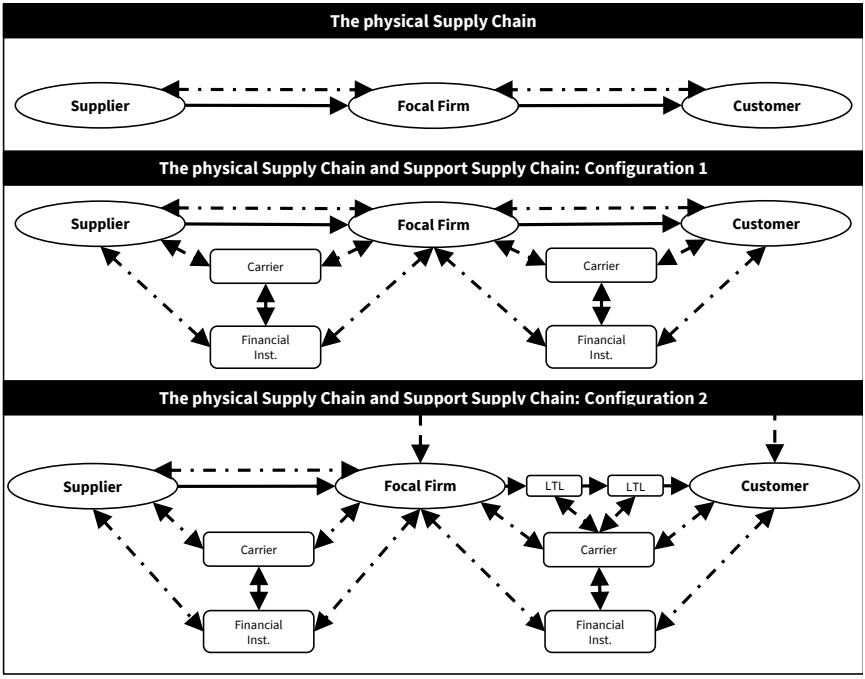

Figure 2.1: The physical and support Supply Chain (Carter et al. 2015, p. 92)

any number of suppliers could exist in the supply chain. The same applies upstream on tier 1 – n customer side.

During the last decade, more factors have been included in supply chain research. Aside from new technologies (Waller and Fawcett 2013), new perspectives must be considered, such as the systems approach; complex adaptive systems or complexity thinking (Nilsson and Gammelgaard 2012); new economic and social perspectives (Fawcett and Waller 2013); and circular material and information flows, which have become popular (Geissdoerfer et al. 2017; Ghisellini et al. 2016).

Supply chain management was traditionally seen as a research field in which the static system (referring to both linear chains and networks) is delimitable from its environment (Nilsson and Gammelgaard 2012). According to Waller and Fawcett (2013), supply chain management "is the value-creation engine of the modern organization" and should operate timeously. Many researchers and managers follow this understanding and expect a supply chain to work deterministically. Once a supply chain is running and functioning, strategies could be designed to control and maintain the established system (Wieland 2021).

According to Wieland (ibid.), current supply chain research considers two main conditions as stable. The first entails the "wide support in business, society, and politics for global sourcing strategies; the long-term availability of sufficient natural resources needed in manufacturing; and the willingness of humans to consecutively consume new product generations" (ibid., p. 60). Second, a supply chain can be isolated from the rest of the world without consideration. Both stable considered assumptions must be questioned in the example of the COVID-19 pandemic. Moreover, general supply chain management has connections to a broader range of political-economic and planetary levels (ibid.).

2.1.3 Logistics and the European Market

Several definitions for the modern concept of logistics exist in the literature. The term logistics has been used in the United States since approximately 1950 and in Germany since 1970, and it has become widespread and influential. Almost every industrial company has its own logistics department

or covers this subject area in detail. For this reason, definitions commonly used in the scientific community are presented below.

In this dissertation, logistics is understood as a smaller focus area of supply chain management that concerns the flow of raw materials, goods, and products between and within companies from the source of raw materials to the end customer. Following Arnold et al. (2008), the various definitions for logistics contain broadly common elements. The logistics processes all involve transport and storage as well as the associated loading and unloading, storage and retrieval (transshipment), and picking. According to Isermann (1998), these common elements can be described as an orientation toward the availability of objects in line with demand. Logistical objects are, for example, material goods such as pallets and products in industrial operations.

Moreover, according to the definitions by Pfohl (2018) and Bowersox et al. (2010) logistics includes the work required to generate added value through the movement and positioning of goods. Pfohl (2018) and Bowersox et al. (2010) extend the previous definition of logistics to include order handling.

Logistics is an integral part of the entire global economy. The logistics market in the United States alone was worth $1.565 billion in expenditures in 2020. However, this value reduced by 3.5% with the economy, shrinking logistics costs to 7.4% of the Gross Domestic Product (GDP) (Kearney 2021). The European logistics market amounts to €1.115 billion in expenditures (Pflaum et al. 2020). This number includes current spending on in-house logistics by industrial, retail, and all the other commercial and public sector participants in the economy and spending on outsourced logistics. The European road freight market, with more than 500,000 players, is characterized by intense price competition. Ninety-nine percent of transport service providers can be classified as small and medium-sized enterprises (SMEs) with fewer than 50 employees (Toelke and McKinnon 2021, p. 7).

In 2020, the total logistics market in Europe amounted to €1.115 billion, with Germany holding a high share of 25% (Pflaum et al. 2020, p. 77). This significant share is due to the country's geographic location directly in Europe and its leading role in logistics technology. The logistics volume from 2019 amounted to a total of €285 billion and included both in-house

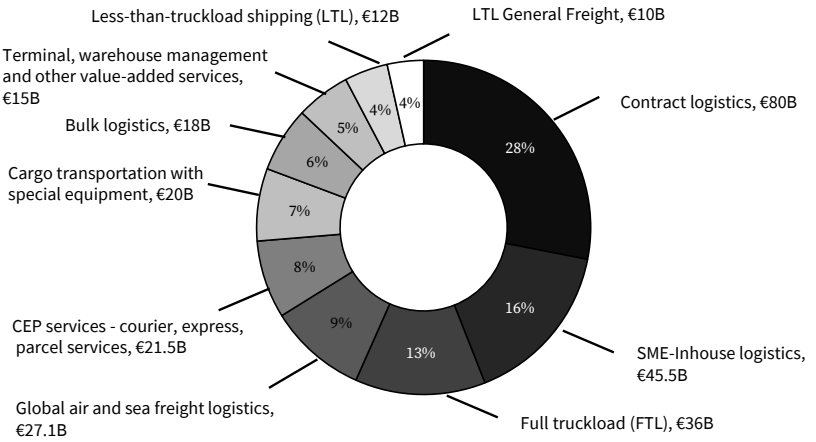

Figure 2.2: The 10 Segments of Logistics in Germany according to Volume in € Billion (% of a €285.1 billion total) (data from 2019 according to Pflaum et al. (2020, p. 77))

and outsourced services in logistics. Figure 2.2 presents an overview of the segments of the German logistics market.

The 10 in-house and outsourced services depicted in Figure 2.2 are carried out and provided by a large number of logistics service providers. Figure 2.2 shows all volumes in € for the following logistics segments. First, contract logistics, also known as third-party (3PL) or fourth-party (4PL) service providers, offer to outsource logistics services to other companies. 3PL and 4PL service providers are similar in that they do not offer tangible assets (e.g., vehicles or warehouses) but instead assume the control and integration function within a supply chain. However, 3PL and 4PL providers differ in that 3PL companies have tangible assets, whereas 4PL service providers are virtual companies (Bozarth and Handfield 2013, p. 232; Coyle et al. 2003, p. 677). Notably, contract logistics accounts for the largest share with 28% (€80 billion). Second, SME-Inhouse logistics refers to the logistics carried out by SMEs without outsourced services (Pflaum et al. 2020, p. 148) with a share of with 16% (€45.5 billion). Third, Full-truckload (FTL) involve road transport with shipping containers or semi trailers with a share of 13%

(€36 billion). Fourth, global air and sea freight refers to active companies in these segments with a share of 9% (€27.1 billion). Fifths,Courier, express, parcel (CEP) services are logistics services that typically deliver parcels or other documents weighing up to 32 kg to end customers at destinations with a share of 8% (€21.5 billion) (ibid., p. 77). Sixth, cargo transportation with special equipment refers to logistics services involving the transport of goods weighing 2.5 tons or more in a tank or in silo transports, heavy goods transports, or cargo transports with special equipment (such as wind turbine rotor blades). Notably cargo transportation with special equipment accounts for a share with 7% (€20 billion). Seventh, bulk logistics refers to bulk cargo shipped unpacked as liquid or solid bulk cargo in large weight classes. Bulk cargo can be further differentiated into granular and lumpy forms. Typical products in this category are petroleum and ores (Coyle et al. 2003, p. 671). Bulk logistics accounts for 6% (€18 billion). Eighth, terminal and warehousing logistics refers to services independent of the overall supply chain, including the retrieval, storage, and shipment of goods (Bozarth and Handfield 2013, p. 225) with 5% (€15 billion). Ninth and tenth, refers to Less-than-truckload (LTL) transports. In contrast to FTL, in which there is usually one customer per shipment, in LTL, orders are collected from several customers to utilize containers to their full capacity (ibid., p. 233). LTL shipping in general accounts for 4% (€12 billion) while LTL general freight refers to network transports for certain goods, for example fashion logistics with 4% (€10 billion).

2.2 Small and Medium-sized Enterprises

Aside from the definitions of L&SCM, small and medium-sized enterprises (SMEs) must also be defined. First, the importance of SMEs for the global economy, but especially for Europe and Germany, is highlighted. Then, the various definitions of SMEs are presented and determined for the subsequent work.

Small and medium-sized enterprises play an essential role on various continents. For example, SMEs are key in Europe, as reported by the EU itself: “Small and medium-sized enterprises (SMEs) represent 99% of all businesses in the EU” (European Union 2020). Similarly, in the United States,

99% of all companies are SMEs (SBA Office of Advocacy 2021). Moreover, SMEs account for half of the US GDP.

In the European Union, Germany strongly focuses on SMEs: In 2019, approximately 3.54 million companies could be classified as SMEs, representing 99.3% of all companies from supplies and services and/or employees in Germany. These companies generated around €2.35 trillion in Germany, which corresponds to 32.9% of total sales in the country. In addition, SMEs contributed approximately 60.6% to all companies' total net value added in 2019. In the same year, the export turnover of SMEs in Germany was around €214.6 billion, constituting 16.0% of the export turnover of all enterprises (Braun and Kay 2019).

SMEs account for more than 32.9% of total sales and are therefore rightly described as the backbone of the German economy. Despite the various key figures in the overview of the importance of SMEs in the international and national context, it is impossible to draw any direct conclusions. However, before the actual definition of SMEs can be elaborated, the term Mittelstand must first be differentiated from the term "small and medium-sized enterprises (SMEs)." Mittelstand is unique to the German-speaking area and is defined based on the unity of ownership and management. The size of a company is not the decisive factor in determining whether the company can be classified as an SME, but rather its qualitative characteristics are. A characteristic feature of the unity of ownership and management is that

- the entrepreneur exercises a significant personal influence;
- the entrepreneur bears the entrepreneurial risk; and
- the company secures the entrepreneur's livelihood.

According to the definition by the lfM Bonn, Mittelstand is synonymous with the following terms: family business, owner-operated business, and family-managed business. The majority of SMEs meet the defining qualitative characteristics of SMEs (management, ownership, and economic independence). Nevertheless, Mittelstand and "small and medium-sized" enterprises are not synonymous (IfM Bonn 2022).

The definition of what constitutes an SME differs depending on the definition used, and statistical studies and evaluations are therefore not always

Table 2.1: SME Definitions according to different Institutions (see also (European Union 2020; IfM Bonn 2022; ZEW 2016; KfW 2018)). The definitions listed here are mainly used in Germany. The definitions by the European Union (EU) and Institut für Mittelstandsforschung (IfM) Bonn are the best known. The definitions by the European Competence Center for Applied SME Research (EKAM), the Leibniz Centre for European Economic Research (ZEW), and Kreditanstalt für Wiederaufbau (KfW) are relevant for the respective industries.

			Institutions				
		Definition	EU	IfM	EKAM	ZEW	KfW SME Panel
Classification criteria	Employees	Micro	<10	<10	<30	<5	
		Small	<50	<50	<300		
		Medium	<250	<500	<3000		
		Large	≥250	≥500	≥3000	≥500	
	Turnover in million € / year	Micro	<2	<2	<6		
		Small	<10	<10	<60		
		Medium	<50	<50	<600		<500
		Large	≥50	≥50	≥600		≥500

comparable. Various definitions of the benchmarks used for classification exist worldwide. As a basic example, the United States defines all companies with fewer than 500 employees as SMEs, while the EU defines all companies with fewer than 250 employees as SMEs. Essential factors are presented next, and definitions are interpreted accordingly. The definitions and frameworks presented are from the European context (for a detailed overview of international definitions, refer to the work of Ayyagari et al. (2007)).

Two to five comparative definitions of SMEs currently exist in Germany, depending on which economic sector is under consideration in the academic literature. Table 2.1 on the preceding page summarizes the definitions of small and medium-sized enterprises commonly used in studies.

Among the listed definitions, two stand out and are often employed. The first is the definition by the IfM Bonn, which uses quantitative criteria for classification: annual sales (≤ €50 million) and the number of employees (<500 employees). The second definition is by the EU Commission. According to this definition, a company is an SME if it has less than 250 employees and annual sales of no more than €50 million. The difference in the threshold value of employees between the two definitions highlights the unique German characteristics of SMEs. Since 2016, the thresholds for classification into micro and small enterprises have been harmonized. In this dissertation, the definition of SMEs is exclusively based on that of the EU Commission: SMEs are considered to be companies with fewer than 250 employees and less than €50 million in annual sales or a balance sheet total of €43 million. Various publications and numerous national and international funding programs in research and development also employ this definition.

2.3 Adoption of Innovations

First, it is necessary to define a common understanding of the level of adoption that underlines this dissertation. This is accomplished by providing definitions of the relevant terms and outlining the generic adoption processes described in the literature.

2.3.1 Defining Technological Innovation Adoption

Rogers (2003, p. 11) defines a general innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption." This definition is well known and applied in research. Others, such as Amabile (1988, pp. 125–127) and Daft (1978), define innovation only as the creation or adoption of new ideas. An item can be deemed an innovation if it seems new, which means innovation can "also refer to renewal in terms of thought and action" (Thong 1999, p. 190). According to Gopalakrishnan and Damanpour (1994), innovation could be new to a group or team, an organization, an industry, or wider society. Most studies in psychology are at the individual customer level, in economics at the industry level, and in management and industrial engineering at the firm level (ibid.).

The term "technology" is often confounded with "innovation" in the literature. According to Rogers (2003, p. 12), a technology is "a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome." This suggests that any product or process that has been put into practice and is not trivial to a business could be considered an innovation (Thong 1999). Therefore, new information systems of businesses could be viewed as technological innovation (Riemenschneider et al. 2003; Ramdani et al. 2013; Iacovou et al. 1995). This dissertation focuses on Blockchain technology, which SMEs might adopt; therefore, the topic of this dissertation is anchored in the subject of technology adoption.

This new technology presents companies with new means of solving problems and exploiting opportunities. Rogers formulates the process of adoption or rejection of an information system (innovation) as follows: "The innovation-decision process can lead to either adoption, a decision to make

full use of an innovation as the best course of action available, or to rejection, a decision not to adopt an innovation" (Rogers 2003, p. 21). According to van de Ven et al. (1989) and Damanpour and Schneider (2006), adoption means that the innovation is new to the adopting unit. There is an intention to derive anticipated benefits from changes that the innovation may bring to the new unit (Damanpour and Schneider 2006; West and Anderson 1996). Adoption is triggered directly by an internal managerial action or by external conditions (Damanpour and Schneider 2006). The decision is reversible later if the company becomes dissatisfied with the innovation after adopting it. The possibility also exists to adopt an innovation previously rejected by a company.

2.3.2 Technology Adoption Processes

Regardless of the innovation and the trigger to innovate, various models exist for explaining how innovations might be adopted. The innovation process is defined as a sequence of stages that every adopting entity must undergo (Rogers 2003). According to Kamal (2006), the mentioned technology adoption processes are replete with frameworks and models theorizing stages of the adoption process. Depending on their alignment, these models range from a two-stage to a six-stage model. However, models also involve parallel phases. For instance, Gopalakrishnan and Damanpour (1997) two-stage process comprises the stages of initiation and implementation. Both consist of different stages, which are more granular, as described by other authors such as Frambach and Schillewaert (2002).

Table 2.2: IT Innovation Adoption Processes (data based on Matta et al. (2012), Kamal (2006), and Damanpour and Schneider (2006))

Process-Models	Initiation	Experimentation	Implementation
Lewin (1947)	Unfreezing	Changing	Refreezing
Hage and Aiken (1970)	Evaluation	Initiation	Implementation, routinization

continued on the next page

(Cont.) Table 2.2: IT Innovation Adoption Processes

Process-Models	Initiation	Experimentation	Implementation
Pierce and Delbecq (1977)	Initiation, cognitive component, awareness	Activities leading to the adoption decision	Implementation, adoption, routinization, institutionalization
Cooper and Zmud (1990)	Initiation	Adoption	Implementation
Klein and Sorra (1996)	Awareness, selection	Adoption	Implementation, routinization
Agarwal and Prasad (1998)	Awareness: information about existence of innovation	Perception, information seeking, evaluative behavior	Decision to accept or reject innovation
Gallivan (2001)	Primary authority is involved in adoption	Secondary authority Organizational assimilation	Organizational acceptance
Rogers (2003)	Knowledge about innovation, attitude toward innovation	Adoption decision	Implementing innovation idea, confirmation of decision
Damanpour and Schneider (2006)	Pre-adoption	Adoption	Post-adoption
Matta et al. (2012)	Initiation	Experimentation	Implementation

The innovation adoption process is divided into multiple stages. Table 2.2 on page 18 overviews these stages per model and author. Generally, the stages are grouped into three more universal stages: pre-adoption, adoption decision, and post-adoption (Damanpour and Schneider 2006). This dissertation uses the classification of phases into initiation, experimentation, and implementation (Matta et al. 2012), in line with Damanpour and Schneider (2006), Rogers (2003), and Matta et al. (2012).

The initiation phase is related to a company's interest in the new innovation. This phase involves researching and discovering issues, opportunities, and solutions and leading the intention to adopt (Matta et al. 2012). Companies learn about the existence of the innovation and communicate with others about a possible adoption (Damanpour and Schneider 2006). This orientation toward the innovation results in the conception and initiation of a plan for possible adoption (Kamal 2006). The experimentation phase reflects adoption ideas from different perspectives, such as the financial, technical, and strategic perspectives. According to Kamal (ibid.), "adoption only involves the decision to commit resources to innovation." By contrast, Matta et al. (2012) indicate that this phase involves trials, pilots, and the evaluation of technological and engineering considerations. Through these trials and pilots, organizations gain an understanding of the possibilities of the innovation and its fit with an organization's specific requirements (Jeyaraj et al. 2008). The implementation phase involves introducing and integrating the innovation into the business processes and preparing it for productive use. The organization and its employees use the innovation until it becomes a routine part of their processes (Rogers 2003). Companies sometimes implement the innovation only to a certain degree due to a lack of resources or scheduling errors, or they have the possibility to continue the evaluation (Matta et al. 2012).

2.4 Blockchain Technology

Blockchain is often explained differently and is interpreted accordingly in each context. The definitions range from essential cryptographic explanations of hashes and algorithms to the general technological concept of decentralized information distribution. In this section, the fundamental technical concept of Blockchain is explained with the technical terms relevant to the subsequent context.

2.4.1 Origin and Technology Concept

Generally, Blockchain describes the aggregation and agreement of transactions in an immutable ledger (Judmayer et al. 2017, p. 7). The term can be classified under the general term distributed ledger technology, which refers to a system with multiple participants and that functions without central control de-spite the unknown reliability of the participants. Blockchain can be understood here as a particular case of distributed ledger technology since information is stored in a data structure of chained hash values (Hinckeldeyn 2019, p. 6).

The groundwork for Blockchain technology was laid in the early 1990s, but the technology as it is known today was not developed until 2008. Many researchers from different disciplines, such as computer science or cryptography, worked on individual problems from security and transparency to trust long before the era of Blockchain. For example, Haber and Scott (1991) developed a concept in their paper "How to time-stamp a digital document" for append-only, cryptographically secured logs (ibid.). In 1994, Nick Szabo developed the first concept of smart contracts, which minimized the need for trusted third parties (Szabo 1997). Then, in 1998, Szabo proposed Bit Gold, a basic conceptual idea for Bitcoin, with a proof of work as a consensus mechanism in a peer-to-peer network (Moskow 2018). In the same year, Bruce Schneier and John Kelsey described in their article "Secure Audit Logs to Support Computer Forensics" a low-computing method to secure sensitive information with secure audit logs using hashes, authentication keys, and encryption keys (Schneier and Kelsey 1999).

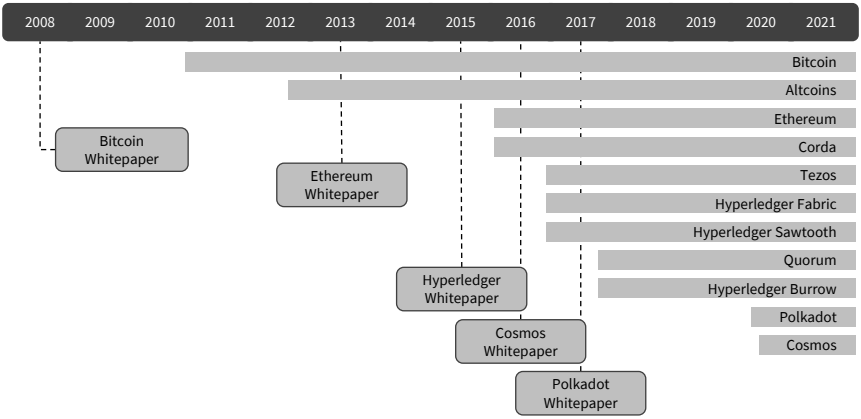

Figure 2.3: Overview of the major Blockchain Implementation Developments (data from CoinMarketCap (2022)). The whitepapers and the implementations based on them are those most commonly used in practice and research (Del Castillo et al. 2021; Groenfeldt 2017; Lacity and van Hoek 2021b).

The Bitcoin whitepaper "Bitcoin: A Peer-to-Peer Electronic Cash System" by Satoshi Nakamoto, published on October 31, 2008, differs significantly from the previous works (Nakamoto 2008). In addition to the currency ideas already mentioned, the authors also combined a data structure for the digital currency Bitcoin and presented a decentralized consensus mechanism. To solve the double-spending problem[2], Nakamoto proposed a system that employs a peer-to-peer network using a proof-of-work consensus mechanism to record a public history of transactions. Various other Blockchain networks emerged from this first large-scale public network. Figure 2.3 presents an overview of the major developments of the Blockchain.

At its core, Blockchain technology lies in a distributed database (Pilkington 2016), where information is synchronized across multiple independent computer systems and validated independently on each system (Swan 2018; Aste et al. 2017). Blockchain implies a decentralized system in which the

2 The double-spending problem refers to the challenge of designing a digital cash system that is at once a digital artifact but cannot be spent more than once.

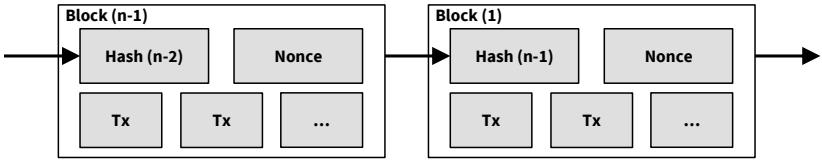

Figure 2.4: Blocks linked in a Chain, by reference to the previous Block Hash (Nakamoto 2008)

validation of transactions does not result in any alteration and in which the tamper-proof nature of the Blockchain is constantly visible (Chen 2018). Any entity participating in the network can trace all transactions and access the root hash (Li et al. 2018). The data is stored in blocks linked by hash values, and a chain is thus created where each link contains the previous block's information (Hinckeldeyn 2019).

The Blockchain uses a consensus algorithm to allow new data to be added to the Blockchain and for entities in the system to validate new transactions (Pilkington 2016). This consensus algorithm groups one or more transactions into a "block" and creates the link to the previous block using a hash, as illustrated in Figure 2.4. Such interdependent blocks, linked together, constitute the Blockchain. All parties participating in the network can verify transactions in a block and their dependencies. Unless there is consensus on the validity of a block, it is not added to the Blockchain (Judmayer et al. 2017). To retroactively change a transaction, the entire transaction block would have to be changed, but such a change could only be made if there is consensus on the transactions, and all dependencies on subsequent blocks are also changed retroactively.

Figure 2.3 on the facing page shows that since 2014, various new Blockchain protocols have been built and launched, including different configurations. According to CoinMarketCap, there are currently 20,308 different cryptocurrencies divided into various implementations (CoinMarketCap 2022). It is essential to understand that an extensive range of different Blockchain implementations currently exist, all with different functionalities, configurations, and consensus algorithms. Blockchain networks can be structured

		Permissions granted to the Participants	
		Permissionless	**Permissioned**
Blockchain Configuration	**Public**	▪ Everyone can validate, read or write.	▪ Everyone can read. ▪ Only members with permissions can validate or write.
	Private	▪ Only invited user can read. ▪ Everyone who is allowed to read can write and validate.	▪ Only invited user with permissions can read, write or validate. ▪ Reading, writing and validating can be done by seperate roles.

Figure 2.5: Blockchain Permission Configurations (see also (Buterin 2015; Varghese et al. 2018; Scully and Hobig 2019). The large, well-known networks, such as Bitcoin, Ethereum, and Cardano, are examples of public-permissionless Blockchains. Examples of private-permissioned Blockchains are Hyperledger Fabric, Hyperledger Sawtooth, Quorum, and R3 Corda. Combined public-permissioned and private-permissionless Blockchains are not considered further, as they are rarely used in practice.

differently depending on their purpose (Varghese et al. 2018). For example, large Blockchain networks such as Bitcoin and Ethereum are public Blockchain networks where anyone can participate without any restrictions (Nakamoto 2008). Every participant can view all data and validate it by themselves. However, not all Blockchain networks follow this structure because specific basic properties such as decentralization or immutability can be leveraged or replaced by central entities in private networks with the help of limited read and write rights (Varghese et al. 2018). Figure 2.5 overviews the typical configurations of Blockchains divided into public and private networks with reading, writing, and validation permissions.

Transactional applications are also possible in some implementations with the emergence of many new Blockchain protocols. These applications are managed by a smart contract. Different implementations have introduced other names for smart contracts, such as Hyperledger Fabric with

"Chaincode" (Androulaki et al. 2018). Smart contracts, which Nick Szabo first mentioned in 1994, are protocols that describe a set of rules – usually those of an application. Due to the immutability of a Blockchain, the rules, once published, cannot be changed. Accordingly, neither faulty logic nor the stored data can be changed. The contract has an address in the Blockchain network and can store data, which can only be accessed with a transaction. Applications written based on smart contracts can be used, for example, when participants (protocol users) must agree on facts (e.g., data in a business case) (Christidis and Devetsikiotis 2016).

The rules and data stored in a smart contract do not necessarily have to be related to a cryptocurrency. Examples of such data are information about container shipment, temperature, or transport documents. Any data sent to the smart contract that is considered correct by the consensus mechanism can be executed. Blockchain applications based on smart contracts also represent the transfer of logistics goods and trigger payments (Hinckeldeyn 2019). Figure 2.6 on the following page exemplifies the logistic transfer of temperature-controlled goods.

2.4.2 Understanding of Blockchain Solutions in the Supply Chain Context

As this dissertation concerns Blockchain solutions in the L&SCM context, the meaning of Blockchain solutions must be specified. Blockchain technology is a useful solution for modern L&SCM problems. Modern supply chains are "inherently complex, comprising multi-echelon, geographically disjointed entities competing to serve consumers" (Saberi et al. 2019, p. 2117). Diverse regulations, globalization, cultural differences, and human behavior render the evaluation of information and management of risks in such a network difficult, if not almost impossible (Dolgui et al. 2018). Supply chains must contend with topics such as fraud, pilferage, and inefficient transactions, but they need better information sharing and verifiability (Kouhizadeh et al. 2021). Many authors have considered the characteristics of Blockchain as a "natural fit" for the L&SCM domain (Casino et al. 2019; Poszler et al. 2019; Swan 2018) since supply chain practice requires information systems to support information on the secure and trustworthy provenance of a good (Saberi et al. 2019). A key promise of

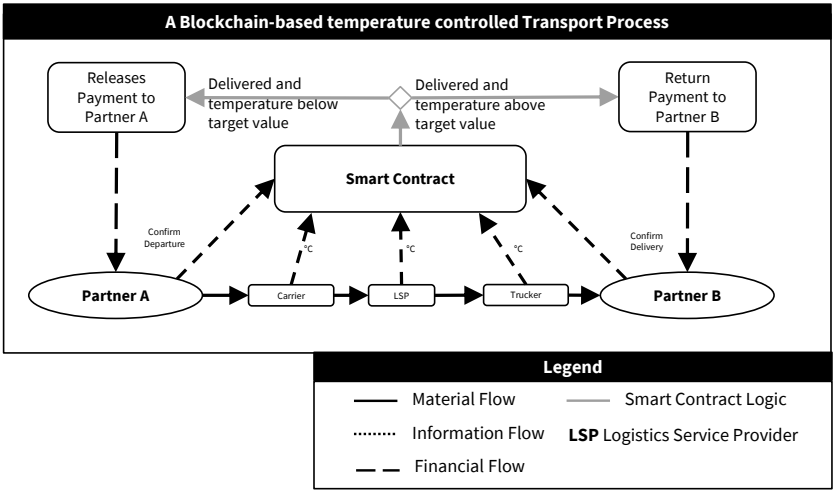

Figure 2.6: Generic Blockchain-based temperature controlled Transport Process

Blockchain for this domain is a single shared truth, with all companies able to read and process a shared ledger (Pilkington 2016). Blockchain is thus seen as disruptive to L&SCM. Since the beginning of 2017, Blockchain trials, or even announcements of trials, in L&SCM have significantly increased. The mentioned trials show companies seeking to implement the benefits of Blockchain in their supply chain operations for traceability of products, as in the cases of Starbucks (Warnick 2019), Provenance (Baker and Steiner 2015), Maersk (Stahlbock et al. 2018), Volvo (Volvo Cars Austria 2019), Walmart (Corkery and Popper 2018), and Bumble Bee Foods (Marr 2019). Other prominent companies use Blockchain to trace their emissions, as in the case of Daimler (Meitinger 2020); to minimize counterfeit, as in the case of Everledger (Holm and Goduscheit 2020); or to improve the re-integration of raw materials in the circular economy, as exemplified in the case of reciChain (BASF 2022). These use cases for tracking goods and emissions or anti-counterfeit are examples of how companies employ Blockchain technology. Since 2019, the number of successful projects beyond the pilot phase has been surprisingly small, although the number of use cases for

L&SCM is well recognized in the academic literature (Hong and Hales 2021; Pournader et al. 2020; Casino et al. 2019; Gurtu and Johny 2019; Labazova et al. 2019; Pedersen et al. 2019; Wang et al. 2019b; Yang 2019).

In the context of L&SCM, research considers different levels of examination in the applicability of Blockchain. The research streams range from fundamental questions about whether Blockchain technology is generally suitable for use in L&SCM (Wust and Gervais 2018) to particular use cases (Yang 2019). General research examines, for example, the circumstances under which the use of a Blockchain adds value and the suitable configuration of a Blockchain (Wust and Gervais 2018; Pedersen et al. 2019). Several papers discuss individual use cases in depth, such as the tracking of sensitive materials in the pharmaceutical supply chain through Internet-of-Things devices (Androulaki et al. 2018; Bocek et al. 2017), the tracing of food "from farm to fork" (Bumblauskas et al. 2020), the tracing of minerals (Chohan 2018), and trade clearing (Tsai et al. 2020), among others.

The common element of Blockchain solutions, mentioned by projects in practice and use cases in the literature for supply chain operations, is the extent of the parties' involvement. If the tracking of a good in a supply chain is considered from the source to the end customer, all companies involved in the flow of goods and information are included in the solution. Thus, all companies along the supply chain, such as suppliers, logisticians, service providers, and distributors, need access to the Blockchain. Companies may need to connect their systems (Warehouse Management System (WMS), Transport Management System (TMS), Enterprise Resource Planning (ERP), or Customer-Relationship-Management (CRM)) to the Blockchain to be able to update the data on the Blockchain (Swan 2018; Banerjee 2018). In addition, the asset that is to be tracked must also be equipped with trackers. In addition, the asset to be tracked must also be equipped with trackers. Tracking can be achieved via QR codes, RFID tags, or NFC labels (Alzahrani and Bulusu 2018; Rao and Clarke 2020). If temperature or other environmental factors are to be tracked, sensor technology is needed that is directly connected to the Blockchain (Hinckeldeyn 2019). Thus, a Blockchain solution for supply chain operations can involve one or more different Blockchain implementations and applications in parallel (Swan 2018; Dujak and Sajter 2019). In practice, examples of such Blockchain solutions are the well-documented Walmart case and the Smart Port in

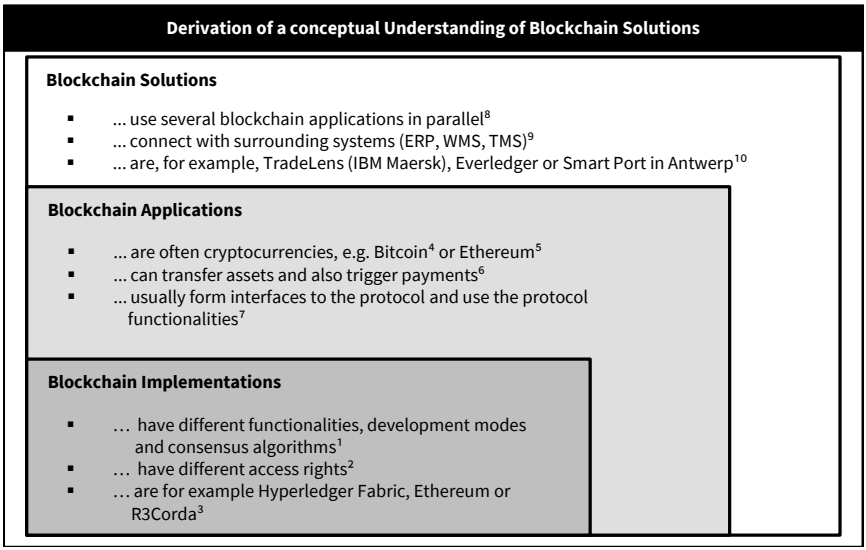

Figure 2.7: Derivation of a conceptual Understanding of Blockchain Solutions (see Judmayer et al. (2017), Varghese et al. (2018), Scully and Hobig (2019), Wust and Gervais (2018), Nakamoto (2008), Buterin (2015), Tapscott and Tapscott (2018), Hinckeldeyn (2019), Dujak and Sajter (2019), Swan (2015), and Stahlbock et al. (2018))

Antwerp (Corkery and Popper 2018; Port of Antwerp 2017). Figure 2.7 presents the conceptual understanding of a Blockchain solution.

The Chapters 3 to 5 on pages 31–81 discuss the Blockchain adoption strategies of SMEs in L&SCM. They outline the actual state of research of SMEs adopting Blockchain (Chapter 3 on page 31), the role of SMEs in Blockchain projects (Chapter 4 on page 63), and the approaches SMEs currently take to adopt Blockchain (Chapter 5 on page 81).

2.5 Summary of the Theoretical Background

This section summarizes the theoretical background of this dissertation as presented in Chapter 2 on page 5. First, the fundamentals of supply chain and logistics were introduced:

- From a macro-level perspective, a supply chain is defined as "a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer" (Mentzer et al. 2001, p. 4).
- Logistics is defined as "that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements" (Council of Supply Chain Management Professionals 2013).

Second, the understanding of the term small and medium-sized enterprise in this dissertation was introduced:

- SMEs are companies with fewer than 250 employees and less than €50 million in annual sales or a balance sheet total of €43 million (European Union 2020).

Third, the understanding of adoption in this dissertation was defined:

- The technology adoption process and adoption are understood as follows: "The innovation-decision process can lead to either adoption, a decision to make full use of an innovation as the best course of action available, or to rejection, a decision not to adopt an innovation" (Rogers 2003, p. 21).
- The technology adoption process model of Matta et al. (2012), consisting of initiation, experimentation, and implementation, is the chosen process for this dissertation.

Fourth, the technology concept of Blockchain was introduced, and the perspective on Blockchain in this dissertation was proposed:

- Blockchain technology lies in a distributed database (Pilkington 2016), where information is synchronized across multiple independent computer systems and validated independently on each system (Aste et al. 2017; Swan 2018).
- Blockchain solutions use one or more Blockchain implementations and applications. These solutions are integrated into the supply chain's information flow and thus into the existing IT infrastructure.

Chapter 3

SMEs' Blockchain Adoption in Literature

This chapter explores the state of research on Blockchain adoption by SMEs. For this purpose, an overview of the current state of research is presented. First, the necessary fields of literature are described, and the current SME Blockchain adoption literature is then overviewed. Thereafter, the theoretical framework for describing an adoption process is introduced. The findings from the review are presented by highlighting the relevant streams and findings in the literature. Finally, the relevant categories for the analysis are described, and the research needs are outlined.

3.1 Delimitation of the superordinate Topics

As described in the previous chapters, various practice-driven Blockchain implementations and a comprehensive scientific basis for applying Blockchain technology in supply chain management exist. Public projects and scientific publications focus mainly on the application possibilities of the technology in specific industries or specific tasks and elements in supply chain management. Examples from established companies are included in the analysis, as they present the first public prototypes and implementations of Blockchain solutions. Studies tend to follow a holistic L&SCM Blockchain approach in specific industries or particular use cases tends, rather than considering specific company sizes in the supply chain, such as Blockchain adoption by SMEs studied in this dissertation.

A review of the published SME Blockchain adoption literature suggests that, to date, publications focusing on this research field, especially in L&SCM, are surprisingly scarce. Due to the low number of publications, a broader range of literature must be considered. The subject area of SMEs' Blockchain adoption is divided into two primary fields. On the one hand, the general adoption of Blockchain in logistics and supply chain management must be explored, even if studies only analyze how incumbent companies attempt to adopt Blockchain and transform it into tangible benefits.

On the other hand, the general technology adoption of SMEs must be considered. Therefore, two major parts must be discussed. The first part is knowledge from general Blockchain adoption in supply chain management that is not generalizable to SMEs because of the fundamental differences between large and small companies (Torrès and Julien 2005; Blili and Raymond 1993; Yap et al. 1992; DeLone 1981; Cohn and Lindberg 1972). These differences are described in Section 3.4.3.1 on page 53. Since Blockchain is a cross-company technology, the second relevant part is the technological collaboration between small and large companies in general. Moreover, the management concept of co-opetition is introduced in Section 3.4.3.2 on page 57. Figure 3.1 on the facing page overviews the relevant research streams, which are used to structure the subsequent presentation of the findings from the review.

The following analysis does not aim to investigate and present different individual aspects of Blockchain adoption by SMEs but rather to provide an overview of the general state of development of the topic. To present a general state of development, three topics must be illuminated. First, the primary, appropriate frameworks for technology adoption are introduced, followed by the current state of research on Blockchain adoption among SMEs. Finally, the two specialist areas of technology adoption among SMEs and Blockchain adoption are also examined in depth. To narrow the focus of the reviewed literature, only the major developments in theory around Blockchain adoption and SMEs' technology adoption are presented. All necessary terminology is introduced and explained.

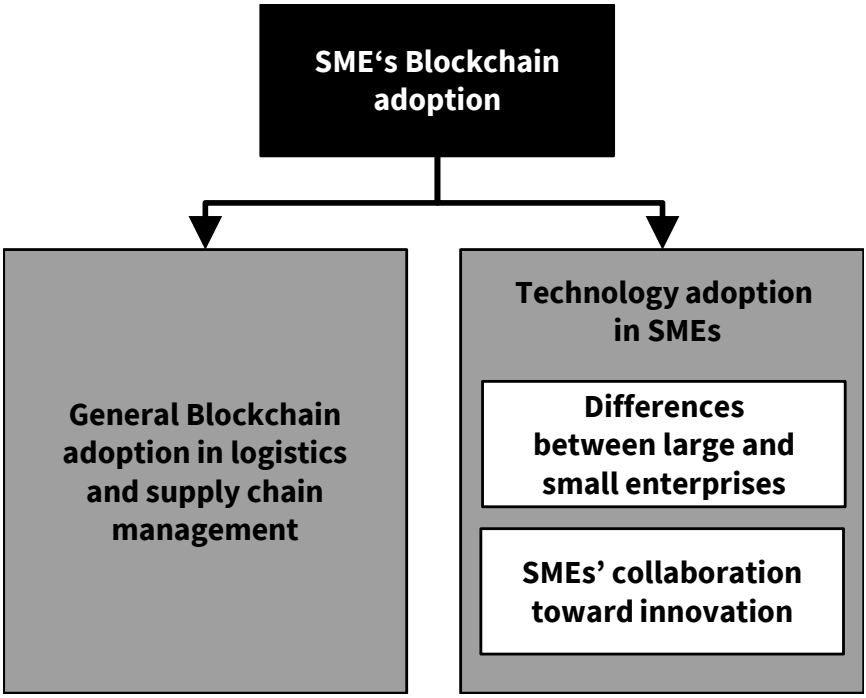

Figure 3.1: Relevant Research Topics for the Literature Review

3.2 Overview of SMEs' Technology Adoption

In general, the adoption and diffusion of new technology can affect a firm's productivity and performance (Caldeira and Ward 2003). Therefore, many published studies have considered the adoption and diffusion of innovative technologies in SMEs. Several empirical and theoretical studies have examined this topic, and many theories have been tested. For science, this development can be quantified, for example, by the growing number of corresponding publications, as illustrated in Figure 3.2 on the next page based on an analysis of the online citation and literature database Scopus. The search terms used to generate the data include the following: `("sme" OR "small and medium-sized" OR "small and medium" OR "small business" OR "small to medium-sized" OR "small organizations" OR "small business") AND "(adoption" OR "diffusion") AND (technology OR "it" OR "information technology")`

This search query was chosen because all common synonyms for the term SME are connected with adoption/diffusion and technology or information technology. The Scopus database was chosen because it has an application programming interface (API) that is useful for analyzing data effectively. Since the review was conducted in February 2022, only studies published prior to or up until this date were considered. Moreover, only English sources were included.

Although first mentioned in 1970, SMEs' adoption and diffusion of technology received little attention until 1990. Researchers began to analyze SME technology adoption as it gained in popularity (Oliveira and Martins 2011). From 2000 to 2016, the number of publications on this topic increased constantly, and since 2016, exponential growth has occurred.

The geographic origin of the relevant articles was investigated. For this purpose, the specific origin countries from the database were counted and summed up. Figure 3.3 on the facing page illustrates the distribution of authors of articles in the sample – only the first 20 countries are shown. The distribution indicates that most publications are from the United Kingdom, closely followed by the United States. These two countries are also mentioned in individual publications as being heavily researched in the SME sector (Ayyagari et al. 2007). They are followed by countries from

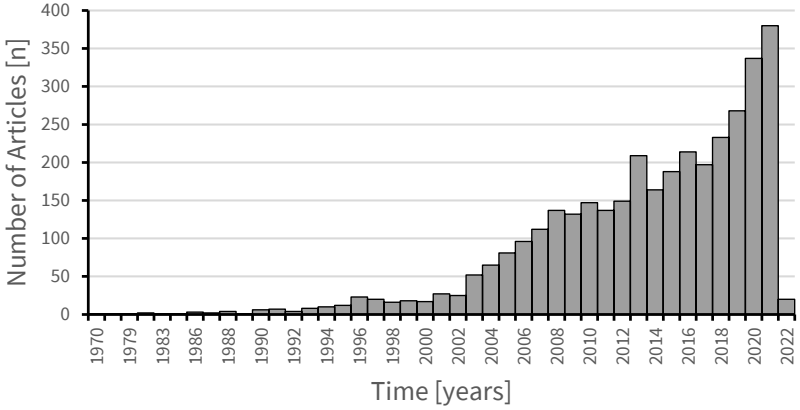

Figure 3.2: Distribution of Articles by Year (total number of articles = 3508)

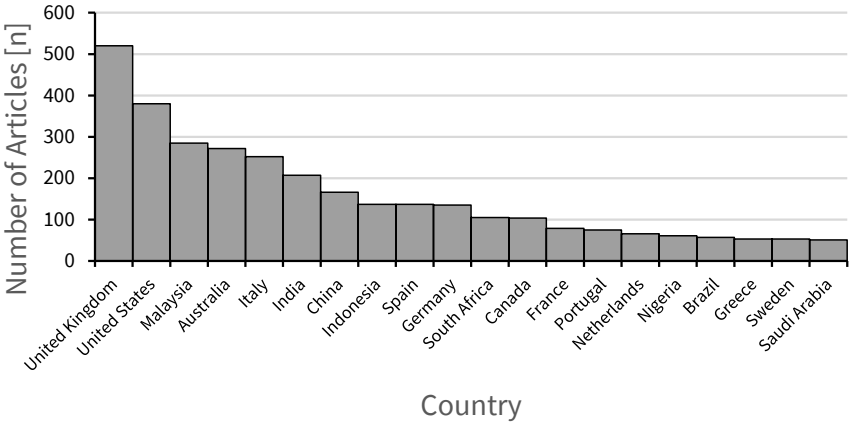

Figure 3.3: Distribution of Articles by Country (only the top 20 Countries are listed).

Southeast Asia, Europe, and Australia, after which Germany ranks 10th in the number of publications.

The majority of these publications are highly specialized and relate to single technologies. Figure 3.4 on the next page overviews the state of research based on author keywords. Electronic Commerce (e-Commerce), information and communication technologies, and cloud computing are the most researched technologies that SMEs are adopting. These are closely followed by the general use of the internet and Enterprise Resource Planning (ERP). Notably, Blockchain technology is also included on this list. The relevant publications mentioned here are detailed in Section 3.3 on page 38. Nevertheless, the number of publications is relatively small, possibly due to the novelty of the technology on the one hand and the general research focus on the other. The first SME-related Blockchain publication included in this sample was published in 2019.

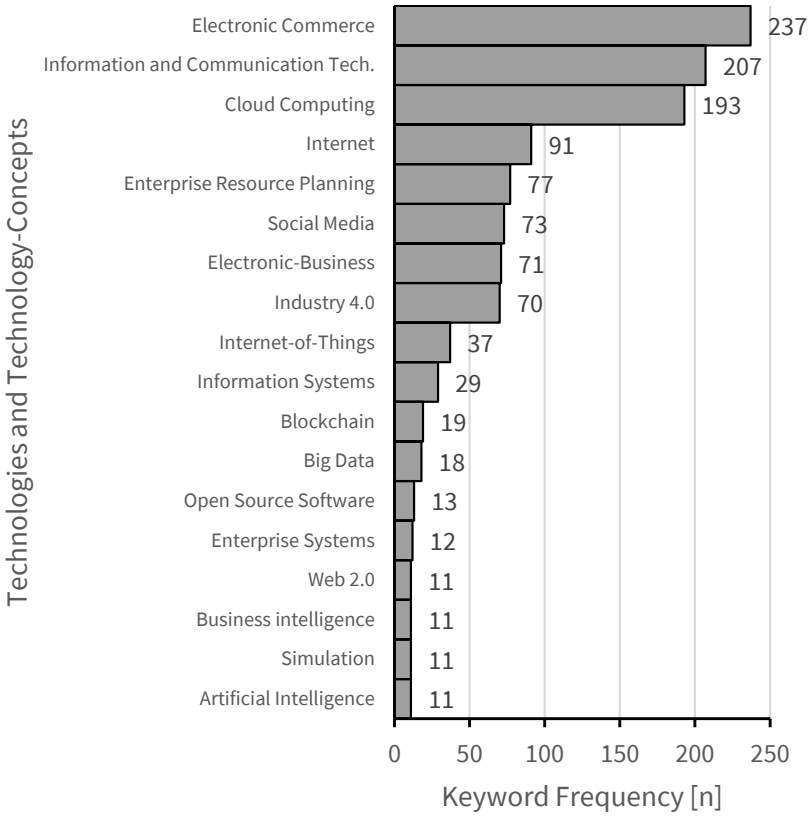

Figure 3.4: Overview of the researched Technologies in the Context of SMEs, measured according to the frequency of mentions in the author keywords in the Scopus meta database (data from February 2022 based on Scopus query search).

3.3 A theoretical Framework for Technology Adoption

Popular science and research literature is replete with articles on the benefits and challenges of implementing new innovative technologies. The potentially significant impact of IS on an organization's productivity is commonly accepted (Oliveira and Martins 2011). An organization can adopt or reject the new innovative, possibly even disruptive, information system.

Many theories have been used to identify specific factors that significantly influence SMEs' technology adoption. Table 3.1 on the next page lists established theories, which require different levels of consideration, such as the individual customer level or the company's level[3] (ibid.).

The firm level is considered in this dissertation because the aim is to explore the opportunities and roles of SMEs regarding Blockchain technology. The firm level provides insight and the possibility to describe why the technology might be adopted or rejected. The individual level is not within the scope of the SME user group.

This section applies the theoretical lens of the TOE framework instead of the DOI theory to analyze the barriers to Blockchain adoption. The framework of DePietro et al. (1990) is chosen for two reasons. First, according to Alshamaila et al. (2013) and Oliveira and Martins (2011), the two frameworks (the TOE framework and the DOI theory) are similar, but the former extends the latter to include the context of the environment and can hence better explain the intra-firm adoption of IS innovations (Hsu et al. 2006). Thus, the TOE framework is distinct from a highly technical approach and can explain the motivations for adopting innovation in a large environment (Alshamaila et al. 2013). Second, a review of the literature revealed that many studies in IS adoption at the firm level use the TOE framework. Moreover, in literature reviews, such as those by Chong et al. (2009) and Oliveira and Martins (2011), the TOE model is broadly used to analyze IS innovations. In addition, the TOE framework has been applied in various studies of different technologies: enterprise resource planning

3 Ontologically, besides the classification chosen here, there are other ways to classify the theories. For example, Alshamaila et al. (2013) classify the theories as follows: the user (micro-level), the firm (meso-level) or the market/innovation (macro-level).

Table 3.1: Overview of Information Technology Adoption Models (see also Oliveira and Martins (2011), Alshamaila et al. (2013), Ramdani and Kawalek (2007), and Ramdani et al. (2013)). Other models such as TAM and TPB (Riemenschneider et al. 2003), TAM2 (Venkatesh 2000), Stage Theory (Poon and Swatman 1999), and the Resource-based View (Stockdale and Standing 2006) are not further elaborated due to low usage in technology adoption of SMEs.

Information Technology Adoption Models	Initial Source	Level of Observation
Technology Acceptance Model (TAM)	Davis (1985)	Individual Level
Theory of planned Behaviour (TPB)	Ajzen (1985)	
Unified Theory of Acceptance and use of Technology (UTAUT)	Venkatesh et al. (2003)	
Technology–Organization–Environment Framework (TOE)	Baker (2012) and DePietro et al. (1990)	Firm Level
Diffusion of Innovations (DOI)	Rogers (2003)	

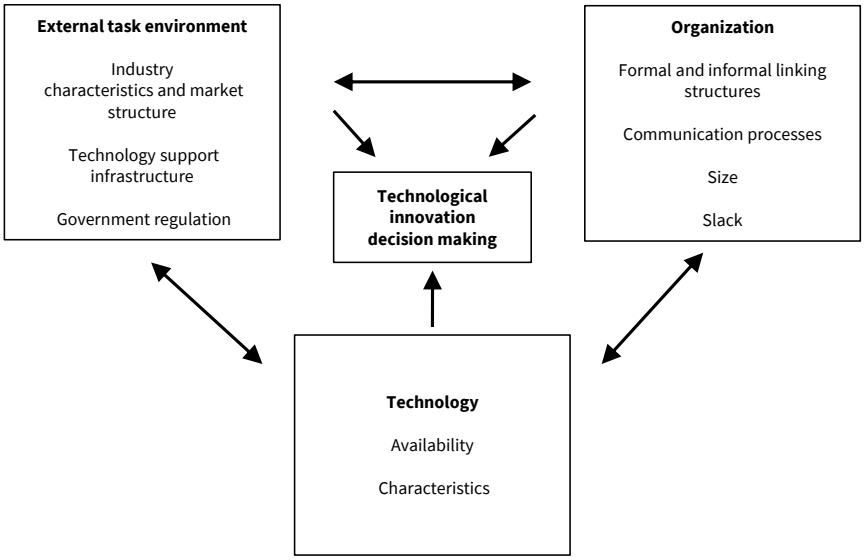

Figure 3.5: Technology, Organization, and Environment Framework (DePietro et al. 1990)

(Buonanno et al. 2005), e-Commerce (Duan et al. 2012), social commerce (Abed 2020), the internet (Mehrtens et al. 2001), and the cloud (Gupta et al. 2013). Furthermore, TOE is also used to identify barriers (Wong et al. 2020a). Section 3.4.2 on page 45 contains a comprehensive study overview for Blockchain.

The TOE framework is a firm-level theory developed by DePietro et al. (1990). This framework represents one segment of the general innovation process (Specht et al. 2002, 16 f.), namely how the firm context influences the adoption and implementation of innovations (Baker 2012). Such an influence is described in the technological, organizational, and environmental contexts. Figure 3.5 overviews the influencing factors.

The technological context generally includes the availability and characteristics relevant to the firm. Availability includes all the technologies relevant to the firm – both those already in use and those available in

the marketplace – and their characteristics (Baker 2012; Oliveira and Martins 2011). The organizational context includes descriptive measures of a firm's size, resources, organizational structure, and general characteristics (Alshamaila et al. 2013). Finally, the environmental context refers to the field in which a firm conducts its business (i.e., its industry, competitors, regulations, and service providers) (DePietro et al. 1990). These three contexts present constraints and opportunities for IS innovations, which influence the firm's level of technological innovation. In the following Sections 3.4.2.1 to 3.4.2.3 on pages 49–51, these three key constructs are defined in relation to this dissertation.

3.4 Small and Medium-sized Enterprises in Blockchain Adoption

To analyze the current state of research for SMEs' Blockchain adoption, three main research streams must be covered. They are Blockchain adoption in SMEs, general Blockchain adoption in L&SCM, and technology adoption in SMEs.

3.4.1 Blockchain Adoption by Small and Medium-sized Enterprises

Numerous scientific works address the use of Blockchain technology and its value to supply chains. There are many reported benefits of using this technology and its different features, such as traceability (Helo and Shamsuzzoha 2020), provenance (Motahhir and Bossoufi 2021), risks (Sengupta et al. 2020), visibility (Garaus and Treiblmaier 2021), transparency (Montecchi et al. 2021), and security (Mistry et al. 2020). However, the technology must be successfully implemented and used to reap these benefits. Moreover, implementation is complicated because multiple parties must collaborate, and all companies in the supply chain must be considered and involved (Kouhizadeh et al. 2021).

Academic research, as listed earlier, has focused on the conceptual level regarding how Blockchain could meet objectives in supply chain management. Only a few studies have focused on SMEs' or practitioners' perspectives, and even fewer studies have explored SMEs' Blockchain adoption in supply chain management or logistics. Table 3.2 lists the relevant works published in scientific journals and conference papers.

Table 3.2: Overview of Contributions to SMEs Blockchain Adoption

#	Author	Data Source and Analysis	Key Findings
1	Ilbiz and Durst (2019)	Conceptual framework	Framework for testing the appropriateness of Blockchain technology for SMEs.
2	Clohessy and Acton (2019)	Multiple-case study of 20 companies based in Ireland	Top management support and organizational readiness are enablers of Blockchain adoption, and large companies are more likely to adopt Blockchain than SMEs.
3	Wang et al. (2019a)	A systematic review of both academic and practitioner literature	Larger corporations can adopt the technology more easily due to their resources, but only smaller organizations have the agility needed to implement revolutionary technology.
4	Wong et al. (2020a)	Survey data (n=194)	Competitive pressure, market dynamics, and technology complexity are significant factors for SMEs.
5	Wang et al. (2020)	Design Science Research with seven interviews and diverse workshops	SMEs' business value of a Blockchain solution may be an accelerated pay system and a digital uptake of their legacy system. SMEs could be connected through an API or web frontend.

continued on the next page

(Cont.) Table 3.2: Overview of Contributions to SMEs Blockchain Adoption

#	Author	Data Source and Analysis	Key Findings
6	Hashimy et al. (2021)	Expert Interviews (n=11)	SMEs might face new obstacles when integrating distributed ledger technologies, such as integration problems, complex transition phases, high setup costs, and problems with attracting and retaining qualified employees.
7	Bracci et al. (2021)	Survey data (n=96)	Results show that Blockchain technology is quite well known, but the level of knowledge is limited. Moreover, the research reveals that the rate of adoption is relatively low.
8	Treiblmaier and Span (2022)	Survey data (n=118)	SMEs expect applications built on Blockchain technologies to positively affect numerous aspects of their business model.

In literature on Blockchain and SMEs, authors discuss the appropriateness of Blockchain and outline major challenges and significant factors. Bracci et al. (2021) show that Blockchain is well known among SMEs, but the level of knowledge is limited, and the adoption rate is relatively low. Ilbiz and Durst (2019) outlines major barriers, 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 (Wang et al. 2019a). According to Hashimy et al. (2021), during Blockchain implementation, SMEs might face new barriers, which the authors categorize as internal and external problems.

On the one hand, the authors highlight high setup costs for solvable internal problems or for attracting and retaining qualified employees. On

the other hand, they mention external problems, such as "contracts, financing, lack of trust, raw materials, lack of information, domestic and international market limitations, IP rights, and governmental regulations as well as bureaucracy" (Hashimy et al. 2021). Moreover, Wang et al. (2020) identified Blockchain-based business value for SMEs when joining a Blockchain solution. In their study, SMEs were able to lower the administrative costs of payment. With the help of Blockchain solutions, payments are processed much faster than classic payment methods and stabilize the cash flows of SMEs. The Blockchain solution also offers possibility to digitalize companies more, especially SMEs, in the supply chain. SMEs are able to upload/download data to a Blockchain solution via an app or a website, so they do not need to host their node. Furthermore, the authors identified business value for SMEs using the Blockchain solution in the form of automated paying and digital uptake (ibid.).

However, on another level, contradictory viewpoints are presented: Wang et al. (2019a) describe, on the one hand, that "small companies would be weeded out due to lack of sufficient funds, while bigger companies may have ability [sic] to develop and maintain the technology [...]." On the other hand, they argue "that small companies are more agile and could be more adaptable to the technology" (ibid.). According to Clohessy and Acton (2019), larger companies are more likely to adopt Blockchain than small companies due to their resources. In addition, they outline that top management support, organizational size, and organizational readiness are vital factors for adopting Blockchain. Furthermore, they list large and small companies' rationales for adoption and non-adoption. They indicate that both small and large companies lack Blockchain awareness and specific industry cases and standards. By contrast, large companies lack "internal staff with requisite Blockchain skills and competencies," while SMEs face challenges in "sourcing employees with requisite Blockchain skills and competencies" and even "sourcing Blockchain educational resources" (ibid.).

Only a few publications focus on SMEs' Blockchain adoption in the context of supply chain management. Most, even in this small sample, focus on specific supply chain segments, special logistic functions, or other business cases (Hackius and Petersen 2020), not on the overall effect of Blockchain on SMEs. Existing research highlights barriers and problems instead of paths to a solution. Given the small sample of SME-related Blockchain adoption

papers, the following Section 3.4.2 and Section 3.4.3 on page 53 widen the range of this topic. Therefore, specific and relevant technological, organizational, and environmental factors are presented.

3.4.2 General Blockchain Adoption in Logistics and Supply Chain Management

From a general supply chain management perspective, Blockchain adoption factors have been broadly researched. Due to the steadily growing number of supply chain management-related Blockchain publications, a significant number of adoption factors have been identified in recent years. Since Blockchain is expected to achieve mainstream adoption in multiple industries (White 2017), different researchers have approached this topic in different industries and use cases using most of the standard theoretical models, such as TOE, DOI, TAM, UTAUT, and TPB mentioned in Table 3.1 on page 39 (Wong et al. 2020a).

This research has provided robust arguments on general Blockchain adoption in L&SCM. On the one hand, researchers have focused on particular topics and summarized the existing literature; on the other hand, they have focused on the general adoption of technology. Comprehensive literature reviews have emerged from these studies on adoption considerations and barriers in specific parts of supply chain management (Wang et al. 2019b; Queiroz et al. 2019; Wamba and Queiroz 2020; Clohessy et al. 2020; Kouhizadeh et al. 2021; Saberi et al. 2019; Clohessy et al. 2019). A detailed analysis of the articles using an adoption research focus (listed in Table 3.3 on the following page, which provides an overview of the field but does not result from a systematic literature review) revealed that these articles have a large area of intersection. Most articles follow the basic definitions of Rogers (2003) and Tornatzky and Fleischer (1990), and only a few have extended the theoretical foundations, for example, Clohessy et al. (2020). The following elaborates the technological, organizational and environmental adoption considerations for Blockchain technology. Of note, the table is meant to give an overview of the field and does not result from a systematic literature review.

Table 3.3: TOE Framework and Blockchain Adoption Considerations (data based on Clohessy et al. (2019, 2020), Kouhizadeh et al. (2021), Wamba et al. (2020), and Gurtu and Johny (2019))

TOE	Consideration	Descriptions	References
Technological Context	Immaturity	Problems such as scalability, performance, privacy, and storage appear due to the immaturity of the technology.	Hackius and Petersen (2017), Pilkington (2016), Swan (2018), and Gurtu and Johny (2019)
	Perceived benefits	Due to the lack of well-documented examples, Blockchain benefits remain anecdotal.	Schuetz and Venkatesh (2020), Woodside et al. (2017), Wamba et al. (2020), and Saberi et al. (2019)
	Immutability	Within the immutability of the Blockchain, problems such as no erasable data or persistent incorrect data appear.	Biswas and Gupta (2019), Pilkington (2016), Swan (2018), and Christidis and Devetsikiotis (2016)
	Complexity	The adoption of Blockchain technology requires consideration of the complex adoption situation due to uncertain factors.	Wong et al. (2020b), Kouhizadeh et al. (2021), Woodside et al. (2017), and Seebacher and Schüritz (2017)
	Compatibility / access	Due to the lack of organizational IT infrastructure or digitalization, essential resources are missing.	Pilkington (2016), Morabito (2017), and Chabani et al. (2021)

continued on the next page

(Cont.) Table 3.3: TOE Framework and Blockchain Adoption Considerations

TOE	Consideration	Descriptions	References
	Security	There are concerns that data may be published unintentionally, and others may gain access to sensitive data.	Kokina et al. (2017), Wang et al. (2019b), Woodside et al. (2017), and Duan et al. (2020)
Organizational Context	Organizational readiness	Organizational readiness includes human, financial and infrastructural resources.	Clohessy et al. (2019), Swan (2015), and Lumineau et al. (2020)
	Top management support	Top management support describes top management's involvement in the adoption process and the degree to which the management team knows the importance of the technology.	Hsu et al. (2019), Wang et al. (2019b), Clohessy et al. (2019), and Swan (2015)
	Organizational policies	Companies must define new policies on how to use Blockchain properly.	Biswas and Gupta (2019), Morkunas et al. (2019), Hughes et al. (2019), and Wang et al. (2019a)
	Lack of company standards	Lack of Blockchain standards, applications, tools and metrics inside companies.	Andoni et al. (2019), Mangla et al. (2018), and Morkunas et al. (2019)

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(Cont.) Table 3.3: TOE Framework and Blockchain Adoption Considerations

TOE	Consideration	Descriptions	References
Environmental Context	Market dynamics	Market dynamics are global market forces that impact the organization, including competitive pressure and market standards.	Dubey et al. (2020), van Hoek and Loseby (2021), and Clohessy and Clohessy (2020)
	Problems in collaboration	Lack of collaboration and communication between the different supply chain partners.	Kamble et al. (2019), Wang et al. (2019b), and Behnke and Janssen (2020)
	Regulatory uncertainty	Regulatory uncertainties in the financial system and supply chain regularization can promote or hinder adoption.	Kher et al. (2021) and Clohessy et al. (2020)
	Privacy	Different privacy needs between supply chain partners can hinder adoption due to different policies and data used.	Wang et al. (2019a), Pournader et al. (2020), and Hackius et al. (2019)
	Cultural differences	Different geographic locations and organizational structures can hinder Blockchain adoption.	Wang et al. (2019b), Patel et al. (2017), and Caro et al. (2018)
	Lack of governmental policies	Governments may be hesitant to support the adoption of Blockchain technology.	Biswas and Gupta (2019), Hughes et al. (2019), Kamble et al. (2019), and Morkunas et al. (2019)

3.4.2.1 Technological Considerations

Table 3.3 on page 46 indicates that immaturity, perceived benefits, immutability, complexity, compatibility/access, and security are relevant to Blockchain technology adoption. The relevance of each factor differs depending on the author. For Clohessy et al. (2020), the most relevant technological considerations for Blockchain adoption are complexity, perceived benefits, and security, while Kouhizadeh et al. (2021) consider other factors such as immaturity and security to be most relevant. This category includes considerations stemming from the Blockchain technology itself.

Blockchain technology is immature (Hackius et al. 2019; Gurtu and Johny 2019), which leads to challenges with scalability, interoperability and usability (Kouhizadeh et al. 2021). Aside from these challenges, the technology also suffers from the connection to legacy systems and incomplete software libraries, which are needed to build a comprehensive working system (Sternberg et al. 2020). Due to the early development stage, a lack of well-documented cases, and the immaturity of the technology, the perceived benefits are primarily anecdotal (Clohessy et al. 2020).

Likewise, one of the key characteristics of Blockchain technology, namely immutability, must be considered. Immutability refers to the basic cryptographic structure of the technology. Using the Blockchain retroactively to change a transaction is only possible with extensive effort. This security mechanism ensures the reliability and authenticity of the information inside the Blockchain – if the correct information is input into the system. Incorrect data points or errors are permanent and cannot be changed (Christidis and Devetsikiotis 2016). In addition to the immutability of the Blockchain, the decentralized structure is another reason the technology is considered to have a high level of security (Woodside et al. 2017). However, concerns about hacking, inaccurate information dispersal, and access to sensitive information also arise (Biswas and Gupta 2019; Casino et al. 2019). These concerns may stem from the public's questioning of Blockchain vulnerability, as major hacking attacks have succeeded in the cryptocurrency area (Lacity and van Hoek 2021b).

Compatibility/access to the technology must also be considered. A key concern is that the Blockchain infrastructure is accessible to all partici-

pants and that all participants can see the whole ledger (Morabito 2017). Hence, for a company to implement Blockchain, it must consider multiple points in the technological context. This complexity and the interaction of the previously mentioned points require further empirical investigation (Clohessy et al. 2020).

3.4.2.2 Organizational Considerations

According to Baker (2012), the organizational context refers in general "to the characteristics and resources of the firm, including linking structures between employees, intra-firm communication processes, firm size, and the number of slack resources." This general definition is also relevant for Blockchain technology adoption, as shown in Table 3.3 on page 46. In summary, a sound body of empirical research supports the impact of organizational factors on Blockchain technology adoption, but to different degrees. For example, Clohessy et al. (2020) suggest that top management support and organizational readiness are most relevant, while Kouhizadeh et al. (2021) rate all single organizational readiness factors as most relevant.

Organizational readiness is a collective term (Wang et al. 2010) for factors such as human resources (Beck et al. 2018), financial resources (Wang et al. 2019b), and infrastructural resources (Swan 2015). Depending on the study, these terms could be more differentiated. For example, in human resources, topics such as the knowledge and expertise of employees, organizational culture, and sourcing of employees are summarized. Financial resources include companies' budgets for investing in new technologies. Finally, infrastructural resources describe the existing IT systems and platforms into which the new technology is to be integrated. Organizational readiness is closely linked to top management support of a company because the top management can support the allocation of the right resources for technology adoption (Hsu et al. 2019). Especially from a Blockchain perspective, top management support is key for multiple reasons: (1) the reimagining of transactional and informational processes, (2) a high degree of technological complexity, (3) standardization of network resources, and (4) allocation of financial resources to upskill employees (Iansiti and Lakhani 2017; Clohessy et al. 2020; Swan 2015).

In addition to organizational readiness and top management support, organizations must consider new policies working with Blockchain. Due to the unclear knowledge of the proper use of Blockchain, companies must define where and when the technology is applicable (Lacity and van Hoek 2021b; Clohessy et al. 2020). Moreover, companies lack data and infrastructural standards, methods, tools, and techniques for implementing Blockchain technology (Morkunas et al. 2019).

3.4.2.3 Environmental Considerations

The environmental context includes industry, competitors, regulation, and linkages between firms and service providers (DePietro et al. 1990). In a Blockchain environment, two categories of environmental factors must be considered: uncertain supply chain factors, such as the communication between partners, and general external factors, such as regulations in the country or market in question (Kouhizadeh et al. 2021).

According to Clohessy et al. (2020), market dynamics and the regulatory environment are the top two considerations. Market dynamics include competitive pressure and the use of market standards, both of which can positively or negatively impact technology adoption. Industrial movements using Blockchain, such as Maersk, Walmart, Daimler, and Pfizer, display this market dynamic well (ibid.). Companies must now deal with the adoption of Blockchain by large corporations and react to this new situation, mainly on how they use Blockchain technology. Moreover, the COVID-19 pandemic is a prime example of the market dynamics. The pandemic revealed how Blockchain technology can be used to ensure supply chain resilience. With the technology, secure communication between partners (one tier at a time) can be extended, thus making information available in real time for the entire supply chain (van Hoek 2020).

However, to implement information sharing on a real-time basis, other supply chain factors influence Blockchain adoption (Behnke and Janssen 2020; Kamble et al. 2019), namely the extent to which partners are willing to cooperate and the goal the individual entities are pursuing (Wang et al. 2019b). Partners' different cultures and companies' geographic positions in the supply chain influence Blockchain adoption (Patel et al. 2017; Caro et al. 2018) and how data may be exchanged. Since Blockchain is a

transparency-creating technology, the hurdle of data confidentiality and privacy in inter-organizational systems arises (Hackius et al. 2019; Wang et al. 2019b). Organizations are skeptical about sharing data because it could create a competitive advantage for other companies.

Aside from the specific supply chain factors, external factors such as country or market-specific regulations must be considered. Government regulations can positively or negatively impact companies' technology adoption (Baker 2012; Clohessy et al. 2020). Given the novelty of the technology, government regulations are not entirely in support of Blockchain, which hampers companies' adoption thereof (Kouhizadeh et al. 2021; Li et al. 2018). Companies must consider that the legal environment could develop differently within the regulation. For example, Blockchain technology affords companies the opportunity to use cryptocurrencies outside the highly regulated financial system. The legal basis for which these new paths fit into existing financial laws and whether companies are allowed to pursue these paths are uncertain. In addition to the financial and legal framework, a certain degree of uncertainty exists in all other areas, such as supply chain regulations, sustainability, and documentation requirements.

To better understand Blockchain adoption in supply chain management, these technological, organizational, and environmental factors must be considered. Some of the mentioned factors overlap with those relevant to SMEs presented in Section 3.4 on page 41, although these cannot be fully generalized to SMEs. In the following section, the general state of technology adoption by SMEs is listed, and the issue of generalizability is elaborated.

3.4.3 Technology Adoption among Small and Medium-sized Enterprises

In this section, technology adoption by SMEs is introduced. For this purpose, the differences between large and small companies are explained first. Thereafter, the companies' behavior concerning collaborative R&D in projects is described. Finally, the actual state of research on SMEs' technology adoption is presented.

3.4.3.1 Differences between Small and Large Enterprises

Management theory acknowledges the differences between SMEs and large companies (Curran 2006). Torrès and Julien (2005) ask, "Can the lessons and precepts of big business be applied to small business, or is there in fact a species barrier between small and big business, meaning that new theories, new models and new analysis grids must be invented specifically for small business?" (ibid., p. 356)

This question must be considered for Blockchain adoption in L&SCM. As elaborated before, most Blockchain research focuses on the whole supply chain or cases of large companies. Because the research focusing on SMEs' Blockchain adoption is scarce, this question is discussed in general and in other SME technology adoption fields.

In research, one predominant mindset, among several others, has taken root: that specific facts and propositions delineate the specificity of SMEs. The majority of the scientific community accepts this mindset and applies it accordingly. Within this mindset, a long list of features supports the specificity of SMEs: the small size of the companies, the centralized management of SMEs, intuitive and short-term strategies, the low level of internal specialization, informal and straightforward internal and external information systems, and sales inside a local market (ibid.). Table 3.4 on the following page outlines example factors with the relevant descriptions.

Several studies suggest that the specific characteristics of SMEs and large companies differ. These studies have identified diverse problems that managers face (DeLone 1981). For example, SMEs must deal with a shortage of resources in different ways. On the one hand, they must work internally

Table 3.4: Example Criteria that differentiate SMEs from Large Companies (according to Torrès and Julien (2005))

Feature	Description	References
Small company size	The number of employees is relatively low, and the organizational structure is simple.	Torrès and Julien (2005), Thong (1999), and DeLone (1981)
Centralized management	The owner-manager plays a prime role in decision-making.	Thong (1999) and Thong et al. (1996)
Intuitive and short-term strategy	Decisions are often made intuitively and reactively with too little risk for a short time horizon.	Thong (1999) and Cohn and Lindberg (1972)
Low level of internal specialization	Employees tend to be generalists rather than specialists.	Thong (1999) and Yap et al. (1992)
Informal and straightforward internal and external information systems	Due to resource restrictions, SMEs tend to adopt the lowest-cost information systems.	Thong (1999) and DeLone (1981)
Local or regional economy	SMEs mainly operate in a local market rather than in the global market.	Julien (1996)

with limited management personnel, technological resources, recruitment advantages, and financial limitations (Lopez-Nicolas and Soto-Acosta 2010; Thong 1999; Yap et al. 1992). On the other hand, they must contend with limited external pieces of information (DeLone 1981).

Due to these resource restrictions, SMEs tend to adopt the lowest-cost information systems, which may be inadequate for their purposes (Thong 1999). In addition, decisions about which system to procure are made by a single person. Thus, these companies are organized in a highly centralized manner (Thong et al. 1996) with flat and flexible structures (Lopez-Nicolas and Soto-Acosta 2010). Therefore, the decisions made by a single person are considered highly critical (Thong et al. 1996). In addition to more resource availability, the information systems of large companies are much more extensive than those of SMEs, and there are many specialized sub-information systems, which means that decisions are also made decentrally. Therefore, these systems tend to be more complex and differentiated than those of SMEs. This greater differentiation can limit the overview of a company's distributed knowledge (Becker 2001).

Another characteristic of SMEs is that they tend to have a narrower range of knowledge than large companies do. Therefore, it is more difficult for them to achieve specialization in their units and staff (Fourné et al. 2019). Generally speaking, SMEs characteristically hire generalists rather than specialists. Even if SMEs wanted to hire specialists, they would have the problem of hiring qualified personnel – since career paths and promotion opportunities in SMEs are limited (Gable 1991). This human resource restriction leads to the problem of personnel having limited technical knowledge and an inability to recognize the potential benefits of new technologies (DeLone 1988).

For large enterprises, however, the advantages of resource availability and system complexity can also be a disadvantage in terms of flexibility and resource allocation to different units. By contrast, small companies have fewer resources and less powerful information systems, but they may be able to allocate resources flexibly, rapidly, and more effectively (Fourné et al. 2019). Moreover, the decision paths in SMEs are much shorter than in large companies due to the flat and flexible structures (Levy and Powell 1998; Gupta and Cawthon 1996).

In addition to the aforementioned characteristics, SMEs are highly susceptible to short-term decisions due to their highly competitive rivals. SMEs operate mainly in local, regional markets, where they are in the same environment as other SMEs or large companies. They are highly susceptible to seasonal changes in sales, as they deplete the capital generated in an off-season instead of spending it on growth (Welsh and White 1981; Levy and Powell 1998). By contrast, large companies plan their strategies thoroughly and operate in global markets.

Due to the characteristics of SMEs, the need arises to examine whether models developed in large businesses can be equally applied to SMEs. Most large companies suffer from the same constraints, but the effect on SMEs is more significant (Thong 1999). For example, human resource or financial constraints are less significant issues in large businesses than they are in SMEs. Therefore, organizational theories and practices developed for large companies have limited applicability to SMEs (Dandridge 1979; Blau et al. 1966).

3.4.3.2 SMEs' Collaboration toward Innovation

The innovative capability of SMEs is a crucial driver for sustainable competitive advantages in today's rapidly changing markets (Nieto and Santamaría 2010). To survive, grow, and generate profit in the market, companies must continuously develop new products and processes (Wolff and Pett 2006). Because the steady in-house development of new products and processes is a resource-intensive procedure (which is less of a problem for large companies), SMEs can profit from alternative innovation processes. SMEs can use cooperative Research and Development (R&D) to overcome the resource gap between large and small companies and minimize the use of internal resources (Nieto and Santamaría 2010; Hewitt-Dundas 2006; Rogers 2004; Bougrain and Haudeville 2002).

Using collaborative R&D, SMEs can access information exchange, resource acquisition, technology transfer, and risk management with minimal resource input. However, these collaborations are, generally speaking, heterogenous, and their impact is not always positive (Nieto and Santamaría 2010). Recent decades have seen a sharp rise in the use of external firm networks among all firm sizes (Hagedoorn 2002). Multiple studies suggest that using these networks can yield unique benefits and challenges for SMEs (Powell et al. 1996).

According to Hewitt-Dundas (2006), the barriers for small and large businesses in collaborative R&D are different: "For small plants the most important barrier to undertaking product innovation is a lack of external partners. In contrast, for larger plants it is the high risk of development or a lack of internal expertise which present the greatest barrier to product innovation." This barrier difference demonstrates that the lack of external partners for small companies is more crucial than for large ones. Rogers (2004) also notes the importance of external partners for SMEs: "SMEs may rely more heavily on external knowledge networks as an input to innovation than do large firms." Using these networks, SMEs reinforce their competitiveness by enabling access to new knowledge, sources of technical assistance, expertise, sophisticated technology, and market requirements (Rogers 2004; Nieto and Santamaría 2010).

Accordingly, SMEs could benefit more from innovative cooperation than large companies could. One explanation could be that they can use external

networks more effectively than large companies (Nooteboom 1994; Nieto and Santamaría 2010). SMEs must use these networks skillfully to overcome resource scarcity. Considering this, the use of collaborative R&D networks is one of the most critical decisions in the innovation of SMEs (Dickson et al. 2006).

Cooperation among SMEs or between SMEs and large companies to generate new innovations is usually accompanied by competition. This simultaneous cooperation and competition is summarized as "co-opetition," which became popular in the last decades (Gnyawali and Park 2009; Luo 2007; Ketchen et al. 2004; Bengtsson and Kock 2000; Alvarez and Barney 2001; Gnyawali et al. 2006; Morris et al. 2007). Co-opetition can be either collaboration-focused, competition-focused, or balanced between the two (Bengtsson and Kock 2000). Contrarily to a regular business relationship, co-opetition involves a higher degree of competition because companies work together to develop a future product (Park et al. 2014; Bouncken et al. 2020). A co-opetition strategy can even be viewed as a form of organizational innovation to improve the organizational structure and its relationships (Hipp et al. 2000; Granata et al. 2016).

When using co-opetition to generate innovation, companies face a dilemma (Bouncken and Kraus 2013). For example, if companies take a co-opetition strategy, they risk losing relevant, private information to other companies (competitors) while gaining information from others (Gnyawali and Park 2009), or they face conflicts when it comes to value capture from the resources invested (Bouncken et al. 2020). Moreover, SMEs can be in co-opetition with a company in a cluster to set up an innovation together, but they can compete with the same company in another area on another level (Perks and Easton 2000).

With the help of these co-opetitions, SMEs have the opportunity to use technologies they otherwise would not have been able to develop on their own (Gnyawali and Park 2009). However, co-opetition has both positive and negative consequences: benefits and costs. Table 3.5 on the next page overviews these consequences.

Granata et al. (2016) show that innovation development in co-opetitions does not necessarily need to be temporary but can instead become a permanently evolving process. Coexistence of competition and cooperation is possible to survive in the market. The authors suggest that long co-opetition

Table 3.5: Consequences of Co-opetition for SMEs (data adapted from Gnyawali and Park (2009, pp. 322–324))

	Consequences	References
Benefits	Technology development is enabled for SMEs, which would not be possible with their resources.	Morris et al. (2007)
	Pooling resources with other enterprises and pursuing common innovation projects could enable economies of scale in R&D and innovation.	Gnyawali and Park (2009)
	Uncertainty, risk, and costs of new developments are reduced along with SMEs' needed time for R&D.	Gnyawali et al. (2006) and Bengtsson and Kock (2000)
	SMEs' are afforded a strong voice in the industry and institute-relevant norms.	Jorde and Teece (1990)
	SMEs gain efficiency in their innovation efforts.	Bengtsson and Kock (2000)
Costs	Company secrets and proprietary knowledge could be lost to competitors.	Gnyawali and Park (2009)
	In partnering with large firms, SMEs could be treated unequally by partners. Loss of control of the partnership is also possible.	Alvarez and Barney (2001) and Rothaermel and Deeds (2004)
	Managing co-opetition is a complex task requiring managers to define competition differently.	Gnyawali and Park (2009) and Gnyawali et al. (2006)
	The incentive to invest in co-opetition will change over time. SMEs may be less able than large corporations to disentangle themselves from these changes and make the necessary adjustments to the collaborative-based relationship.	Barnir and Smith (2002) and Morris et al. (2007)

relationships must be researched to determine whether competition and/or cooperation leads to success over time (Granata et al. 2016). According to Tomlinson and Fai (2013), long and valuable relationship require these innovation networks to be nurtured and the dyad between the partner firms to be improve. Tomlinson and Fai (ibid.) also note that state funding and a larger role of trade associations might be required to facilitate network development. Conversely, SMEs can invest too heavily – in terms of resources and time – in specific dyads or networks (Granovetter 1973).

Studies by Cimon (2004) and Bouncken and Kraus (2013) indicate that SMEs should avoid knowledge, information, or learning asymmetries between business partners when targeting highly novel innovations. They explain contrary research by neglecting the difference between radical and revolutionary innovations. According to Bouncken and Kraus (2013), these innovations go along with long-term investments for SMEs, which are highly sensitive due to their risks. Moreover, power asymmetries are highly relevant for SMEs because such companies might be not in a powerful position to influence decisions in their favor.

3.5 Derivation of the Research Objective and Differentiation of the Research Questions for the Present Work

The previous literature analysis revealed the low number of publications on Blockchain adoption by SMEs. Based on the overview of relevant publications concerning SMEs and Blockchain, predominantly empirical research studies have been conducted. These studies identify and describe SMEs' barriers and hurdles to Blockchain adoption. However, they do not include a discussion of possible solutions. Hashimy et al. (2021) reached a similar conclusion in their interview study, although they invited other researchers to shape this area further.

The much broader research on Blockchain adoption in the field of supply chain management primarily targets entire supply chains or large enterprises as a research objective. However, the individual discussion of SMEs or the role of individual companies is absent. This research is necessary

to address how Blockchain can benefit an entire supply chain and, by extension, the participating companies. This research gap necessitates the establishment of a suitable value-creating use case for the technology. However, since the role of smaller companies must also be considered, the role of individual smaller players in a supply chain in the use of Blockchain technology is of particular interest.

From the previously described research needs, the research objective of this dissertation is as follows:

Research Goal:	Gaining a better understanding of small and medium-sized enterprises' roles and approaches in adopting Blockchain.

Based on this research objective, three research questions are derived for this dissertation. According to the idea of the implementation status of Blockchain by SMEs, the first question concerns how companies see the role of SMEs in Blockchain projects. Since Blockchain is a cross-company technology, smaller companies also participate in Blockchain projects. This leads to the first research question:

Research Question 1:	How do companies perceive the role of SMEs in Blockchain projects?

Blockchain project implementations concede a role for SMEs in Blockchain projects. The second research question aims to analyze the different approaches to adopting Blockchain technology. The scope of this research question is not limited to the approach of a single company but incorporates internal and external stakeholders:

Research Question 2:	What approaches do SMEs take toward the adoption of Blockchain technology?

Building on the findings from the second question, the third research question covers SMEs' considerations when deciding on an approach. SMEs should consider the advantages and disadvantages of each approach because not every approach will be appropriate for every SME. Knowledge

about the consequences of a decision favoring an SME is lacking. The third research question thus addresses the apprehension in selecting an approach:

Research Question 3: What should SMEs consider when choosing a particular approach?

Different methods are required to answer the three above-mentioned research questions. These methods are presented individually in the following chapters. First, research question 1 is answered in Chapter 4 on the facing page, followed by research questions 2 and 3 in Chapter 5 on page 81.

Chapter 4

Surveying the Role of SMEs in Blockchain Projects

"By tracking hundreds of fresh food items, including leafy greens, meat, and seafood on the Blockchain, Walmart has made it easier to identify the origin of potentially contaminated products – a benefit to not only the retailer but also the FDA" – these words by Archana Sristy, the Senior Director Software Engineering at Walmart, exemplify the supply chain management community becoming aware of Blockchain technology. Aside from the well-known and often discussed Blockchain case of Walmart, many other supply chain management cases exist – even on the Forbes 50 list – that lead in employing distributed ledger technology and have revenue or a valuation of at least $1 billion, namely Nornickel, Maersk, and Novartis (Del Castillo et al. 2021). In all supply chain management Blockchain projects, the Blockchain solution includes SMEs, but they participate in different ways. However, SMEs' technical competence must also be considered, as Lacity and van Hoek (2021b) did in their Harvard Business Review article. Regarding SMEs' competencies, the authors cite Kiran Garimella – chief scientist and chief technology officer at KoreConX – who said, "We could not imagine our small business owners posting transactions on public networks or learning to manage their own digital wallets." KoreConX solves this problem "by providing SMEs with a global platform to manage fundraising and compliance reporting" (ibid.).

After the Blockchain hype in supply chain management in 2017, numerous reports regarding large companies' intentions to use Blockchain (Del Castillo et al. 2021; Dobrovnik et al. 2018; Corkery and Popper 2018; Popper

and Lohr 2017) and descriptions of possible use cases (Wust and Gervais 2018; Yang 2019; Al-Jaroodi and Mohamed 2019; Casino et al. 2019; Gurtu and Johny 2019) emerged. These studies present, as elaborated in Chapter 3 on page 31, use cases and the intentions of large companies to adopt Blockchain technology. Blockchain technology is used primarily by large companies and start-ups; by contrast, SMEs do not use this technology, although they must be integrated into the Blockchain solution. Therefore, companies with Blockchain experience must be asked about their perceptions of the involvement of SMEs in their Blockchain projects, which research question 1 does:

Research Question 1: How do companies perceive the role of SMEs in Blockchain projects?

This chapter investigates the role of SMEs in Blockchain projects. A web-based survey highlights the experiences of companies that have worked with SMEs in Blockchain projects and outlines differences between participant groups. The chapter concludes with implications for research and management, limitations, and further research opportunities.

4.1 Method

Industry experts' evaluation of the role of SMEs in Blockchain projects was investigated using a web-based survey. Sections 4.1.1 to 4.1.4 on pages 64–68 describe the suitability of the method, the design of the questionnaire, the setup and data collection, and the methodological approach for data analysis, respectively.

4.1.1 Suitability of the Research Method

Because the literature on Blockchain adoption by SMEs is surprisingly scarce, as elaborated in Section 3.4 on page 41, fieldwork is necessary to generate new data. The collection of new data requires practical procedures for accessing the subjects of the research (e.g., small business owners,

large companies working with SMEs, SME employees, suppliers, customers, and support providers) and the methods employed (e.g., surveys, interviews, secondary data, and case studies). Defining the characteristics of a research project aid in narrowing down the possible methodology choices. For instance, a project on small business owners' economic confidence level aimed at changes over time would be survey-based, whereas a qualitative method, such as an interview or case study, would be appropriate for projects on how small business owners would adopt a technology. Studies aiming at specific adoption factors would also be survey-based and identify the relevance of specific factors (Curran and Blackburn 2001, pp. 58–72; Mullen et al. 2009; Anderson et al. 2019). When it comes to analyzing the adoption of new technologies, it is difficult to access small businesses because (1) there are no up-to-date lists of SMEs from logistics, manufacturing, or retail engaging in specific technologies; (2) SMEs' time is limited through their daily business; and (3) business owners are often skeptical about the relevance of research (Curran and Blackburn 2001, p. 60).

Due to the scarcity of literature on SMEs' Blockchain adoption and missing explorative data, the chosen method is survey-based. The method addresses the research question in an exploratory way because only a few SMEs work with Blockchain technology. To obtain a broad overview of practitioners' perceived role of SMEs in Blockchain projects, a survey is suitable to generate preliminary results (Anderson et al. 2019). An exploratory survey on the experiences of SMEs in Blockchain-based projects is an ideal starting point for guiding research activity to subsequently build theory. The same procedure was chosen by other researchers, such as Lubatkin et al. (2006), Pal et al. (2014), and van de Vrande et al. (2009).

Various types of investigations can be conducted concerning "how" to measure: On the one hand, cross-sectional analysis aims to observe a phenomenon; on the other hand, experiments can be conducted in which the researcher directly manipulates independent variables. Since the present analysis aims to observe SMEs' behavior in Blockchain projects, the observation approach was chosen instead of intervention. With the help of a web-based survey, a dataset can be collected at a low cost and sent to potential addressees in a standardized manner (Fowler 2014; Döring and Bortz 2016). An anonymous web-based survey is advised to identify inconsiderate responses through examination (Meade and Craig 2012).

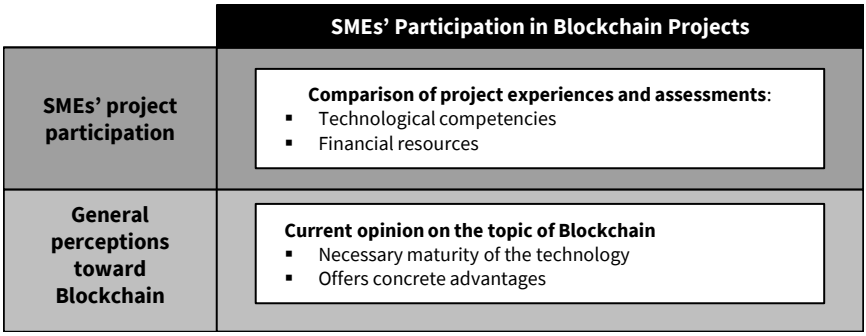

Figure 4.1: Structure and Content of the Questionnaire

To ensure methodological rigor, the application of the methodology (Hair et al. 2009; Field 2009) is detailed below, and the results generated are presented in relation to the literature from Chapter 3 on page 31.

4.1.2 Design of the Questionnaire

The development of the questionnaire was driven by the limited research on SMEs' Blockchain adoption and the scarcity of public Blockchain projects. Figure 4.1 overviews the content of the internet survey. One of the main parts of the survey was the benchmark of companies that had worked with SMEs in Blockchain projects and companies that had worked in Blockchain projects without SME participation.

With the help of the software Typeform, the survey was implemented and divided into three major sections with 34 questions. Part 1 inquired about the demography of the participants. The main features were the branch the company was working in, the number of employees, and the annual sales. Part 2 differentiated the respondents into two groups: whether or not they had any experience with SMEs from logistics, manufacturing, and retail in Blockchain projects. The participants answered questions concerning how the logistics, manufacturing, and retail SMEs could have contributed to the individual project in the respective branches. The participants also answered questions about technical knowledge, financial resources, user

knowledge, and motivation to participate in the project. If they participated in a Blockchain project with SMEs from logistics, manufacturing, or retail, they had to answer a few more specific questions. Since the research object of this dissertation is SMEs' Blockchain adoption, the survey focused on participants with Blockchain knowledge. The more specific questions focused on the configuration of the Blockchain projects: (1) the status of the project, (2) the organizational form of the project, (3) project financing, and (4) the motivation for project participation. In Part 3, the participants answered questions about their general opinion on the overall maturity of Blockchain, its real-world application, and how they would adopt a system.

This study uses established and new scales, all operationalized using a 7-point Likert scale. A 7-point Likert scale was chosen because it could generate higher validity and reliability than a scale with fewer or more points (Krosnick and Fabrigar 1997, p. 148). Most questions in the two primary parts, shown in Figure 3.4 on page 37, were designed with a 7-point Likert scale. The literature drove the questions with the selection possibilities; for example, the use cases from question 5 are in line with the work of Casino et al. (2019). The complete questionnaire is presented in Appendix A on page 225, along with the scales for the quantitative studies.

4.1.3 Data Collection and Sample

The research question explores the experience of companies that have worked with SMEs in Blockchain projects. Therefore, companies that have participated in Blockchain projects had to be approached. Since neither a common database of Blockchain-based projects nor a list of companies approaching a specific novel technology exists, participants were recruited manually. Moreover, questioning only SMEs with Blockchain project experience is difficult because not enough public Blockchain projects consist solely of SMEs. Therefore, all companies (SMEs and large companies) with Blockchain project experience were targeted, but they were only asked about their experience with SMEs.

The data collection took place between May and July 2021. Participants were mainly recruited via social media, for instance through posts about

logistics and in Blockchain interest groups on LinkedIn or Xing. In addition, Blockchain research projects from the Blockchain sector, such as SiLKe (Thume et al. 2021), were contacted to determine the participating companies' interest in the survey.

Within the aforementioned time window, 299 companies were contacted. In total, 129 re-spondents opened the survey, and 80 completed it. This number of full answers led to a response rate of 26.75% and a completion rate of 62% (67 companies answered on a desktop and 13 via mobile devices). The companies were separated into two categories, as elaborated in Section 4.1.2 on page 66: small and medium-sized companies (n = 57) and large companies (n = 23). Furthermore, the entire sample was further subdivided as follows for another test regarding sector affiliation: companies with less than 99 employees (n = 43), those with less than 1,000 employees (n = 19), and those with more than 1,000 employees (n = 18).

4.1.4 Analysis

The statistical analysis was prepared using IBM SPSS Statistics, following the guidelines of Field (2009) and Hair et al. (2009). The response dataset was first exported from Typeform, then aggregated, and subsequently imported via the SPSS Syntax Editor for further processing. Before statistical testing, the processed dataset was verified due to missing data and cleaned (Schendera 2007, p. 3). With the help of the metadata in Typeform and the Syntax-Log of SPSS, the completeness of the data could be verified (ibid., pp. 24–27). Because the survey only includes mandatory questions, no missing values or doubled data was identified – all of the 80 answers were usable.

For statistical tests to be performed, their prerequisites must be checked. The initial tests assume a normal distribution of the data and homogeneity of the variances (Field 2009, p. 133). A Kolmogorov-Smirnov test, a Shapiro-Wilk test, and a Levene test were conducted analytically to check the prerequisites (ibid., p. 147). Moreover, a visual inspection of the data and an analysis of the slope and kurtosis were carried out according to Schumacker and Lomax (2010). No correlations between groups could be determined, because the null hypothesis was rejected. Moreover, the available non-parametric test indicated no significant group differences.

4.2 Summary and Discussion of the Findings of the Quantitative Analysis

4.2.1 Summary of the Findings of the Quantitative Analysis

The study results are presented in this section. First, the demography is further explained, followed by the companies that participated in Blockchain projects with SMEs. Therefore, the used frameworks, use cases, and their motivations are outlined. Thereafter, assessments of actual projects with SMEs are juxtaposed with those of companies with Blockchain experience. Finally, the general theses evaluated by the participants on the subject of Blockchain are presented. Mostly the mean values of the participants' assessments are presented. The differences between the mentioned groups are also outlined. The results of the study are juxtaposed with relevant literature.

Figure 4.2 on the next page overviews the characteristics of the 80 participants. The majority worked for SMEs with a headcount of under 250 employees, followed by medium-sized companies and large corporations. Most companies operate in logistics, closely followed by IT services. The survey uniformly covers the areas of production, consulting, and research, among others. The distribution is a result of the high number of participants from small logistics companies. Half of the complete sample had an annual turnover of less than $10 million; the other half had an annual turnover of more than $10 million, and only 20% of the sample had a turnover of more than $250 million. Although the companies were all familiar with Blockchain technology, only 30 out of 80 had experience with SMEs from logistics, retail, or manufacturing in Blockchain projects.

As elaborated in Section 4.1.3 on page 67, Blockchain projects with SME participation (n = 30) were closely evaluated. Figure 4.3 on the next page illustrates the respective frameworks of the Blockchain projects with SME participation. In the context of collaboration within the respective projects, it became clear that most projects operated under the cover of a consortium agreement (n = 19). Only a few companies worked "loosely together without a legal framework" (n = 7) or were commissioned by an "assigning company" (n = 5). The companies, moreover, financed themselves

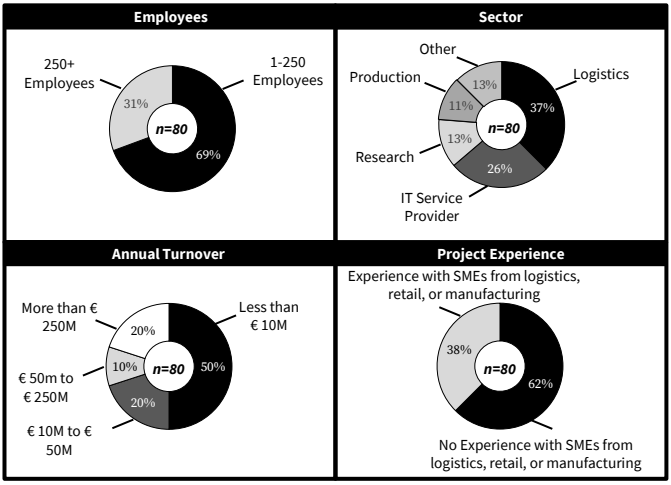

Figure 4.2: Quantitative Sample Description

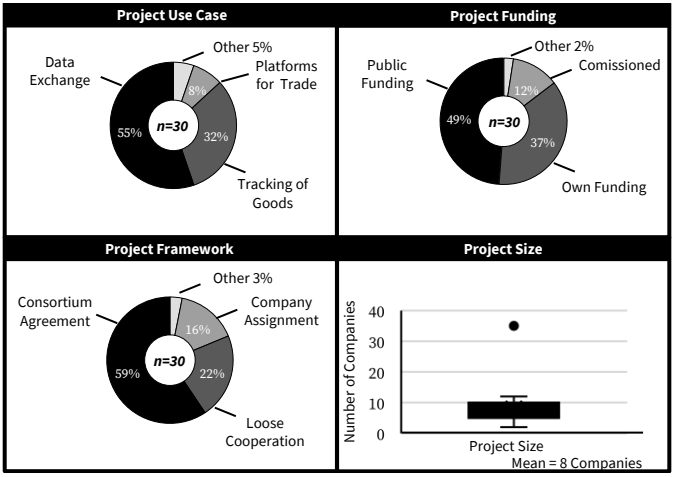

Figure 4.3: Overview of Blockchain Projects with SMEs (each question was designed as a multiple choice question)

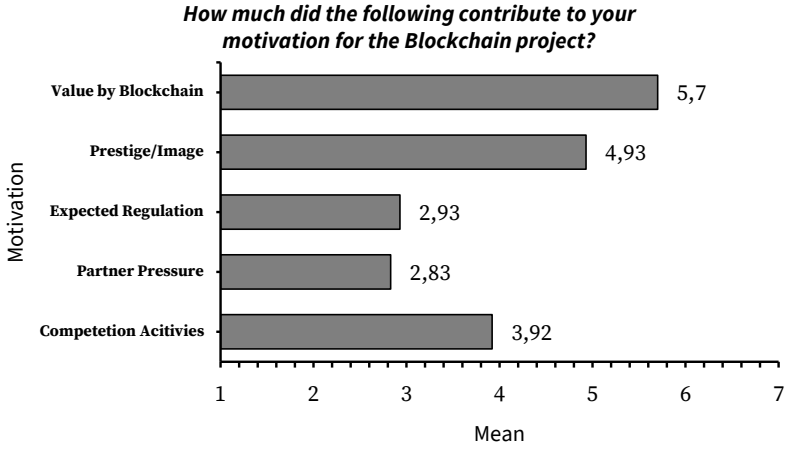

Figure 4.4: Motivation for Project Participation (measured on a scale from 1 = very little to 7 = very much)

through "public funding" (n = 20) and "own funds" (n = 15). However, it should be noted that multiple answers were possible for the framework of cooperation and the financing options. For the most part, projects were advised to use cases such as "data exchange between companies" (n = 21) and "traceability of goods" (n = 12). Only 8% of the sample focused on "platforms of trade" (n = 3).

In addition to the framework data mentioned, such as funding, legal framework, and use case, the motivation for joining the project was also questioned. Figure 4.4 shows clear increased mean values at within the motivations. "Prestige/external image" in particular as well as "value by Blockchain" were more likely to motivate the companies to participate in a project than "expected regulation," "pressure from partners," or "competitive activities."

Companies in the survey were asked about the extent to which SMEs (from logistics, manufacturing, and retail) had contributed or could contribute their process expertise to the projects. The technical competencies regarding Blockchain technology were surveyed to determine how SMEs

could contribute Blockchain expertise. In addition, the competencies for the work process to be mapped were addressed to determine the extent to which companies could contribute their experience for the respective processes. The possible and actual contribution of financial resources, exclusive user participation, and business model collaboration were also surveyed. Figure 4.5 on the next page summarizes the results. In each of the explored competencies, SMEs' actual participation was rated lower than their potential contribution: 30 responses fall on the side of actual participation in Blockchain projects with SME participation, compared with 50 responses without SME participation. The most significant differences lie in technical competence and the development of the business model, while contributions of knowledge to the work process almost coincide. Moreover, the competence fields of being "participants only as a user" and contribution of financial resources were rated much lower.

In the next step, after the SME's competencies were evaluated, participants with project experience with SMEs offered their opinions on the value of SME participation and the distribution of expertise in projects. Figure 4.6 on page 74 depicts the findings. Based on the results, project implementation would not have been as successful as it was without the participation of SMEs. Furthermore, the findings illustrated in Figure 4.7 on page 74 indicate that the technical expertise lies with a small part of the consortium.

However, the opinions were not uniform across the various company sizes. Therefore, the sample was divided into SMEs and large companies (in line with the definition of an SME by the European Union, described in Section 2.2 on page 13. Survey participants shared their opinions on five different theses about Blockchain technology (Table 4.1 on page 76 lists the mean values). The theses cover three essential areas relevant to Blockchain adoption. The first two distinguish between companies that want to be involved in developing the system themselves and those that want to adopt a ready-made system. Generally, all companies included in the sample are more inclined to be involved in developing a Blockchain solution. The third thesis addresses whether a Blockchain project can be successful without the participation of SMEs. All participants, regardless of company size, took a neutral stance. Concerning participants' company size, no significant difference could be reported in the use of a turnkey system,

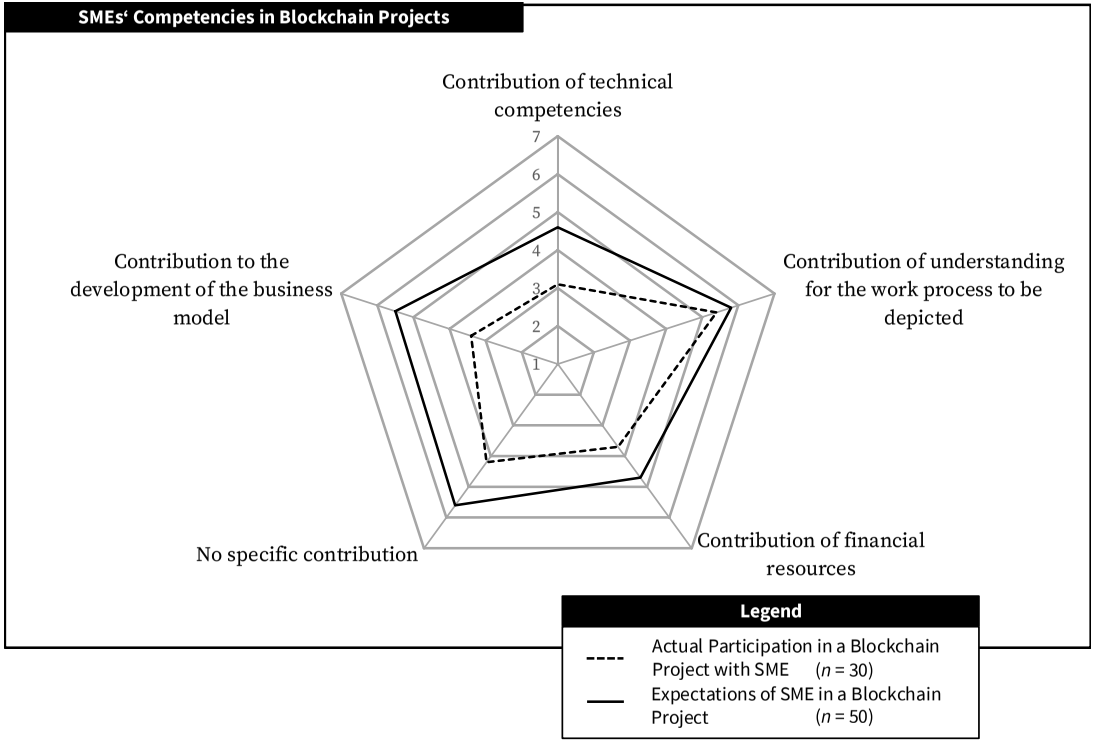

Figure 4.5: Juxtaposition of actually contributed and expected Competencies of SMEs in Blockchain projects. (measured on a scale from 1 = very little to 7 = very much)

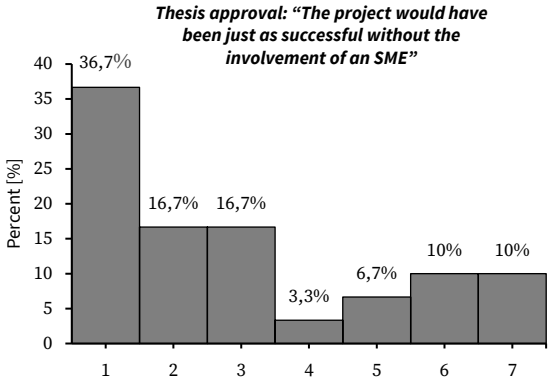

Figure 4.6: Overview of the Success of Blockchain Projects without SMEs (measured on a scale from 1 = very little to 7 = very much)

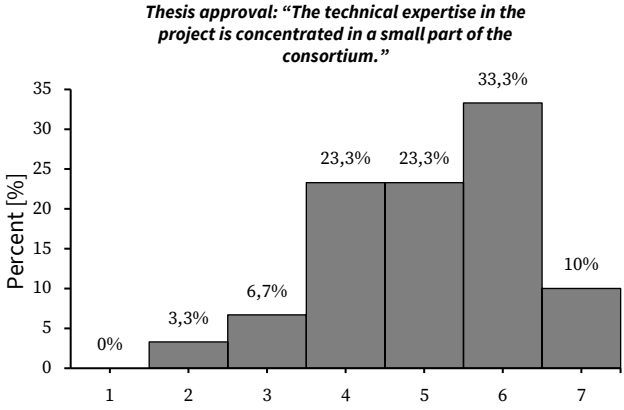

Figure 4.7: Overview of the Distribution of technical Expertise (measured on a scale from 1 = very little to 7 = very much)

the involvement of system development, and the success rate of a project without SME participation.

The last two thesis shed light on the issues of whether a Blockchain solution has reached technological maturity for enterprise use and whether Blockchain offers actual use cases for the real economy. The mean values indicated that SMEs (4.281 ± 1.628) were more optimistic than large companies (3.652 ± 1.555), especially regarding the maturity level of the technology. Moreover, SMEs (4.825 ± 1.692) and large companies (4.913 ± 1.345) share mostly the same position due to use cases and tangible benefits. The size of the standard deviation (1.345 up to 1.959 overall) shows a skeptical to neutral assessment.

4.2.2 Discussion of the Findings of the Quantitative Analysis

This study yielded valuable insights into SMEs from logistics, production, and retail in Blockchain projects in the field of L&SCM. Despite the significant increase in Blockchain projects in recent years, SMEs are poorly represented. The Blockchain projects in the survey were mainly publicly funded, and collaboration occurred through consortium agreements. This finding is in line with the work of Tomlinson and Fai (2013) and Huggins et al. (2012), who state that public funding is a strong motivation for SMEs to join research projects. For the most part, Blockchain projects were conducted for data exchange and tracking of products. Motivating factors were mainly "prestige/external image" and the "added value of the technology." Only 38% of companies in the analyzed sample were involved in Blockchain projects with SMEs. This low diffusion of Blockchain technology is in line with the samples of Bracci et al. (2021) and Treiblmaier and Span (2022).

Reasons for the observation could be the difficulty in setting up such a project and a lack of the competencies required for it. The most pursued use case of data sharing, as well as the Blockchain technology itself, requires cross-company collaboration. An inability to share data could be a barrier, especially for SMEs with a limited level of digitalization (von See et al. 2021). In addition, the composition of the project poses a barrier, as public funding was mainly used for this purpose and is only available for a limited time. SMEs are inhibited from investing due to a lack of resources,

Table 4.1: General Perceptions regarding Blockchain Adoption (measured on a scale from 1 = very little to 7 = very much)

#	Thesis	All Participants	By Company Size	
			SMEs	Companies
		n = 80	n = 57	n = 23
1	My company wants to deploy a turnkey Blockchain system without having to deal with the technical design.	3.025 ± 1.828	2.842 ± 1.878	3.478 ± 1.648
2	My company would like to make its own contributions to the technical and organizational design in order to influence the development of a Blockchain system.	5.013 ± 1.725	4.965 ± 1.792	5.130 ± 1.576
3	How likely is it that a Blockchain project will succeed without the involvement of a large company?	3.838 ± 1.796	3.877 ± 1.734	3.739 ± 1.959
4	Blockchain technology has reached the necessary maturity for enterprise use.	4.100 ± 1.621	4.281 ± 1.628	3.652 ± 1.555
5	Blockchain has real use cases and offers tangible benefits for businesses.	4.850 ± 1.592	4.825 ± 1.692	4.913 ± 1.345

limited funding, and limited access to knowledge at universities and research centers, all of which contribute to the above-mentioned barriers (Bracci et al. 2021; Treiblmaier and Span 2022; Hashimy et al. 2021; Wong et al. 2020a). As Bitkom's study in 2021 revealed, 87% of 652 companies "have not yet engaged with the use [of Blockchain]."

If logistics, production, and retail SMEs have participated in projects, their role is open to discussion. Based on the data, the competencies contributed by the SMEs, especially the technical competencies and those related to collaboration on the business model, are underdeveloped. Bracci et al. (2021) show that SMEs' general knowledge and awareness of Blockchain technology are also relatively low. Furthermore, a small part of the consortium holds the technical knowledge regarding a Blockchain project. As a result, SMEs are neither the technical nor the management knowledge carriers. However, other companies fill these roles, providing Blockchain-based knowledge and technical support. These technology companies consequently play an intermediary role – offering services without participating. This finding is in line with the findings of Tönnissen and Teuteberg (2020) and Lacity and van Hoek (2021b). They also find that Blockchain service providers replace other intermediaries.

By contrast, the data suggests that Blockchain projects would not have been as successful as they were without the involvement of SMEs (from logistics, production, and retail). On the one hand, this may be because SMEs understand the precise work process to be mapped and help with the design of the Blockchain solution. On the other hand, SMEs bring the necessary transactions to the Blockchain network to generate a network effect.

4.3 Conclusions Regarding the Quantitative Findings

This study was the first broad investigation of the role SMEs play in Blockchain projects. The results illustrate how projects are structured and what competencies SMEs have brought to Blockchain projects, thereby having implications for research and management practice.

4.3.1 Preliminary Implications for Research

In addition to highlighting the competencies and describing the skills of SMEs', this explorative study highlights that SMEs play a substantial role in Blockchain projects. Existing research primarily highlights the challenges in and barriers to Blockchain adoption (Hashimy et al. 2021; Ilbiz and Durst 2019; Wong et al. 2020a; Bracci et al. 2021) and only slightly integrates findings from pilot projects or trials (Wang et al. 2019a). The results of this study contribute to existing literature in two ways.

First, few publicly available studies outline the number of SMEs participating in Blockchain projects and the way in which these projects are structured. This gap in data leaves two key questions unanswered: What role do SMEs play in Blockchain projects, and how can they best position themselves to adopt the technology? The work of Bracci et al. (2021) contributes insights into SMEs' perceptions of Blockchain itself and their actual knowledge about the technology. Other research has also identified SMEs' low level of Blockchain knowledge (Clohessy and Acton 2019; Hashimy et al. 2021; Ilbiz and Durst 2019). This study contributes insights into the structure of Blockchain projects involving SMEs. SMEs are not the knowledge carriers in Blockchain projects – neither in technology nor in business model development. Moreover, the technological power in a Blockchain project is held by a small part of the consortium. This implies that, especially for Blockchain projects, technological Blockchain-related services will be provided by single companies. This finding is in line with the work of Tönnissen and Teuteberg (2020). Research should focus on what medium- and long-term effects Blockchain projects have on SMEs. Both qualitative and quantitative studies are needed to address these questions.

Second, Blockchain projects are mostly publicly funded and organized with a consortium agreement. This structure highlights the resource limitations of SMEs identified in research. This finding is in line with the work of Tomlinson and Fai (2013) and Huggins et al. (2012), who identified (public) funding as a strong motivator for SMEs to join innovation projects. Qualitative studies should explore how SMEs could approach Blockchain projects. In addition, researchers should also investigate how SMEs can best enter into cooperative partnerships and with which companies they

should cooperate. Furthermore, it is advisable for studies to collect experience reports from completed research projects, thereby addressing why companies decided to participate in a project and how SMEs contributed to the project's success.

Quantitative studies will aid in analyses of the ecosystem around Blockchain projects. Through surveys or quantitative case studies, it is possible to discuss what role SMEs play in project landscapes and which influence factors for the contribution of competencies have. Such factors could be identified by testing the perceived experiences of companies that have worked with SMEs in Blockchain projects. It would then also be possible to determine which strategies SMEs are likely to adopt in Blockchain projects.

4.3.2 Preliminary Implications for Management

Two implications for management follow from this study. These implications are depicted within the overall context of this dissertation in Figure 6.1 on page 181.

(M1) Prepare employees for Blockchain solutions: SMEs will not be the knowledge carriers of management or technology in Blockchain projects but will primarily contribute to mapping the work process. Therefore, companies, especially SMEs, should prepare themselves to question every technical and business model-related decision in Blockchain projects. On the one hand, the company could gain new business models based on Blockchain. On the other hand, the company's data in the Blockchain network must be considered. For this purpose, preparing staff specifically for the possible consequences of entering Blockchain projects is advisable.

(M2) Avoid dependencies through Service Providers: Even though SMEs are not the knowledge carriers in projects, Blockchain projects would not have been successful without their participation. As stated in the discussion, new intermediaries are forming in Blockchain projects, where knowledge is centered. Therefore, to avoid dependencies, companies, especially SMEs, should be careful not to give the new intermediaries too much power of determination in Blockchain projects.

4.3.3 Limitations and Further Research

To correctly interpret the results of this study, some limitations must be considered. First, only SMEs from Germany's logistics and supply chain sectors were considered in this study. Second, the entire data collection was carried out during the COVID-19 pandemic, and the results may hence have been somewhat distorted. Extending the study to other countries in Europe would be advisable to minimize the geographic limitation. Due to rapid development in the Blockchain sector on other continents, such as the United States and Asia, conducting similar studies would also be advisable.

Third, the distribution of the samples is a limiting factor. Only 34% of the study participants worked in the logistics sector, and 26% worked in the information technology sector. Study participants from the IT and research sectors constituted a marginal proportion of the sample. These participants have sales intentions or do not have to use the created solutions themselves. During the search for suitable study participants, particular attention was paid to ensuring they had experience with Blockchain technology. In future research, logistics companies without Blockchain experience in this field should be interviewed.

Finally, the subject of "SMEs in Blockchain projects" is challenging to evaluate because many requested projects were research projects with public funding. Projects supported by private funding and that cannot be found publicly could not be acquired for this study. The sample acquisition also resulted in bias because companies did not want to bring forward projects with self-funded resources. Future research should compare Blockchain projects involving other technologies to filter out differences.

Chapter 5

SMEs' Approaches to Blockchain Adoption

Blockchain technology is associated with beneficial applications for operations and supply chain management (Wamba et al. 2020). Data needs are currently not satisfied, but a growing willingness to share data with supply chain partners is recognizable. Moreover, the ability to connect to an uninterrupted IT system becomes a matter of survival for suppliers and contractors (Kersten et al. 2017b). As elaborated before, large companies use Blockchain technology to optimize their supply chains and generate well-executed information flows. Blockchain scholars focus on questions such as "what" (i.e., use cases) and "why" (i.e., possible benefits) rather than "how" (i.e., adoption), due to the early stage of the technology (Treiblmaier 2018). Predominantly whole supply chains or incumbents are the focus of their research (Hackius and Petersen 2020; Koens et al. 2020; van Hoek 2020). To achieve these Blockchain-based benefits, all companies in the supply chain, including small businesses, must input data into this infrastructure.

In Chapter 4, two major contributions were presented: On the one hand, the research highlighted that smaller companies play a role in Blockchain projects because these projects would not have been successful without their participation. On the other hand, smaller companies in particular are not the bearers of knowledge in these projects, neither from a technical nor from a business model-related perspective. The technical knowledge in Blockchain projects may be held by a small part of the consortium and will not be distributed to all project participants. The question hence arises

regarding the roles smaller companies assume in Blockchain projects and their approaches to entering them. This leads to the second research question:

Research Question 2: What approaches do SMEs take toward the adoption of Blockchain technology?

The second contribution relates to centering knowledge of different dimensions in Blockchain-based projects. A core characteristic of Blockchain is the immutability of the data structure (Hackius and Petersen 2017). Users of this infrastructure uploading data to the system will no longer modify or delete the information but only post updated references. This new data handling procedure means that, especially for companies, uploaded data will be available for companies with access as long as the infrastructure is maintained. Furthermore, the posted data can be analyzed to collect information about the respective company (Hackius et al. 2019). In addition to data analyses, possibilities to access the infrastructure and comprehensive services for data import are also offered.

Because small businesses from logistics, manufacturing, or retail are not the knowledge bearers in Blockchain projects, they must consider specific technical and business-related dependencies. These dependencies lead to the third research question, which specifies individual points:

Research Question 3: What should SMEs consider when choosing a particular approach?

The remainder of the chapter is structured as follows. First, the employed methodology, Grounded Theory (GT), is introduced. The sampling and data collection are explained in the GT introduction, followed by the data analysis. Second, the saturation and sample size are discussed along with research validity. Third, the results are presented: Factors influencing the choice of Blockchain approach (e.g., the motive or position in a particular supply chain) identified during the interviews are presented and discussed in depth. Finally, the chapter concludes with a description of the implications of this study and opportunities for further research.

5.1 Methodological Approach to explore SMEs Blockchain Adoption

This section outlines the methodology used for data acquisition and analysis and describes the procedures applied to ensure internal validity, external validity, and reliability.

5.1.1 Qualitative Research and Grounded Theory

In the mid-20th century, qualitative research was developed in modern psychology and was often used to build inductive theory models (Döring and Bortz 2016, p. 64). As the term "qualitative" suggests, the used data is nonreducible text, including words and visuals delivered in static (e.g., papers, interviews, and case studies) or non-quantifiable observations (ibid., p. 63). This qualitative data is now mostly digitalized and synthesized, and it can even be counted. The researcher extracting the relevant information is required to interpret the data to discern patterns and insights. Qualitative data can take many forms; hence, the researcher's onto-epistemological assumptions often shape the analytical approach (Bansal et al. 2018).

One of the advantages of qualitative research is that it allows for new insights that can often introduce theory in entirely new directions. Inductive theorizing is one of the fundamental components of qualitative research; "such inductive theorizing based on qualitative data are particularly appropriate in new or understudied empirical contexts where there is relatively little prior work" (ibid.).

The qualitative research paradigm includes diverse genres, each of which can be used to consider a phenomenon through a different lens. Examples are case studies, process studies, engaged scholarship, and historical or discourse studies. Since this study aims to explore the role of SMEs in Blockchain adoption, and little prior work has been done, a qualitative explorative approach is suitable.

A new phenomenon can be explained using different approaches depending on how well the phenomenon is understood and how much theory

exists to explain similar phenomena[4]. An inductive theory generation approach is suitable if no comprehensive theory is available and if a phenomenon is poorly understood. In this context, grounded theory approaches are often chosen (Jones and Noble 2007). However, if there are theories on a phenomenon, a boundary-spanning approach is suitable; in such an approach, existing theories are transferred to the respective topic (Hambrick and Mason 1984). If, however, the phenomenon is well understood and explained, but no unified theory exists, a theoretical consensus-shifting approach, in which new theories are created, may be suitable (Barney 1991). A theoretical integration approach may suit further research if unified theories exist for a well-understood phenomenon. Different perspectives on a phenomenon are brought together to create a holistic picture in this approach (Chattopadhyay et al. 2001).

A qualitative, explorative GT approach was chosen to investigate how SMEs decide to adopt Blockchain in supply chain management. GT application is also feasible 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."

Glaser and Strauss (1967) established GT. The general idea of developing theory based on empirical data, rather than basing it on purely conceptual ideas or merely expanding preconceived notions, is central to their approach. Since then, the theory has been further developed by many other authors, such as Goulding (2002), Charmaz (2014), and Bryant and Charmaz (2007).

Since the development of GT, two separate research streams have developed[5]. On the one hand, Glaser (1992) follows a puristic approach where the researcher should not bring any a priori knowledge to the research study. On the other hand, Strauss and Corbin (1990) follow a more pragmatic approach, where "techniques encourage researchers to use their own personal and professional experience and acquired knowledge as a positive advantage in the grounded theory process to enhance theoretical sensitivity" (Strauss 2010). Over the years and in different publications (Corbin and Strauss 1990; Strauss and Corbin 1998), Corbin and Strauss

4 This list was adapted by Nadkarni et al. (2018).

5 For an extensive comparison of the Glaserian and Straussian School see Jones and Noble (2007).

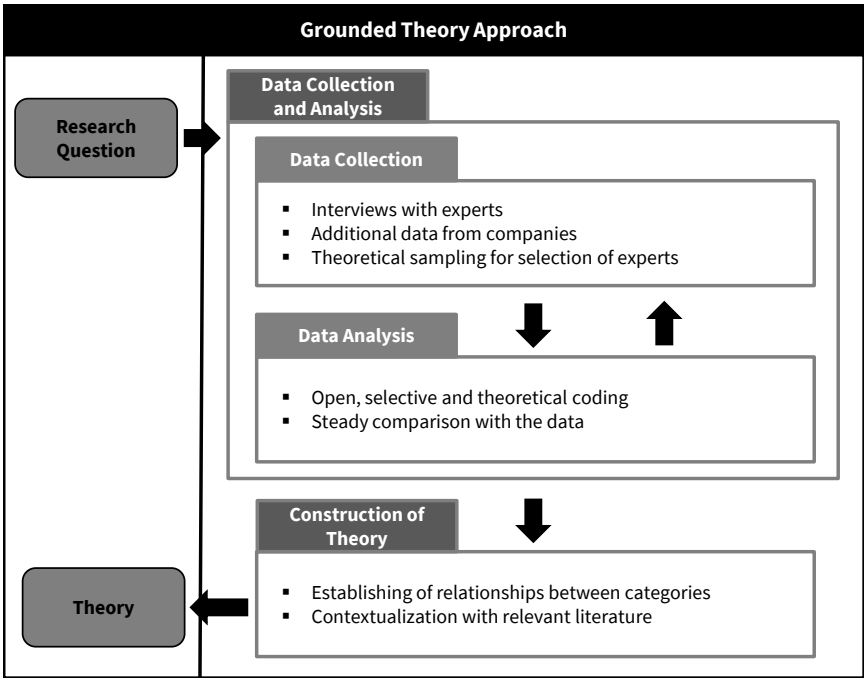

Figure 5.1: Research Process of constructing Grounded Theory (illustration based on Petersen et al. (2016))

have softened their approach that only theory can be formed. In their second book, they acknowledge that "some will use our techniques to generate theory, others for the purpose of doing very useful description, or conceptual ordering [classifying and elaborating]" (Strauss and Corbin 1998, p. 9). According to Jones and Noble (2007), researchers can combine elements (i.e., sampling techniques and coding templates) to generate a conceptual or descriptive product. This product can be an integrative (core category) theory, a loosely connected theory embedded in numerous narratives and stories, or no theory.

As the Blockchain adoption approaches of SMEs are investigated, and the literature on this topic is scarce, GT is suitable for exploring the subject (Mello and Flint 2009, p. 108). Since knowledge from large companies is not easily transferable to small companies, as outlined in Section 3.4.3.1 on page 53, this dissertation aims to identify adoption strategies in an industry that has not yet adopted the technology on a large scale; GT is most suited for this topic. In their early work, Curran and Blackburn (2001, 126ff.) state, "Grounded theory, despite the considerable literature devoted to it, is only one approach to analysis in qualitative research. There are a very large number of alternatives, most of which have not been discussed [...] because they are not much used in small business research." This statement is supported by numerous studies with GT as a methodology (Fraccastoro et al. 2021; Loforte Ribeiro and Timóteo Fernandes 2010; Chen et al. 2008; Hari et al. 2005; Murillo and Lozano 2006; Chaston et al. 1999).

Due to the lack of rigor in the methodology, as noted by Jones and Noble (2007), the method and process are detailed in Section 5.1.2 on the facing page, based on their three suggestions. Figure 5.1 on the previous page overviews the necessary elements of the research process. First, this dissertation follows the guidelines of Charmaz (2014) due to the softened and pragmatic approach. Second, the objective of this study is to explore the different approaches to Blockchain adoption by SMEs. Third, the data collection (including the sampling strategy and theoretical saturation), data analysis (including constant comparison, systematic coding, memoing, and sorting), and category development (including the core category) are described.

5.1.2 Sampling and Data Collection

The sampling process of this study aims to generate information on SMEs in logistics or supply chain management and their behavior in adopting Blockchain. The sample includes logistics companies, manufacturers, software vendors, and Blockchain service providers. In total, 37 interviews were conducted, recorded, transcribed and analyzed. Moreover, additional information from the companies and project reports were included in the analysis. Five additional interviews were conducted with companies from Blockchain projects, but recording and analysis of those interviews was prohibited. The study started with an initial sample of six companies to test the interview guide and generate initial results. Following these initial insights from the interview, the question guideline was adapted according to emerging topics. The interview guideline was adapted twice more to yield the final interview guideline. The final interview guideline can be found in Appendix B on page 230. After analysis of the first interviews, the initial sampling strategy changed to theoretical sampling in the sense of GT (Strauss and Corbin 1990, p. 143). During theoretical sampling, the researcher collects and analyses data and decides which interview partner could contribute additional information to the study (Binder and Edwards 2010).

The study participants represent a cross-selection of branches with different levels of experience. Notably, as elaborated before, SMEs have not broadly adopted Blockchain technology, and their knowledge of Blockchain is limited. Since the research goal is to identify the Blockchain adoption approaches of SMEs, interviews were conducted with interesting industry partners and participants with Blockchain experience. These interview partners are not only operational companies to adopt Blockchain but also technical companies currently providing Blockchain solutions.

Because the most Blockchain experience in this sample was project-based, whole Blockchain projects were included in this study. For this purpose, five interviews were conducted with participants in two Blockchain projects: the “HANSEBLOC” project and the “Release Order based on Blockchain” project. Additional information, such as project reports and protocols, were also included and analyzed. Figure 5.2 on the next page depicts the data sources. Next, each component of the data collection is presented.

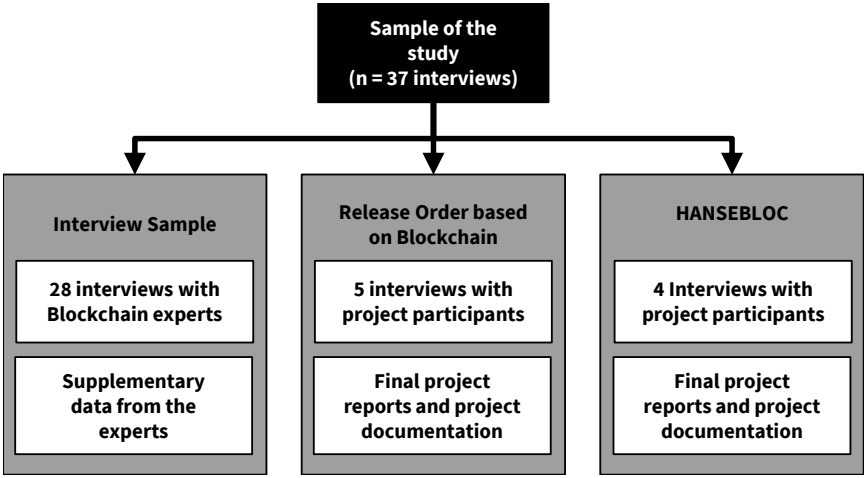

Figure 5.2: Overview of the Study Sample

5.1.2.1 Interview Sample

In total, 28 in-depth, semi-structured interviews were conducted from March 2020 to May 2021. Each interview lasted between 32 and 111 minutes, with a mean of 58 minutes and a median of 54 minutes. Due to the COVID-19 pandemic, all interviews were conducted via web call or phone in German (22/28) or English (6/28). Interviewees were primarily identified and contacted through the business network LinkedIn and through the interviewees' connections.

Supplementary data on the Blockchain projects, prototypes, and solutions of the companies in question was collected before each interview. This supplementary data was downloaded from the companies' openly accessible websites. A few study participants offered additional information themselves: own Blockchain case studies, Blockchain protocol whitepapers, or product descriptions. With this data, the interview results could be further deepened, and specific technical specifications of individual cases could be better understood, as additional technology explanations aided in accurately classifying individual projects.

Table 5.1 introduces the study participants who contributed to the GT study. For best describe the company's interview participants, the respondents' positions, a range of employees, and their level of experience are presented. The experience level was categorized into three levels: a medium experience level, indicating that the company was investigating a use case; a high experience level, describing own proof of concepts; and a very high level of experience, denoting companies with Blockchain as part of their core business (Hackius and Petersen 2020).

Table 5.1: Sample of Interview Respondents

#	Company	Number of Employees	Experience
1	IT Solutions Provider	11–100	Very High
2	University	>1 000	Very High

continued on the next page

(Cont.) Table 5.1: Sample of Interview Respondents

#	Company	Number of Employees	Experience
3	IT Solutions Provider	101–1 000	High
4	Logistics Service Provider	11–100	Medium
5	IT Solutions Provider	101–1 000	High
6	Logistics Consulting Company	1–10	Very High
7	Blockchain Protocol Provider	1–10	Very High
8	Blockchain Consulting Company	1–10	Very High
9	Logistics Association	11–100	Medium
10	Waste Management	>1 000	Medium
11	IT Solutions Provider	>1 000	Very High
12	IT Solutions Provider	11–100	Very High
13	Manufacturer	>1 000	Very High
14	Blockchain Consulting Company	11–100	Very High
15	Manufacturer	>1 000	Medium
16	Logistics Service Provider	>1 000	High
17	IT Solutions Provider	1–10	Very High
18	IT Solutions Provider	11–100	Very High
19	IT Solutions Provider	11–100	Medium
20	Logistics Service Provider	11–100	Medium
21	IT Solutions Provider	11–100	Very High
22	Logistics Authority	>1 000	Medium
23	IT Solutions Provider	11–100	Very High

continued on the next page

(Cont.) Table 5.1: Sample of Interview Respondents

#	Company	Number of Employees	Experience
24	Logistics Association	11–100	High
25	Blockchain Protocol Provider	11–100	Very High
26	University	>1 000	Very High
27	Manufacturer	>1 000	Medium
28	Manufacturer	>1 000	Medium

5.1.2.2 Release Order based on Blockchain

Release Order based on Blockchain (ROboB) is a research project within the framework of Innovative Harbor Technologies (IHATEC) funded by the Federal Ministry for Digital and Transport (BMVI). The DAKOSY Datenkommunikationssystem AG is in charge of the project, supported by the network partner of the Hamburg University of Technology. Well-known representatives of the port industry (freight forwarders, carriers, and terminal operators) joined as associated partners. The project duration was from August 2018 to May 2020[6]. Further insights into the research project can be found in research by Hackius et al. (2019) and Reimers and Kersten (2020).

The main research object of the ROboB project was to determine, "Is Blockchain technology suitable for use in logistics?" As a research target, the release order process in the port of Hamburg was chosen. This process is relevant in sea freight import and particularly important for the region of Hamburg. In the release order process, the "release order" is a piece of data that allows truck companies to collect a container from the terminal. Due to the high costs of goods moved inside the port of Hamburg, this

6 The author of this dissertation was involved into the ROboB project for the complete duration. During the time of this project, the author designed the basic concept of privacy and a demonstrator (Kersten et al. 2020). The concept is implemented into the ongoing solution of the follow-up project called German Ports.

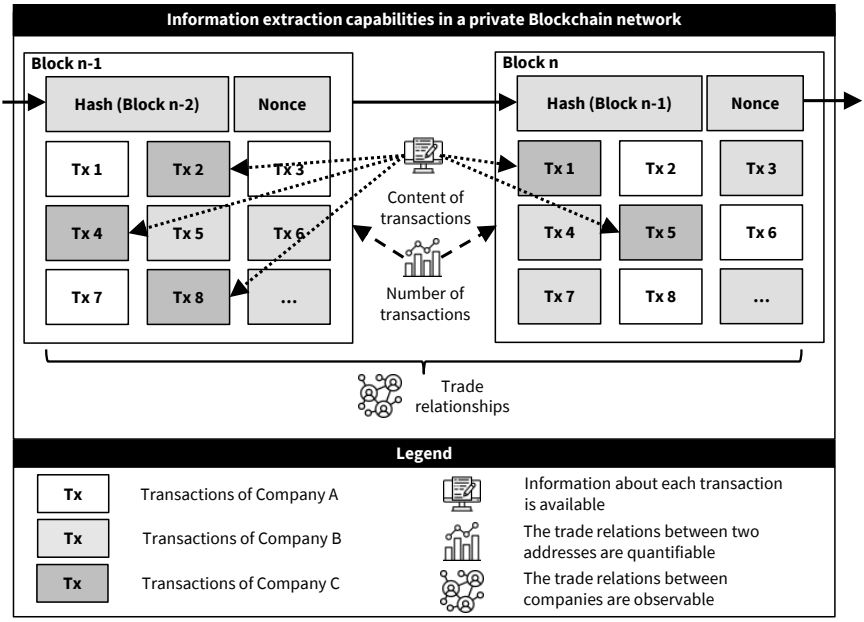

Figure 5.3: Possible analysis of Blockchain data (Hackius et al. 2019)

security process must be safe. To date, there is no digital information flow along this process. Blockchain can build a secure data structure for all involved parties. As part of the project, a procedure using Blockchain technology was integrated into the existing infrastructure and tested for its practicality.

Project results indicate benefits and barriers to a Blockchain-based release order process. On the one hand, Blockchain allows for consolidation of the diverse information flows in the port of Hamburg and unique identification of truckers at the terminal. On the other hand, Blockchain-based transparency could lead to the disclosure of trade relationships and sensitive company information, as illustrated in Figure 5.3. Moreover, the SMEs that might subsequently use the Blockchain technology are not digitalized enough to host an own node. To implement Blockchain properly, these barriers – specifically these transparency concerns – must be overcome.

Table 5.2: Sample of Interview Respondents from the RObоB Project

#	Company	Number of Employees	Experience
R1	Container Terminal Operator	>1 000	High
R2	Container Terminal Operator	>1 000	High
R3	Ocean freight carrier	>1 000	High
R4	Ocean freight carrier	>1 000	High
R5	Logistics Service Provider	101–1 000	Medium

In this project, a private-permissioned Blockchain solution based on Hyperledger Fabric was chosen, and this has some implications for SMEs. As highlighted in Chapter 3 on page 31, most SMEs are not digitalized enough to participate in the Blockchain easily. Therefore, it was decided to integrate SMEs – which cannot provide their Blockchain node – via interfaces or web interfaces. In this scenario, however, it is essential to consider that SMEs will be unable to change the infrastructure and will not have access to data analysis.

The RObоB sample included three data sources. The first data source comprised five interviews; all interview partners were from port logistics companies (two container terminal operators, two ocean freight carriers, and one logistics service provider), as listed in Table 5.2. The interviews lasted between 11 and 43 minutes (average: about 31 minutes). All interviews were transcribed and analyzed afterward. The second data source was reports created using workshop outcomes and project documentation. These reports were used to derive the current and expected process, and they aided in maintaining project management. The third data source comprised the final project reports from each participant. These reports contained the main points of the project and summarized the whole project process.

5.1.2.3 HANSEBLOC

HANSEBLOC is a research project in the program "Promotion of strategic SME innovation alliances in networks and clusters (KMU-NetC)" funded by the Federal Ministry of Education and Research (BMBF). The program is part of the Right of Way for SMEs – the BMBF's 10-point program for more innovation in SMEs. HANSEBLOC has a broad consortium of 11 North German partners. The Logistics Initiative Hamburg is in charge of the project and is the coordinator of four logistics providers, four IT service providers, and two university partners. Furthermore, seven logistics, regulation, and customs entities are associated partners. The project duration was from April 2018 to March 2021. Further insights into the research project can be found in research by Twenhöven et al. (2020) and Twenhöven and Petersen (2019).

Logistics, especially transportation, requires documents, signatures, and customs documents for the exchange of goods. Information exchange currently occurs in various ways: paper, email, cloud services, and freight exchanges. However, unlike Blockchain technology, these means of transmission are not tamper-proof. In HANSEBLOC, a platform was to be created for secure document exchange for all goods. Different providers offered various solutions with the same goal. However, these solutions were incompatible, as no suitable standards and interfaces existed. This incompatibility represented the intended starting point of the project, with the aims of offering an automated solution using Blockchain technology and building on existing systems so that legacy systems can remain in place.

Those goals were achieved with the successful deployment of a prototype in March 2021. Data protection from unauthorized access is essential to such a system, yet existing Blockchain systems do not provide sufficient data protection capabilities. The project prioritized the development of suitable architecture and its deployment as part of the prototype system. During the project, two changes were made to the work plan: First, a task force for privacy and government was set up; second, the development mode was changed to an agile procedure.

With the help of Blockchain, data should be shared between companies to optimize processes or add value to logistics companies. This transparency

Table 5.3: Sample of Interview Respondents from the HANSEBLOC Project

#	Company	Number of Employees	Experience
H1	Logistics Service Provider	11–100	High
H2	Logistics Service Provider	11–100	High
H3	Logistics Association	11–100	High
H4	University	11–100	High

might be a problem for single companies in the supply chain, as companies could speak directly to subcontractors, rendering the forwarder irrelevant through the generated transparency. With this in mind, no company would join a Blockchain network. Generally speaking, there is a risk that the recipient of the information will not use it as intended by the sender.

Similar to the RObоB research project, a private-permissioned Blockchain configuration was chosen. Since primarily SMEs are involved in HANSEBLOC, the project's governance findings, technological configurations, and data structures are generally transferrable to SMEs. Moreover, a requirement was that every participant would be able to operate an authority node if desired.

The sample from the HANSEBLOC project includes two data sources. The first source comprised four interviews: two with companies from logistics, one with a logistics association, and one with a university, as listed in Table 5.3. The interviews lasted between 21 and 34 minutes (on average, 24 minutes). All interviews were transcribed and analyzed afterward. The second source was the final report of the project.

5.1.3 Data Analysis

In parallel to the data collection process, the data analysis was conducted. The coding process followed the guidelines of Glaser and Strauss (1967), outlined by Charmaz (2014, pp. 42–70). It involved the following three stages. First, the initial coding took place. The text was broken down line by line in the initial coding to label the results. Groups were summarized, and memos were written. Writing memos was an essential part of the first coding stage to keep specific relationships in mind and support the analysis (ibid., pp. 72–90). The first coding phase resulted in approximately 1,600 codes.

In the second coding stage, focused coding was conducted; the most frequent codes were reviewed and further generalized (ibid., 57ff.). This step did not follow a linear path, as more abstract and higher-level constructs were formed.

After the initial coding fractured the data into separate pieces, and focused coding identified higher-level concepts, the third phase of theoretical coding brought the data together (ibid., pp. 60–62). Five axial groups were found. This stage aimed to determine the structure of the new theoretical construct and the connections inside (ibid., p. 63).

After the three-stage analysis, approximately 675 pages of the transcript were coded. The software MAXQDA 2020 was used to analyze all pages of the transcript and the supplementary data. MAXQDA 2020 was chosen because it is a common means to analyze qualitative data, set coding, write memos, and organize transcripts (Kuckartz et al. 2007, p. 10; Mayring 2002, p. 170).

5.1.4 Theoretical Saturation and Sample Size

The data collection of this study was completed after 37 interviews. Theoretical saturation was assumed because the last four interviews only confirmed already known items. The main categories of theoretical saturation were satisfied since the properties and dimensions of the categories were consistent (Charmaz 2014, p. 113). In addition, the categorizations and adjuncts presented a comprehensive picture of how SMEs face Blockchain

adoption. According to Carter and Jennings (2002, p. 150), "6–8 sampling units are commonly sufficient for a homogenous sample (i.e., each of the functional areas), while 12–20 are often necessary for more heterogeneous samples (i.e., across the three functional areas)." Because the present GT study has a heterogeneous sample and exceeds the recommendations of Carter and Jennings (ibid.), the author assumed that theoretical saturation had been achieved.

5.1.5 Validity of the qualitative Research Process

In empirical research, the results are inevitably compared to quality criteria (Mayring 2002, p. 140). In quantitative research, the quality of the results can be determined mainly by the possibility of recalculation and the description of measuring instruments, but these quality criteria cannot be transferred to qualitative research (Wrona 2006, p. 204). The quality criteria in qualitative research must be more flexible and must require both justifiability and generalizability. Since the standardization of data collection and analysis is not possible, the respective studies cannot be repeated; hence, the issue of transparency arises (Aguinis and Solarino 2019). Therefore, the research process should be well documented to ensure clarity (Mayring 2002, p. 142). Table 5.4 on the next page lists the described approaches and other approaches implemented in this dissertation.

Table 5.4: Measures to ensure Quality in the qualitative Research Process (data and categories based on Mayring (2002, pp. 144–148), Jones and Noble (2007), and Wrona (2006))

Criteria	The realization of measures to ensure quality in the present dissertation
Procedure documentation	• The research process was accurately documented following Jones and Noble (2007). • The created concepts and codes were constantly reflected upon with researchers from the projects, constant mirroring was performed with companies from logistics and supply chain management. • The software MAXQDA 2020 was used for the analysis
Argumentative interpretation assurance	• All emerging interpretations were documented. • When viable, quotes from participants are referenced. Methodological rigor • General procedures of the GT philosophy were employed as mentioned in Section 5.1 on page 83. • Codes were constantly compared with the interview data.

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(Cont.) Table 5.4: Measures to ensure Quality in the qualitative Research Process

Criteria	The realization of measures to ensure quality in the present dissertation
Proximity to the subject	• The interviews were held in all cases with companies from logistics or supply chain management related to Blockchain. • Supplemental data sources contributed by interviewees (e.g., whitepaper or product descriptions) were used. • A semi-structured interview guideline was employed.
Communicative validation	• Found higher-level concepts were discussed with the interview participants.
Triangulation	• Findings were presented at three scientific conferences and 24 industry talks for feedback. The feedback was accounted for the construction of the theory. To simplify the presentation of the results, the topology created was transferred to a web tool. • Researchers reviewed the data collection and analysis and evaluated the higher-level concepts.

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(Cont.) Table 5.4: Measures to ensure Quality in the qualitative Research Process

Criteria	The realization of measures to ensure quality in the present dissertation
Integrity	• Anonymity was guaranteed to all interviewees. • Direct quotations were used to substantiate the categories developed (Pratt 2009). • Falsified statements by the interviewees were avoided through assurance of confidentiality.

5.2 Summary and Discussion of the Findings of the Grounded Theory Analysis

This section summarizes the findings of the GT analysis. Individual aspects of the findings have already been published in papers by Reimers et al. (2021a), Reimers and Kersten (2020), Reimers et al. (2021b), and Hackius et al. (2019).

Pratt (2009) recommends presenting concept maps from qualitative research to guide readers through the findings. The explanatory model evaluated from the codes is illustrated in Figure 5.4 on the next page and used to present the findings below. The model design starts with the four Blockchain adoption approaches of SMEs. For each project, an SME must choose one of these four approaches, which are not mutually exclusive. An SME can simultaneously choose the approach of a Participant for one project and that of a Cooperator for another project. These adoption approaches are based on several internal and external conditions, most notably a company's core competency. The approaches define the procedure that the SME adopts in the upcoming Blockchain project. This conceptualization is the core category of the findings.

Before an SME chooses a Blockchain approach, it must consider its current situation in its supply chain, specifically its organizational readiness, information systems and data sharing behavior, and market power. Moreover, concurrent companies must consider their motivation to adopt Blockchain technology. Both categories directly influence a company's business model, which clarifies the degree to which the adaption of the value proposition changes. Aside from the value proposition, SMEs must consider the magnitude of a Blockchain project, the network effect, and the way in which the Blockchain fits into the legacy system. The specifics of Blockchain technology directly influence the business model category.

In the following Sections 5.2.1 to 5.2.5 on pages 104–150, the findings of the GT study, visualized in Figure 5.4 on the facing page, are detailed. Individual interview quotes (e.g., power quotes) are presented and interpreted in each section (ibid.). The interpretations shown are also discussed in relation to the relevant literature. Finally, the findings, in combination

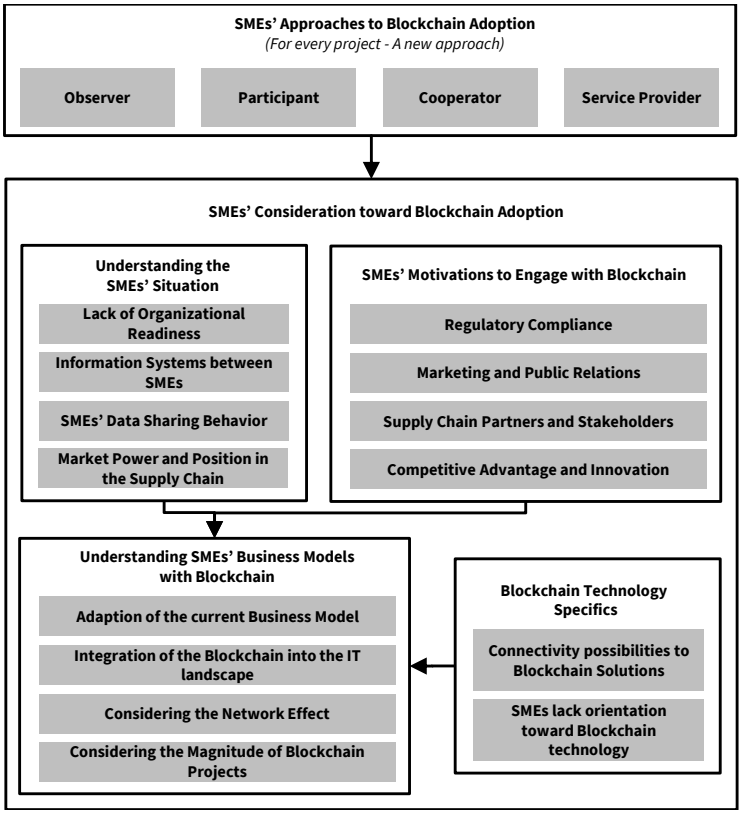

Figure 5.4: Explanatory Model of SMEs' Approaches to Blockchain Technology

with the relevant literature, are aggregated and abstracted into propositions, which describe the content of the developed theory derived from the interviews. These propositions connect two basic constructs (i.e., if–then or the greater–the less) that have the broadest possible scope (little limited space-time reference) - which may be confirmed or rejected in future research (Döring and Bortz 2016, p. 56).

5.2.1 SMEs' Approaches to Blockchain Adoption

The gathered data provides considerable insight into SMEs' approaches to leveraging Blockchain technology. The different approaches must be considered based on each SME's situation (e.g., organizational readiness and position in the market), the motive to adopt Blockchain technology (i.e., regulation or competitive advantage), Blockchain-specific conditions (e.g., connectivity possibilities), and the SMEs' business model (e.g., competitive strategy). These considerations are elaborated in the following presentation of the findings. Observations of incumbents, global companies, and large IT solutions providers have already demonstrated that companies are taking different approaches to this technology (BASF 2022; Corkery and Popper 2018; Volvo Cars Austria 2019).

SMEs' approaches to Blockchain adoption are differentiated into four general categories, and a typology is developed to clarify these possible approaches. In line with Marradi (1990, p. 129) and Kelle and Kluge (2010, pp. 91–105), the term "typology" is employed here. The introduced typology offers further research opportunities and explains the emerging observations in parallel. Figure 5.5 on the next page overviews the developed typology and details each approach.

Observers' do not consider adopting Blockchain technology but rather observe the market. Participants join existing Blockchain solutions hosted by other companies or consortia. Cooperators team up with other interested parties, while Service Providers offer their Blockchain technology-based services to other companies. Most importantly, the approaches discussed are not mutually exclusive, because they are project-based. For example, if an SME receives two joining requests for Blockchain projects, it can join one project as a Cooperator and assume the role of an Observer in the other project.

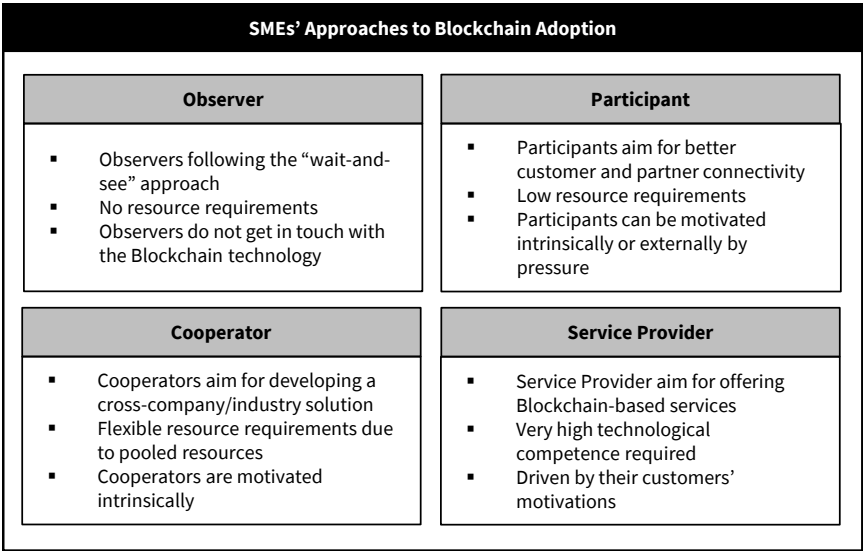

Figure 5.5: SMEs' Blockchain Approaches

5.2.1.1 Observers

Observers are companies that follow the "wait-and-see" approach. These companies approach Blockchain solutions with much skepticism and wait until most of their supply chain partners have adopted the technology. They may be convinced of the benefits of new ideas, but support and possibly pressure from other supply chain partners are necessary to invest in those ideas. The benefits of the new Blockchain technology must be clear, and uncertainty must be removed before observers feel safe to invest any resources. As an expert stated,

> *You will only be able to convince logisticians if you make it clear that by using it, you are solving problems that would otherwise cause costs. That means if you reduce the costs, you will inspire people to use it*
>
> *#4 Logistics Service Provider*

> *So the medium-sized businesses are less focused on, yes, merging and developing. [...] They take a look at it, and if it works, if the added value is assured, then they do it. But they are less likely to invest in it themselves, to organize it*
>
> *#15 Manufacturer*

Observers do not consider adopting Blockchain technology, implying that they do not receive any benefits from the technology or gain any experience with it.

Observers' motivations for not adopting Blockchain are diverse. First, the literature broadly describes SMEs' resource limitations (Hashimy et al. 2021; Bracci et al. 2021). If SMEs do not have the resources – time, finances, and personnel – they cannot spend time working with new technology. Moreover, the topic of Blockchain is complex and holds potentially negative associations, based on the media's coverage of cryptocurrencies (Rohleder 2021). Finally, companies fear the transparency of their data (see Section 5.2.4.1 on page 145). As participants stated,

> *People don't deal with it, because it is perhaps not properly understood or communicated, and then they also don't have the knowledge about this advantage of it. So I would say that not many, if not none, in the companies really know what Blockchain means. So, there is also a lack of knowledge about it. And currently also because of the lack of time and the lack of manpower.*
>
> *#20 Logistics Service Provider*

There are no preconditions to taking the "wait-and-see" approach of Observers – contrary to the other approaches. However, SMEs face the risk of being left behind. If they take the Observer approach in every Blockchain project participation request, they may find themselves in a set system without any option to shape the general conditions.

Rogers (2003, pp. 249–251) supports a skeptical approach to innovations. The ideal adoption types of the "late majority: skeptical" and "laggards: traditional" show a high level of reservation about technology adoption. Moreover, Clohessy and Acton (2019) and Bracci et al. (2021) show smaller companies' reservations regarding adoption.

5.2.1.2 Participants

Participants are companies that adopt finished Blockchain solutions. They are mostly "operational" companies with core competencies from logistics, manufacturing, or retail but no core competencies from IT. Once Participants discover a solution relevant to them, they deploy it as a turnkey solution:

> *We are users of this technology. We see ourselves as users. We do not see ourselves as a partner or as a pusher of an infrastructure. [...] We work with companies that offer us certain services. And if there's a company that says, "we're going to do communication this way and that way and there's a Blockchain behind it," we wouldn't say no. But we wouldn't demand it.*
>
> *#28 Manufacturer*

> *The middle class then simply buys whatever and uses It. And virtually uses the features of a Blockchain indirectly, without even knowing it in case of doubt.*
>
> *#17 IT Solutions Provider*

Participants face a completed system to which they must merely connect. This predefined, ready-to-use system implies that the Participant's legacy system will be connected to the Blockchain solution – without hosting an own node.

Two types of motivation drive Participants. On the one hand, they could be intrinsically motivated by a desire to save costs, establish a better connection to a valuable supply chain partner, or improve their products and processes. Therefore, they approach companies that offer Blockchain-based services and connect themselves to the Blockchain solution. On the other hand, they could be extrinsically motivated – by regulation or pressure from business partners. As previously mentioned, companies or consortia with substantial market power can force less powerful business partners into specific projects or infrastructures. Interview participants explained,

> *"Either you use this exact technology, or we can't make you a reasonable offer." So it already comes down to size and market power.*
>
> *#15 Manufacturer*

> *So, the decisions are triggered from the outside [...] "We are the big ones, and if you don't do it, you are out." This is an excellent trigger to enforce it.*
>
> *#16 Logistics Service Provider*

Participation in a Blockchain solution – without hosting an own node – does not require technological resources or knowledge. Companies participating in the Blockchain solution will be supported by IT Solutions Providers or the more powerful business partner in terms of connection. Moreover, Participants have access to a complete system, which they do not need to develop or maintain. To take the Participants' approach, no market power but some internal resources (e.g., training employees on new systems or

transferring data to the new system) are required. Therefore, Participants need solutions that are easy to use:

> *And then they just need solutions where they can practically just log in without changing their system, without changing their business model. Where you can also simply say, "We are part of the whole and benefit from it, if we then complied with the regulations."*
>
> *#12 IT Solutions Provider*

If Participants are connected to a Blockchain solution – either voluntarily or involuntarily – they cannot shape the existing system because the characteristics have already been determined. This predefined system may negatively affect Participants because the supply chain power is extended into the infrastructure. Participants are imagined as companies that excel in their particular supply chain niche. They succeed because they focus on their strengths rather than attempting to improve on their weaknesses, and they extend the same approach to Blockchain adoption:

> *I don't have to take on a pioneering role. I don't have to hire a service provider myself or join a consortium. Because at the end of the day, what keeps my business going is that I comply with my customers' rules.*
>
> *#23 IT Solutions Provider*

As mentioned in the literature review in Chapter 3 on page 31, Tan et al. (2018), Lacity and van Hoek (2021a), and Ilbiz and Durst (2019) provide support for this finding in the power imbalance between SMEs and more powerful supply chain partners. Joining the Blockchain solution as a Participant needs to be considered from two sides: First, from the more powerful partners' perspective, offering a turnkey solution is beneficial to lower the adoption hurdles for smaller companies. These powerful partners can onboard smaller companies to achieve, for example, high transparency and data quality, as in the Walmart case (Corkery and Popper 2018; Tan et al. 2018), or the opportunity to track their valuable, critical goods, as in the Volvo case (Volvo Cars Austria 2019). Second, from the Participants' perspective, the decision to join Blockchain solutions could be voluntary or involuntary. Joining a Blockchain solution could be beneficial because

Participants could use the advantages of the solution without development efforts. Moreover, it could be a purposeful part of their strategy for relationship development because they receive a better IT connection to their supply chain partner and possibly fulfill customer requirements.

5.2.1.3 Cooperators

Cooperators team up with other interested supply chain partners to set up a cross-company and/or cross-industry Blockchain solution. SMEs in the logistics industry highlighted that they lose money together in shared inefficient processes that must be optimized, as described in Chapter 3 on page 31. A "community spirit" is needed to resolve cross-company problems. Cooperators apply this community spirit and seek to shape developments in their industry. As an interview participant stated,

> *"So, you know what. We're going to map out an ecosystem, and this area is going to have Blockchain." If there is an application for this, and everyone says, "Yes, let's do it!" And just also work exclusively with each other and want to improve our supply chain together to the extent that none of us is left behind. [...] Where do we actually lose money together? So there's also a bit more community thinking.*
>
> *#4 Logistics Service Provider*

In contrast to Participants, Cooperators do not have access to a completed system; they must plan, develop, and set up their Blockchain solution. This development process implies intensive use of Blockchain technology and possibly the hosting of an own node (with support from IT Solution Providers).

Cooperators' motivations to set up a Blockchain solution are diverse. They expect the Blockchain solution to benefit their company (e.g., cost savings, better communication, or increased sales) and their supply chain (e.g., cross-company information sharing). Another mentioned motivation (see Section 5.2.3 on page 132) for joining a Blockchain project is to gain "prestige" or better "public relations" as an otherwise invisible SME. The

company's goal in joining a project might be to develop a productive system, develop new business models, or evaluate the technology for itself in general:

> *[...] these are, of course, industry problems. And that's why it makes sense for the entire industry or the entire sector to work together to find a solution. And that's where Blockchain is of course a good use case for that, where you say, "Okay, you're now bringing in different companies with different data security ideas and challenges." That's when Blockchain starts to make sense. These are then these so-called consortia.*
>
> *#23 IT Solutions Provider*

> *Yes, or simply out of interest to participate in something like a Blockchain project and see what happens. Maybe without the intention of actually putting it into practice, maybe more out of interest.*
>
> *#16 Logistics Service Provider*

Joining a Blockchain project could also work in reverse for cooperators: If a respected industry player pushes a project, others might be forced to join the project. The motivations are the risk of being left behind and the possibility of losing public esteem.

There are some preconditions to assuming the role of a Cooperator. Developing and shaping a Blockchain solution requires a varying investment of resources depending on a Cooperator's competencies and available resources. Nevertheless, to enable collaborative project success, resources must flow from each project contributor. Moreover, in most smaller projects, Cooperators know one another because they operate in the same field or address the same problems. Cooperators must consequently be willing to collaborate with their competitors and share data to make the Blockchain solution work:

> *Today, you also have to have the right technical skills. And the right mindset. So that always plays a role. I also said that you have to be prepared to work with competitors.*
>
> *#9 Logistics Association*

Literature on co-opetition, as elaborated in Section 3.4.3.2 on page 57, supports companies' willingness to work with competitors and the possibility of losing secrets to them (Gnyawali and Park 2009; Luo 2005; Alvarez and Barney 2001; Luo 2007). Gnyawali and Park (2009, p. 323) state, "If a firm is not quite careful or happens to get an opportunistic partner, it could lose its secret and proprietary knowledge to the competitor-partner." According to Alvarez and Barney (2001), this outcome might be even worse if SMEs partner with larger firms. The interviews confirmed this, as an expert stated,

> *So, it was preferred to listen to the people who work in larger companies. In other words, if a managing director from [a larger company] was physically present on the project [...], then that somehow had a completely different impact on the decisions that were made than if someone else said something.*
>
> *#H3 Logistics Service Provider*

Decisions should be collaborative and fair or all parties, especially in Blockchain projects. Decisions made in favor of larger partners and transferred to the Blockchain solution might have negative consequences for smaller companies, and these decisions are not changeable due to the immutability of the Blockchain technology. These findings lead to the following proposition:

Proposition 1: Power imbalances in Blockchain projects influence decisions, which can be translated into the infrastructure. This may have negative consequences for smaller partners.

In addition, the literature on co-opetition states that the development process is temporary. According to Granata et al. (2016, p. 96), "formal cooperation among competing SMEs is not necessarily temporary but can actually become a permanently evolving process, like the process of competition." This finding is in line with the present study's finding because if a Blockchain project is successful, cooperation between the Cooperators will not be temporary as long as the Blockchain solution is used. This finding leads to the following proposition:

Proposition 2: A permanent state of co-opetition emerges between Cooperators if a Blockchain project is successfully implemented.

5.2.1.4 Service Providers

Service Providers focus their business model on Blockchain and are true believers in the success of this technology. They offer other companies the benefits of Blockchain solutions without taking advantage of the potential themselves. They serve their customers a "carefree package" toward Blockchain technology – offers range from connecting customers to the Blockchain in a Software-as-a-Service model and providing services based on the Blockchain infrastructure to selling the Blockchain itself as an infrastructure for others to build on. These companies usually provide software to other companies and have a core competency in IT, as a participant explained:

> *[...] we are a service provider. Clearly, because of course, we help companies use Blockchain technology. I say, simply onboarding. Because what we also take from the customer, of course, is quite a lot of Blockchain knowledge.*
>
> *#21 IT Solutions Provider*

Service Providers offering Blockchain solutions or connecting Participants and Cooperators to a Blockchain solutions, so they can benefit from the technology. However, Service Providers do not exploit the potential of Blockchain themselves.

Because they offer Blockchain Solutions, Service Providers are driven by their customers' motivation to employ Blockchain technology. If their customers need to comply with regulations, their motivation is to provide software to fulfill this objective. Like every company, Service Providers aim to sell their product to their customers. In the interviews, Service Providers continuously mentioned that Blockchain is an excellent opportunity to comply with different regulations or can optimize processes and products

based on their analysis if a Blockchain solution is deployed. The experts stated,

> *When the London Metal Exchange (LME) rules come into force that require you to have knowledge of what location your materials have been transported through, you're not going to get backwards and figure it out. You needed to include it in the material itself. And this is where the technology really shines.*
>
> *#7 Blockchain Protocol Provider*

> *The Blockchain part of our solution offers us the possibility to provide our customers with an immutable proof of origin. And the immutability is simply the Blockchain part of it.*
>
> *#12 IT Solutions Provider*

To provide Blockchain-based services, a company must have high technical competency. Service Providers also need other companies without technical knowledge to outsource connection to the Blockchain Solution to these providers instead of connecting to the solution themselves. To this end, Service Providers must have Blockchain specialists on their team to provide technical knowledge and consulting. Moreover, Service Providers must hold market power and be highly trustworthy. If a Service Provider offers a complete service, from connection to the Blockchain solution to network analysis, it holds the necessary keys for their clients:

> *If someone loses their keys, what happens? Well, this is the problem when you don't have a middleman holding all the keys. And so it was very complex to sort of negotiate and figure out how to design the system. And not all the problems are fixed yet.*
>
> *#25 Blockchain Protocol Provider*

> *But the customer in itself actually has relatively few points of contact with the Blockchain. Of course, they benefit from the characteristics of the Blockchain.*
>
> *#12 IT Solutions Provider*

In this vein, Service Providers form the link between their client and the Blockchain solution. Therefore, the client cannot communicate directly

with the Blockchain solution themself; the Service Provider holds all the keys as an intermediary. If, in the long term, the client expands its business activities on the Blockchain solution and does not build Blockchain-related competencies, it depends on the Service Provider. Tönnissen and Teuteberg (2020) support this finding because in their analyzed sample, disintermediation did not occur. On the contrary, in one case in their sample, an intermediary was replaced with a new one. These findings lead to the following proposition:

Proposition 3: Blockchain adoption generates new intermediaries when Service Providers are engaged.

5.2.1.5 Discussion of the Interrelationships between the Approaches

If the approaches are considered from a general perspective, questions arise concerning which approach is suitable for which SME and what the right cooperation partners are for Blockchain projects. This dissertation only focuses on SMEs, which means approaches of large companies are not considered, because they can approach Blockchain technology in various ways with different opportunities. For example, due to resource restrictions, SMEs cannot afford to develop a Blockchain solution until deployment. Moreover, their market power and position in the supply chain do not offer the possibility to push a Blockchain solution into a supply chain – as Walmart did in 2018 (Corkery and Popper 2018).

SMEs do not need to choose only one approach toward Blockchain adoption. For example, if an SME needs to join a Blockchain solution of a larger supply chain partner as a Participant, the SME could, in parallel, set up a Blockchain solution as a Cooperator with other interested parties. This two-way approach would be a strategic decision to achieve a better connection to the industry partner. By contrast, the SME may set up a Blockchain solution to be independent in the future.

The mentioned approaches differ in terms of the depth of involvement of SMEs in Blockchain technology. Figure 5.6 on the next page illustrates the level of involvement depending on the type of company and its continuous

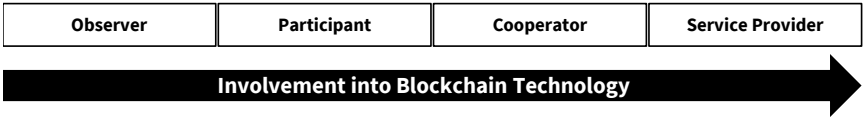

Figure 5.6: SMEs' Involvement in Blockchain Technology due to their Approach

Blockchain efforts. SMEs must not only weigh the advantages and disadvantages (i.e., perceived benefits and costs) but also consider the suitability of the approach for their company. An SME can only adopt a certain approach in the right situation and with the necessary competencies – where the market power in the supply chain and the SME's level of digital readiness may be the most important factors. An SME that has core competencies from logistics, manufacturing, or retail but no core IT competency and that does not provide IT solutions to other companies is most likely to become an Observer, Participant, or Cooperator. However, it would struggle to become a Service Provider because it lacks the experience and organizational setup to provide Blockchain-based software services. Conversely, an SME already providing software to other companies will most likely become a Service Provider or Cooperator. It could also become an Observer, which is a valid alternative if the project is not beneficial to the company's situation. However, such an SME would not take a Participant's approach because its role lies in providing Blockchain-based services to its (preexisting) customers. Figure 5.7 on the facing page illustrates the proposed decision opportunities.

Furthermore, finding partners willing to solve the same problem is a requirement for setting up a Blockchain solution. To solve large logistics and supply chain problems with Blockchain solutions, interviewees from companies mentioned ideas such as tracking emissions or using a paper-based bill of lading. These problems could result from shared processes or similar products/services affecting multiple companies. Finding the right collaboration partner is crucial for Blockchain projects since the

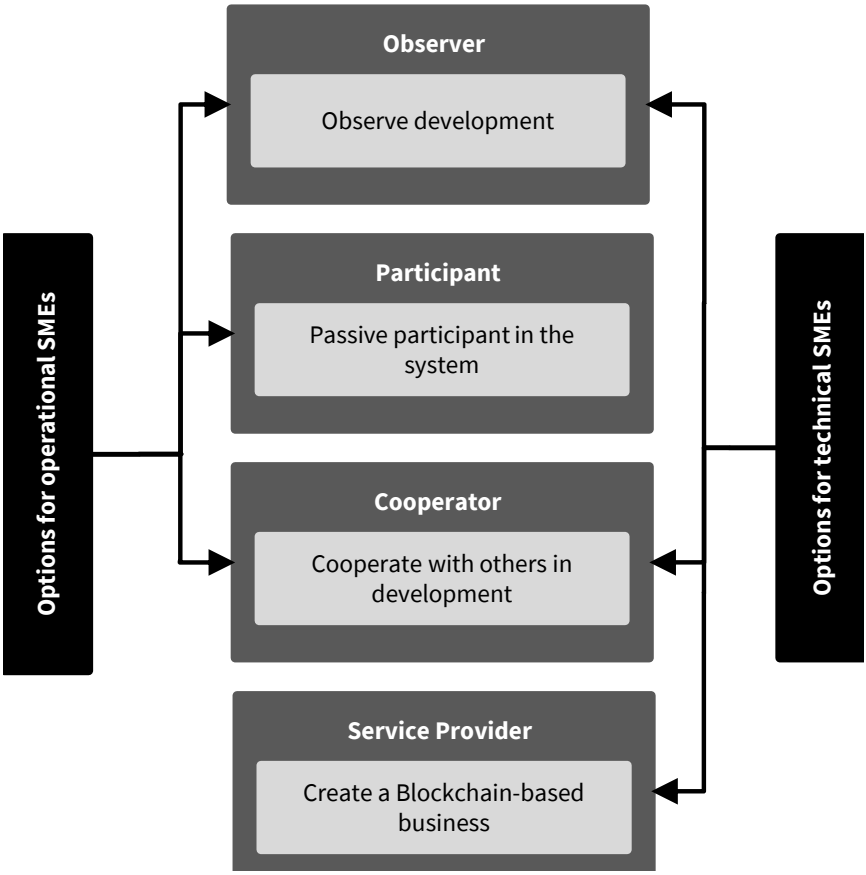

Figure 5.7: Options for SMEs to adopt Blockchain

sought-after network effect (discussed in Section 5.2.3.3 on page 139) requires many participants (Ilbiz and Durst 2019; Wang et al. 2019a; Koens et al. 2020). In the literature, SMEs tend to cooperate with competitors with resource similarity for collaborative R&D because it increases the economies of scale and ensures that the risks of project failure are shared (Gnyawali and Park 2009; Kultti et al. 2006). Additionally, resource similarity provides common ground and supports communication between collaborators (Gnyawali and Park 2009; Emden et al. 2006). Mowery et al. (1998) mention that SMEs in R&D alliances should involve companies with ex-ante technical knowledge and of similar size and scope. Therefore, Cooperators are advised to cooperate with other companies with similar resources and scope to avoid power imbalances. They should also integrate Service Providers of the same size and scope to avoid possible system alignments by the Service Providers. Finally, their ecosystem should be open to Participants and indecisive Observers to generate a network effect. Figure 5.8 on page 120 overviews all factors relevant to the approaches of SMEs.

5.2.1.6 Remarks on the Typology

Since almost all interview participants were familiar with Blockchain technology, their perspective on the approaches was not limited to the technical specifics of the Blockchain. Instead, they considered the market in which their company operates and their company strategy regarding Blockchain. The interviews revealed that the different approaches are fundamental for the companies because of their involvement in the technology. For example, if a company constantly follows an Observer approach and ignores the market situation (especially the activities of larger market participants or consortia), it is likely to assume a Participant's approach if necessary due to its missing Blockchain knowledge. The previously presented typology was crafted to discuss the mentioned influences on SMEs. In the literature, other typologies (or identified core categories) appear, focusing on different industries and observation levels (Della Valle and Oliver 2020; Kouhizadeh et al. 2020; Zheng et al. 2022). However, these studies do not focus on SMEs' approaches to Blockchain adoption. The current typology allows for investigation and comparison of different Blockchain approaches by

contextualizing them in relation to relevant company characteristics, motivations, and opportunities with the Blockchain technology and business models. Therefore, a company's considerations when choosing a Blockchain approach are presented in the Sections 5.2.2 to 5.2.5 on pages 119–150. The typology functions as a differentiator for the considerations because not all parameters are relevant for each approach.

5.2.2 Understanding the SMEs' Situation

During the interviews, the following four internal and external conditions were identified regarding the actual organizational situation and the associated difficulties in changing it when approaching Blockchain: (1) a lack of organizational readiness, (2) information systems between SMEs, (3) SMEs' data sharing behavior, and (4) their market power and position in the supply chain. The reasons for and consequences of these barriers are outlined in this section. Figure 5.9 on page 121 overviews the SMEs' situation.

5.2.2.1 Lack of Organizational Readiness

Before the SME-specific Blockchain potentials and barriers could be identified, the general situation of SMEs was discussed with each interviewee. Overall, all interviewees shared the mentioned lack of resources in different dimensions (i.e., time, technological resources, finance, or know-how). The lack of resources in SMEs has been broadly discussed in academic literature (see Section 3.4.3.1 on page 53). Even the lack of resources for SMEs' Blockchain adoption has been discussed sporadically (Bracci et al. 2021; Hashimy et al. 2021; Ilbiz and Durst 2019; Treiblmaier and Span 2022; Nandi et al. 2020; Wong et al. 2020a; Wang et al. 2019a; Clohessy and Acton 2019). Resource shortages are primarily caused by a lack of funds and capital, limited human resources, and limited technical resources (Kersten et al. 2018). Along with these fundamental resource barriers, Hashimy et al. (2021, 7ff.) mention infrastructure barriers such as outdated organizational and technical systems.

Involvement into Blockchain Technology	Approach Characteristics			Approach Implications		
	Goal	Motivation	Resources	Influence on the design	Risk of Project Failure	Organizational Complexity
Observer	Avoiding adopting Blockchain Technology	No motivation to get engaged with Blockchain	No resource requirements; They do not connect to a Blockchain solution	No influence, because Observer will not be integrated	Low risk on project level, but a high risk on being left behind on a larger level	Few learnings, only how to connect to a Blockchain
Participant	Better customer and partner connectivity	Intrinsically, by a desire to i.e. save costs; motivated externally by regulation or pressure	Few resources, only connecting their legacy system	Low influence, can't shape the existing system	Low risk, because Participants will only be integrated	Low complexity, has to set up a business relationship
Cooperator	Developing a cross-company/industry solution	Providing benefits for their company, generating visibility or evaluating the technology	Resource invest due to their core competency; Resource pooling between the Cooperators	High influence on the design of the Blockchain solution and the participants of a project	Medium risk, only the resources used are affected	High complexity, whereby it can also contradict the technology principle
Service Provider	Offering Blockchain-based services	Driven by their customers' motivation	Need a large technological competence; Maybe investing in pre-designed products	High influence on the design of the Blockchain solution, but low influence on the project participants	Low risk on project level, but existential on a larger level	Medium complexity, but a possible mismatch with technology

Figure 5.8: Characteristics and Implications of the SMEs' Blockchain Approaches

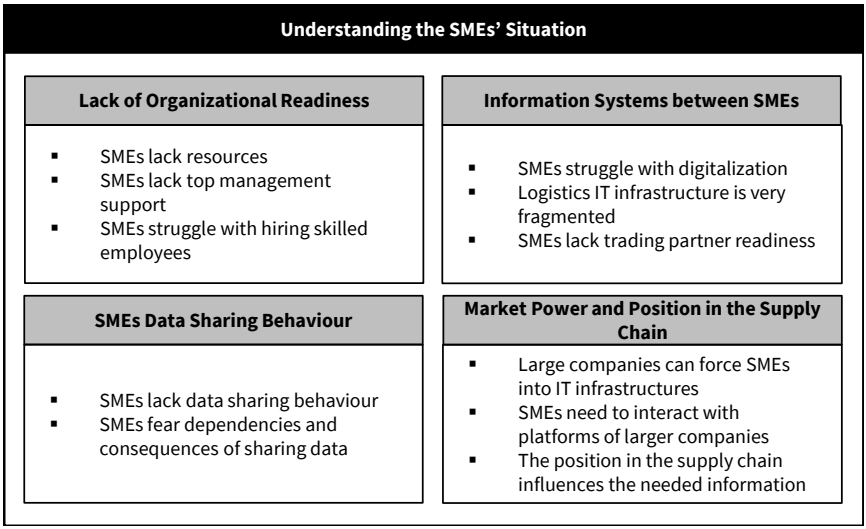

Figure 5.9: Overview of SMEs' Situation regarding Blockchain Adoption

For all interviewees, it was clear that SMEs' Blockchain adoption is hindered by their resource restrictions, especially concerning their know-how and ability to generate it in the Blockchain domain. While all interviewees were aware of Blockchain technology through the cryptocurrency Bitcoin, all interview partners reported a lack of time and know-how to identify relevant use cases of Blockchain in their domain. An interview partner suggested a prerequisite for joining a Blockchain project as a Cooperator,

> *This means that they have to create scope for themselves, from resources to finances, in order to tackle such projects. And then, of course, they need people who are not just caught up in day-to-day business.*
>
> *#15 Manufacturer*

Each possible approach requires different resources. While the resources required to take an Observer or Participant approach are quite low, the resources required to be a Cooperator or Service Provider are relatively high.

In addition to their awareness of resource restrictions, most interviewees are also aware of the lack of skilled employees. The literature supports that skilled employees are challenging for SMEs to find and keep (Thong 1999; Nieto and Santamaría 2010). One interviewee stated,

> *And I think that's the problem that a lot of medium-sized companies have, that the young people who have a clue don't get excited and because they also don't offer the environments. –*
>
> *#4 Logistics Service Provider*

Aside from the general problem of hiring skilled employees with Blockchain knowledge, another critical point is the hiring of a Blockchain developer. SMEs tend to hire generalists rather than specialists (Gable 1991) and are restricted due to their local business area (Julien 1996). Blockchain experts are highly specialized, handpicked employees. Setting up a Blockchain solution requires one or more Blockchain full-stack developers with experience, depending on the project size. The developer problem poses a challenge for an SME for two reasons: first, acquiring Blockchain developers is difficult, and second, these developers are much more expensive than developers from other IT areas:

> *[Blockchain Developers are] handpicked; well, they're handpicked for sure. So in as in many new techniques. And, as I said, think about whether three top developers are going to a medium-sized company or a start-up company, or whether they would rather start at a large corporation.*
>
> *#15 Manufacturer*

> *[Blockchain developers] are, in my experience, two or three times more expensive than a normal IT developer.*
>
> *#8 Blockchain Consulting Company*

Only Service Providers and Cooperators might need to hire a Blockchain developer due to their approaches toward Blockchain projects. For Service Providers, Blockchain developers are a key resource to offer Blockchain-based services. By contrast, not every Cooperator in a consortium needs a Blockchain developer since the consortium pools its resources. Furthermore, Observers and Participants need not hire a Blockchain developer

or employees with Blockchain knowledge since Observers do not adopt Blockchain technology, and Participants will be onboarded.

General technology adoption literature and even literature on Blockchain adoption among SMEs also emphasize top management support (Clohessy et al. 2019). Top management support is considered one of the most essential factors in adopting technology because, in most cases in SMEs, top management is represented by a single person (Thong et al. 1996; Blau et al. 1966). Data analysis shows the same considerations in the sample:

> *And you also have to have a visionary in the company who drives the whole thing forward. Otherwise, I think you're pretty much behind the times.*
>
> *#20 Logistics Service Provider*

> *For example, it makes a big difference whether you have someone at the top of the company or in management who is generally amenable to [Blockchain] technology or not*
>
> *#12 IT Solutions Provider*

Most interviewees involved in a Blockchain technology implementation or a Blockchain project always had top management as part of the project planning. Without top management's support, the implementation of Blockchain technology is hindered, especially in SMEs, as they usually have a single leader. In addition, especially in small companies, top management must also release resources for employee training or investments in infrastructure, as one interviewee described:

> *And what is also simply missing is the possibility to train the staff. We are doing that now, but everything is done in-house, under our own direction, and that costs an enormous amount of resources. And many companies don't have that. In our case, the happy coincidence is that we had a generation change six or seven years ago in the management. There are "younger people."*
>
> *#4 Logistics Service Provider*

These findings are in line with the existing literature that discusses organizational readiness with a focus on Blockchain-competent employees (Clohessy and Acton 2019; Hashimy et al. 2021) and with the literature on

general top management support (Rogers 2003; Dong et al. 2009; Thong et al. 1996).

5.2.2.2 Information Systems between SMEs

For most SMEs in an ecosystem, Blockchain holds enormous potential, for example fast payment processes or digital uptake (Wang et al. 2020). With Blockchain, companies could use the same data along the supply chain and work with it in real time. One expert explained,

> *The benefit from [the Blockchain] is when you really extend this to the entire supply chain later and thereby make processes leaner. It also makes them clearer and more transparent, both for us and for the customers.*
>
> *#R1 Ocean freight carrier*

All companies must be involved to achieve continuous digitalization within a supply chain. One major learning from the interviews is the insufficient digitalization between SMEs in logistics. The majority of interviewees mentioned that most SMEs are not digitalized enough to apply Blockchain solutions or even participate without help. A running, active Blockchain solution requires a minimum level of digitalization from the participating companies. However, actual communication between SMEs is still paper-based (e.g., fax) or occurs via phone or email, as the experts described:

> *But then we also have companies. These are individual truck entrepreneurs who may simply work independently. They either work with an Excel spreadsheet, where I would say, "Well, an Excel spreadsheet is not yet very advanced in terms of digitalization," or, as we have also heard, communication takes place partly via written notes. This is an example that I always like to use. Because you can see that in some cases there is no digitalization at all.*
>
> *#5 IT Solutions Provider*

> *As far as trucking companies or haulage firms are concerned, they are still a long way off. In some cases, faxes are still being sent, and the topic of digitization has arrived, assuming it has at all, but not yet Blockchain.*
>
> *#21 Logistics Service Provider*

> *And there is no connection between the information from our, let's say, factory and the way a logistics service provider works.*
>
> *#27 Manufacturer*

Even if SMEs gained, at minimum, a working information system (e.g., ERP or TMS), no current standard exists. The logistics market is fragmented, and every company uses its own system. Consequently, even the information flow between SMEs occurs based on different standards and communication paths. As the experts elaborated,

> *Logistics is very fragmented, and many companies have different transport management systems. Of course, there are some transport management systems that are also used by the masses and then perhaps also adapted, but the bottom line is that everyone has their own TMS.*
>
> *#H1 Logistics Service Provider*

> *[...] but if you look at our industry, everybody is doing his own way of working and collecting what he needs as information to calculate and analyze the way of working.*
>
> *#27 Manufacturer*

The experts emphasized that SMEs lack digitalization in logistics and even general supply chain management. Since Blockchain is a technology that works best under cross-company conditions (Wust and Gervais 2018; Koens et al. 2020; Koens and Poll 2018), the question arises as to how companies want to exchange information via a Blockchain if neither data is exchanged nor the necessary degree of digitization has been achieved. One expert stated,

> *So I could spend money on that, but I don't have anyone to network with because the rest of them haven't even gotten that far yet and figured out what it's all about.*
>
> *#4 Logistics Service Provider*

> *So, the companies have to learn to share and to have positive experiences with it. But if they don't have anything to share, because nothing is connectable. Yes, that is difficult.*
>
> *#9 Logistics Association*

Blockchain is a valuable approach to minimize costs in an ecosystem and help companies obtain the data they need at the right time. In the literature, supply chain disconnections and complexities are framed as drivers for the deployment of Blockchain technology (Wang et al. 2019b). The technology could reduce paperwork and "provide better information management across the entire supply chain" (Casino et al. 2019, p. 66).

From the perspective of a Cooperator willing to start a Blockchain project, trading partners are not ready to exchange data. According to Iacovou et al. (1995) and Chwelos et al. (2001), a trading partner's readiness must be considered for Electronic Data Interchange (EDI) adoption. Trading partner readiness refers to a company's readiness (i.e., possession of the necessary resources) and motivation to adopt EDI but an inability to adopt due to trading partners lack of readiness (Chwelos et al. 2001). The interview sample shows the same situation because SMEs are not ready to adopt Blockchain. Therefore, SMEs must consider that in a Blockchain solution, they would share data not just with one company but with a whole network of companies if the Blockchain solution is successfully deployed.

All companies must be included in the Blockchain network to achieve the mentioned benefits. An interview participant in a qualitative study investigating Blockchain adoption in Ireland mentioned that, "however, we are struggling to get our SME supply chain partners to implement our flagship Blockchain authentication service which can result in performance management, supply chain traceability, counterfeit, cyber and customer engagement benefits" (Clohessy and Acton 2019, p. 1478). The quote supports the problem of involving SMEs in a Blockchain network, namely their organizational readiness – especially at the point of digitalization (ibid.).

This involvement is primarily a problem when integrating an SME as a Cooperator instead of a Participant. Integrating an SME as a Cooperator requires hosting an own node and actively shaping the system. By contrast, integrating an SME as a Participant requires only a connection to the Blockchain solution without actively shaping the system.

The general state of digitalization of companies is broadly discussed in the literature (Kersten et al. 2017b; von See et al. 2021; Kersten and Koch 2010). To benefit from new technologies, companies must experiment with them and rethink their actual business processes. A key challenge in introducing new technologies is the incompatibility of existing information systems and interfaces (Kersten et al. 2017b). Even if an SME is highly digitalized and possesses the necessary knowledge to use a Blockchain network efficiently, it needs partners with a similar level of digitalization. Based on the findings from data analysis and literature, the following proposition emerges:

Proposition 4: The higher the readiness of trading partners is, the more likely SMEs are to take the Cooperator approach.

5.2.2.3 SMEs' Data Sharing Behavior

A primary fact for Blockchain is that SMEs must consider their willingness to share data with supply chain partners. Data must be exchanged somehow to achieve the vision of real-time data exchange within a Blockchain solution (Tönnissen and Teuteberg 2020). As described in the previous section, most SMEs work with stand-alone solutions and classic methods of communication (e.g., fax, mail, or telephone) or do not share data. Moreover, SMEs are unsure about the benefits of sharing data with other companies. On the one hand, SMEs lack knowledge about what they can do with the exchanged data, as one expert described,

> *The difficulty is that SMEs in the user community have not actually sufficiently gotten to the heart of the issue of added value from data, business models, and value-added services from data that they are clear even for themselves, what advantage can I derive from this?*
>
> *#H3 Logistics Association*

On the other hand, SMEs do not want to share any data with other companies. Either these companies do not want to cause any dependencies, or their IT systems are ancient and cannot handle any data exchange. One interviewee described their situation as follows:

> *We would like to network, we would like to provide our customers with an interface and say, "Please don't send us any more orders by PDF, but use an interface and just push it into our worklist." So, you can just do that. EDI interfaces or whatever. That's not state of the art; it's been around for at least 20 years. And then we hear from our customers, and it doesn't make any difference whether it's a small company or a large corporation: "We can't do that."*
>
> *#4 Logistics Service Provider*

Companies could use the data to integrate steady partners or customers into their system, but they could also harm the sharing entity. Thus, they share data with some companies and hide it from others. Sharing or not sharing data is therefore an important strategic decision (Paulraj et al. 2006). This topic has received attention in previous information systems research (Bélanger and Crossler 2011) and is on the future Blockchain research agenda (Kim and Laskowski 2018; Lindman et al. 2017; Rossi et al. 2019).

Since the top management in SMEs mostly comprises one person who makes important decisions (Thong et al. 1996), these SMEs must consider their data sharing behavior. One participant reported,

> *And I think that is the only way for SMEs to remain competitive in the future. That they straighten out their data structure and that they share this data more willingly with others.*
>
> *#9 Logistics Association*

This data sharing topic is most important for Participants and Cooperators because they might benefit from using Blockchain. Participants would need to arrange their internal data structure and prepare to connect to a new interface, and Cooperators would need to prepare to negotiate any data shared with the entire consortium. Moreover, Service Providers would organize the data sharing for participating Participants and Cooperators but not share their own data. Observers would also not need to share any data, but preparation is still advisable. Based on the current statements (see also the previous section) and the aggregated data analysis, the following proposition emerges:

Proposition 5: The lack of data sharing between SMEs in logistics could result in Blockchain solutions not being considered in a valuable way.

5.2.2.4 Market Power and Position in the Supply Chain

Aside from SMEs' information systems and data sharing behavior, their market power and position in the supply chain emerged from the interviews as two essential factors for Blockchain adoption. Two points are relevant for Blockchain adoption by SMEs: their market power (Kano 2018) their position in the supply chain (Bowersox et al. 2010). Due to the actual situation of SMEs (see Section 2.1 on page 5), they often rely on jobs from large companies. One interview participant elaborated,

> *If the very smallest wants to participate with the big ones, he has to meet certain basic requirements. But they don't really have the money, time, or know-how to play along.*
>
> *#3 IT Solutions Provider*

According to Gölgeci et al. (2018), conformity to these requirements of a partner is submissive behavior. Submissive behaviors are actions that are adaptive, accommodating, and conforming to the requirements of a business partner. If a company (only an SME in this context) realizes it is more dependent to their supply chain partner and/or has no market power in their industry, it is likely to behave submissively in response to a partner's demands (Caniëls and Gelderman 2007). As an interview partner explained,

> *Now speaking in the role of the trucker – if you don't just want to drive as a simple subcontractor for larger truck companies, but you really want to hold your own on the market as a truck company, then you have to play along nowadays. [...] And "playing along" means getting the data at least in electronic form. That's the minimum. [...] And if you want to get orders from MSC, for example, then you have to use their platform.*
>
> *#3 IT Solutions Provider*

The more adaptable a company is to a partner's resource requirements (Lu et al. 2010), the more willing it is to adopt submissive behavior. This behavior may be part of the submissive partner's relationship development strategy (Gölgeci et al. 2018).

However, according to Malagueño et al. (2019), "it cannot be assumed that large buyers will treat smaller suppliers fairly, given the existence of market power." Many respondents mentioned that large companies force smaller companies to use their platforms or other infrastructures if the smaller companies want to work with them. Interviewees described this power imbalance as follows:

> *"Either you use this exact technology or we can't make you a reasonable offer." So it already comes down to size and market power.*
>
> *#13 Manufacturer*

> *Exploiting market power makes every big [company], with or without Blockchain.*
>
> *#11 IT Solutions Provider*

With this in mind, SMEs may willingly or resentfully become Participants in the IT infrastructures of supply chain partners. Conversely, SMEs may also engage in dominance behavior. In this case, an SME "expects its partner to comply, often with an expressed or implicit implication that failure to comply will have adverse consequences" (Gölgeci et al. 2018, p. 281). However, medium-sized companies are more likely to adopt this dominant behavior than small and micro-companies.

Aside from market power, an SMEs position in a supply is also relevant for Blockchain adoption. With different positions in the supply chain, companies tend to need different information. Based on the different information, other use cases might be interesting for the company in question. Use cases for Blockchain are broadly discussed in the literature (Hackius and Petersen 2017; Yang 2019; Dujak and Sajter 2019; Wamba and Queiroz 2020). For example, in the provenance use case (Thume et al. 2021; Bumblauskas et al. 2020), information is needed about the origin of a product, and for the integration of Internet of Things (IoT) devices (Da Xu et al. 2018; Christidis and Devetsikiotis 2016), information is needed from single processes. An interviewee stated,

> *So, it's, if we look at my position on the supply chain, if I'm an end user, right? Generally, I want to know more about my supply chain. [...] So, if you're downstream, you care about asking, what's coming from the upstream maybe.*
>
> *#25 IT Solutions Provider*

As discussed in this section, small companies or companies that must comply with partner requirements may be forced into IT infrastructures[7]. In an ideal Blockchain network, the participants must typically be part of the infrastructure in a Blockchain solution. If a company needs to access an infrastructure to comply, it might need to accept the conditions of the infrastructure. The topic of how SMEs could link themselves to a Blockchain network is explored in depth in Section 5.2.4.1 on page 145.

Overall, the analysis suggests that SMEs must be aware of their possibilities and supply chain partners, which might force them into the partners' infrastructures. An SME's use case and approach results depend on its

7 Of course this finding is of limited validity. SMEs would not speak (public) about joining an infrastructure because they were forced to do it.

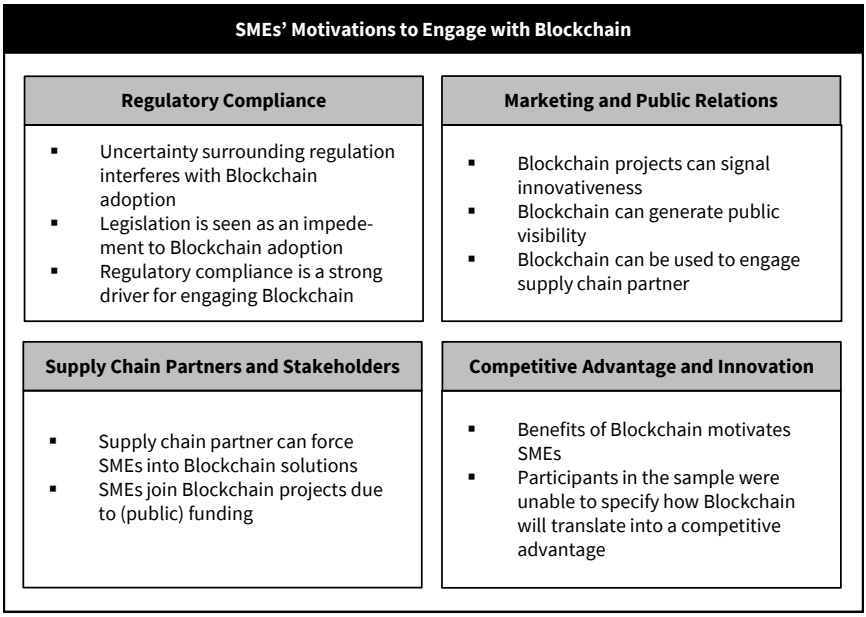

Figure 5.10: SMEs' Motivations to Engage with Blockchain

market power. Based on the empirical findings, the following proposition for further research emerges:

Proposition 6: The distribution of market power across the supply chain influences the specific Blockchain use case and approach for SMEs.

5.2.3 SMEs' Motivations to Engage with Blockchain

All participants were asked to discuss the motivation for their company to engage with Blockchain. The data revealed four major motivations for SMEs to adopt Blockchain. The motivations and the key findings from this section are summarized in Figure 5.10.

5.2.3.1 Regulatory Compliance

Compliance with regulations was identified as a motivation to adopt Blockchain in supply chain management. Many activities in the Blockchain sector are driven by legislation (e.g., the provenance of goods and the measurement of emissions) that is common law or will be enacted in the future. As elaborated in the literature review, regulatory compliance is regarded as an environmental consideration in the TOE framework (Saberi et al. 2019; Clohessy et al. 2020; Wang et al. 2019b). According to Wang et al. (2019b), "Blockchain-enabled global supply chains operate in a complex environment that requires various parties to comply with diverse laws, regulations, and institutions." In addition to the currently applied regulation, which already leads to uncertainties in adopting the Blockchain, announced regulations notably complicate the situation.

All interviewees voiced concerns about the consistency and international harmonization of legislation and regulation in the current development of Blockchain solutions. In this context, uncertainty in the development process emerged, as one interviewee described:

> *"There is still a relatively high degree of uncertainty about what you are really allowed to do, or where you are really allowed to do it, and what the laws will really look like at the end of the day."*
>
> *#16 Logistics Service Provider*

Furthermore, the experts, especially from SMEs, wondered how they should deal with differences in technical and legal boundary conditions. To set up a Blockchain solution, local and international laws, data sharing regulations, intellectual property, liability, and general commercial agreements must be examined carefully (ibid.). For example, the decentral aspect of a Blockchain raises legal questions, as an interviewee explained,

> *In data protection law, we need authorization criteria for each individual data processing operation. You have to ask yourself the question, "Does data protection law even contain a permissive act for the distribution of my personal data in such an entire network to people with whom I actually have no connection other than via this Blockchain?"*
>
> *#2 University*

In the literature, regulatory compliance is broadly discussed regarding cryptocurrencies (Kher et al. 2021; Sandner and Gross 2022; Ferreira and Sandner 2021; Schubert et al. 2021). Even in supply chain management, regulatory compliance is discussed, primarily focusing on international operating supply chains. Therefore, companies must be aware of different regulations in different countries (Wang et al. 2019b; Lu and Xu 2017; Atzori 2017). All participants agreed on the uncertain situation of legislation concerning Blockchain adoption. Even in the interview cases, legal concerns had arisen, especially with regard to the General Data Protection Regulation (GDPR) and privacy implications (Twenhöven et al. 2020).

In addition to the current applied legislation, regulations announced for the future must also be considered. Future regulations such as the German Supply Chain Act (BMZ 2022) or the European Green Deal (BMWi 2021) will force companies to work on regulatory compliance. Upcoming regulations have the potential to promote or hinder the adoption of new technology, depending on their design. According to the experts, upcoming regulations might be realizable with Blockchain technology, but there will be no specific regulation for the technology itself. Some future regulations may require a verifiable record, which companies will have to provide to comply with these regulations. An example is the conflict material regulation (European Union 2017):

> *And so when a conflict material regulation comes into force in January 2021 in Europe, small and medium importers will need due diligence information included in the material they receive.*
>
> *#7 Blockchain Protocol Provider*

> *We have discussed it [Blockchain] again in a topic about conflict raw materials, because there will be some legal changes in the next few years.*
>
> *#10 Waste Management*

With the help of Blockchain technology, companies could make their data verifiable for regulators and other entities. Especially regulations with a focus on traceability or data storage are interesting for Blockchain adoption, as one participant stated:

> *Now many processes are being digitalized, but you also have to make this data, which is now digital and no longer on paper, verifiable. [...] Or also when you say that the data should be verifiable, that the third person then comes back and wants to verify data there.*
>
> *#21 IT Solutions Provider*

To achieve regulatory compliance, large companies have started to set up Blockchain projects. Neither the interviews nor the quantitative exploratory preliminary study indicated that SMEs participate in a Blockchain project for regulatory reasons. In the industry market, only diverse Blockchain projects of large companies have begun to accomplish regulatory compliance, for example the prominent Walmart case. To achieve this compliance and traceability of lettuce specifically, Walmart implemented a Blockchain solution with IBM (Corkery and Popper 2018; Popper and Lohr 2017; Tan et al. 2018; Bhattacharyya 2022). Aside from Walmart, many other companies have adopted Blockchain for traceability, as indicated by an interviewee:

> *There is a regulatory effect that they have to show off their sustainability data in Canada in a few years. So, they thought, "Ok, we have to prove that we really have only this sustainability data and not higher value or something like this." They started a project where they save the sustainability data on the Blockchain, and now they are developing a project in this case.*
>
> *#24 Logistics Association*

As Blockchain solutions for entire supply chains span multiple countries and continents internationally, the various local jurisdictions must also be considered. Only a few countries plan to implement any law on Blockchain; most of the planned legislation is found in the finance sector. Even fewer countries have plans to work on the reliability of smart contracts (which are necessary for a working Blockchain solution) and their effects on cross-border trading (Low and Mik 2020). Based on the current findings from the data analysis, the following proposition for further research emerges:

Proposition 7: Governmental regulation is a stronger motivation to engage in Blockchain technology for large companies than for SMEs. However, the uncertainty surrounding regulation and its long lead times are perceived as impediments to successful Blockchain projects.

5.2.3.2 Marketing and Public Relations

Marketing and public relations were identified as another motivation to engage with Blockchain technology. All experts noted the considerable potential and estimated benefits of a Blockchain. Based on these perceived benefits, companies consider adopting this technology, even without a working use case. An expert explained,

> *And I think what we've seen in the last few years is a lot of hype, a lot of enthusiasm for the technology, but not necessarily always a connection to the business or to, "Does the solution really make that much more sense now?"*
>
> *#17 IT Solutions Provider*

The interest in marketing with Blockchain may stem from the public relations strategy of large companies, such as Walmart with FoodTrust, A. P. Møller-Mærsk with TradeLens, and most companies on the Forbes Blockchain 50 list (Paz 2022)[8]. On the Forbes Blockchain 50 list, the finance sector

8 According to Paz (2022) the Forbes Blockchain 50 is a list of companies which are worth of one billion-dollar by sales or market value through the Blockchain technology.

accounts for the largest category, followed by the technology (hardware, software, and the internet), supply chain, manufacturing, and healthcare sectors (ibid.). Through the public relations of these companies and various media articles about optimizing their supply chains with Blockchain technology, an innovative and accepted image of these companies is portrayed to the market. However, this type of attention might also be helpful for SMEs, as one participant stated,

> *I think their [SME manufacturer's] decision was predicated on, "We need to prove where this comes from, Blockchain seems to be the way to do that, that the market accepts that everyone is talking about. So, we want to do what the market is talking about."*
>
> *#25 Blockchain Protocol Provider*

Joining a public Blockchain project as a Cooperator is another way in which to work on their public relations. Interview participants mentioned that the topic of Blockchain and the fear of missing out on potential benefits are motivations to join a Blockchain project. Moreover, they stated that public relations and funding are other strong motivations to join Blockchain projects:

> *On the one hand, you have just the topic that interests you, the Blockchain topic, where we don't want to be behind. Of course, you then also have a bit of attention, public relations work, perhaps with it. I would say that all of these projects are already publicity generating.*
>
> *#H1 Logistics Service Provider*

> *In terms of motivation, there's a bit of prestige there, but as a mittelstand company, I think that they're looking to get a higher visibility as a company. What, you know, at the beginning, one of the reasons they wanted to work with us was because we were able to get on TV.*
>
> *#25 Blockchain Protocol Provider*

The analysis revealed that within SMEs, efforts toward Blockchain adoption are driven by a "fear of missing out" and public relations. By participating

in Blockchain projects or publicly accessing them, SMEs send a message to potential customers and partners. Rejeb et al. (2020) mentioned that Blockchain could empower digital marketing security and enable creative loyalty programs. According to Treiblmaier and Span (2022), Blockchain could help companies to target specific customer segments (e.g., customers with special privacy concerns). Aside from the mentioned participation as a Cooperator, interviewees in the sample also mentioned SMEs joining a Blockchain solution as a Participant. In doing so, SMEs could offer their customers additional information about their products and provide insights into their supply chain to signal responsibility.

To the best of the author's knowledge, the issue of "marketing and prestige" has not been discussed in the Blockchain SME literature. If this finding can be replicated across a larger sample, an explanation for this phenomenon would provide an opportunity for further research:

Proposition 8:	Generating public visibility is a strong motivation for Cooperators to adopt Blockchain. Blockchain projects address a variety of different stakeholders.

5.2.3.3 Supply Chain Partners and Stakeholders

Supply chain partners and stakeholders were identified as further sources of motivation for SMEs to engage with Blockchain technology. This motivation is strongly connected to all other motivations, especially SMEs' "market power and position in the supply chain" from Section 5.2.2.4 on page 129. All interviewees revealed that Blockchain would not work without their respective supply chain partners. The question emerges, how do supply chain partners of SMEs motivate them to adopt Blockchain technology? One expert summarized the possible paths:

> *The first is that the big ones either push it through [...] The second is that there will be ways in which a sufficient amount of power is grouped together outside the big ones, gladly also with the big ones. [...] And they do something together. Of course, that's super hard to do.*
>
> *#6 Logistics Consulting Company*

Both mentioned paths are in accordance with the literature in the literature review (see Chapter 3 on page 31). The majority of the interview participants mentioned the first described path of "big ones push it through."[9] A few experts critically noted this path:

> *One of our customers works for [a global corporation], and they've come up with something. So they also say themselves, "We had to do a project."*
>
> *#19 IT Solutions Provider*

> *If you want to play with Maersk, then you must at least show willingness: "Yes, I can give you the data in 'TradeLens.'" These are certain basic requirements.*
>
> *#3 IT Solutions Provider*

9 Of note, mostly it is difficult to find direct companies which are forced into a Blockchain system. IT Service Provider are a good source to discuss the situation of companies that need to comply with supply chain partners requirements. Companies that complied to such system would not speak in public or do marketing with their delicate, possibly involuntary situation.

> *So, in the conversations that we have, actually the reasons why midstream people talk to us are either because they have to, because the OEM, or a supply chain partner, has said, "Watch that and you have to do that. And this is [a service provider], and you talk to them please."*
>
> *#24 IT Solutions Provider*

In short, large companies are pivotal in setting up Blockchain solutions and forcing supply chain partners to be Participants in these infrastructures. This approach creates a Blockchain solution where the large company widens the information disparity between itself and the joining company. Based on these findings, the following proposition emerges:

Proposition 9: Participants are (often) forced into Blockchain projects by large supply chain partners.

The second mentioned path is the possibility of adopting Blockchain to set up a consortium as a Cooperator. Depending on the interview partner and their connection to Blockchain, different opinions appear on cooperation in Blockchain projects. In the literature, Blockchain projects are discussed sporadically. In this vein, the general topic of governance (Lumineau et al. 2020; Beck et al. 2018; Filippi and Loveluck 2016) and technological factors for projects (Scully and Hobig 2019; Schmidt and Wagner 2019) are discussed in the literature. Several studies focus on practitioner data, but literature on general Blockchain projects with empirical data is scarce, and studies focusing on SMEs are mostly nonexistent. Some focus on categorizing start-ups (Blossey et al. 2019; Poszler et al. 2019), some on literature reviews of practitioner projects (Gonczol et al. 2020; Batta et al. 2021), and some on multi-case study research (Kshetri 2018; Tönnissen and Teuteberg 2020).

A high level of uncertainty was encountered among the interviewees on how SMEs group together as Cooperators to build a Blockchain solution themselves. The majority of interviewees agreed that prime opportunities exist for SMEs to build their solutions – the barriers notwithstanding – but only a few SMEs are currently exploiting these opportunities:

> *Yes, although we have observed that very few small and medium-sized companies do it on their own. [...]. But you always need fellows or friends who want to do the same thing with you in a similar way at the same time.*
>
> *#11 IT Solutions Provider*

> *Such own chains, for example, that several medium-sized companies join forces [...] and then implement their own Blockchain? Maybe that's still a bit early? Or isn't it? It's hard to imagine at the moment, at least for the customers we deal with.*
>
> *#19 IT Solutions Provider*

However, SMEs cooperate in Blockchain projects that are currently publicly funded. The experts also stated that participation in a Blockchain was strongly driven by – aside from the public relations focus – public funding and stakeholders' requests. Due to the resource restrictions of SMEs and their possibility of gaining knowledge from external projects (Dickson et al. 2006; Hagedoorn 2002; Nooteboom 1994), the companies joined Blockchain projects. The participants elaborated,

> *When a project like this became viable, we were actually asked whether we would be interested in throwing our hat into the rain. So it was a good fit for us, precisely because we were able to create another position.*
>
> *#H2 Logistics Service Provider*

> *You get a grant for it. The money is not out of the question, either, so I think that if there were no funding, many companies would not be as willing to invest the time in it – as they have done.*
>
> *#H1 Logistics Service Provider*

These statements align with much of the literature on the differences between SMEs and large companies (see Section 3.4.3.1 on page 53). However, the interviewees mentioned that without public funding, their ability to experiment with this technology would not be possible. The possibility of joining a research project is in line with the work of Tomlinson and Fai (2013) who state that external (state) funding positively impacts the

nurturing and establishment of SME innovation networks. Huggins et al. (2012) find that SME innovation performance is significantly and positively related to network funding, depending on the region. Based on these findings, the following relationship is proposed:

Proposition 10: Public funding strongly motivates Cooperators to engage in Blockchain technology.

5.2.3.4 Competitive Advantage and Innovation

The motivation to establish an innovation or competitive advantage through Blockchain adoption is connected to the other motivations that emerged from the data, especially the motivation in Section 5.2.2.3 on page 127: supply chain partners and stakeholders. Interviewees repeatedly reported that their efforts to build a Blockchain solution could strengthen their competitive position in two ways: first, against other SMEs on the market and, second, possibly against solutions of industry giants. The interview participants noted,

> *The motivation for users, for logistics SMEs in particular, was, of course, first and foremost to get to grips with the technology, because they noticed big players on the market are dealing with it and developing solutions. They wanted to develop their own understanding so that they would be able to use it when they were confronted with it and perhaps have an advantage over other SMEs.*
>
> *#H3 Logistics Association*

> *The motive [...] was ultimately the question, "How do you survive on the market as a medium-sized company?" What options do medium-sized companies have to hold their own against industry giants? To offer a service on the market that can ultimately somehow compete with industry giants.*
>
> *#H2 Logistics Service Provider*

To reach a competitive advantage over other companies, the interview participants mentioned the potential of an active, working Blockchain solution, through which SMEs could achieve better transparency, automated processes, or improved quality of incoming data. A project participant explained,

> *The second issue, of course, the pain point of manual processing of orders, manual processing of everything that comes in in emails and phone. The wish for systems [...] that provide you with a higher degree of automation and that also give you greater visibility in the supply chain. –*
>
> *#H3 Logistics Association*

The potentials of Blockchain have been well described in literature, and clear value propositions have been identified (Poszler et al. 2019; Tönnissen and Teuteberg 2020; Morkunas et al. 2019; Kifokeris and Koch 2020; Dobrovnik et al. 2018; Tiscini et al. 2020; Park and Sung 2020; Wang et al. 2020). According to Wang et al. (2020, p. 1468), "Blockchain should be deployed in areas where it adds value to ALL its supply chain ecosystem actors, and its value proposition needs to be clearly articulated" – these actors include SMEs. Since every participating company uses the same infrastructure on a Blockchain solution, a real competitive advantage would not be afforded to the other participating companies but to SMEs outside of their solution.

The finding regarding a competitive advantage against other companies is in line with the literature on co-opetition and technological innovation in SME inter-firm collaborations (Gnyawali and Park 2009; Luo 2007; Morris et al. 2007; Gnyawali et al. 2006). Co-opetition relies on two central elements: creating value and capturing value (Gnyawali and Park 2009), where creating value is inherently cooperative, and capturing value is inherently competitive (Luo 2005). The same situation is observed when Cooperators set up a Blockchain solution: Cooperators pool their resources for a collective benefit, but it is unclear whether single companies would gain a competitive advantage, as all firms attain the same benefits (if the network was set up a fairly way). In addition, the finding of competitive advantage against a stronger player is also in line with the literature (Gnyawali and Park 2009). Gnyawali and Park (ibid., p. 321) stated that "To confront large dominant firms, vulnerable SMEs may join hands with each other and try

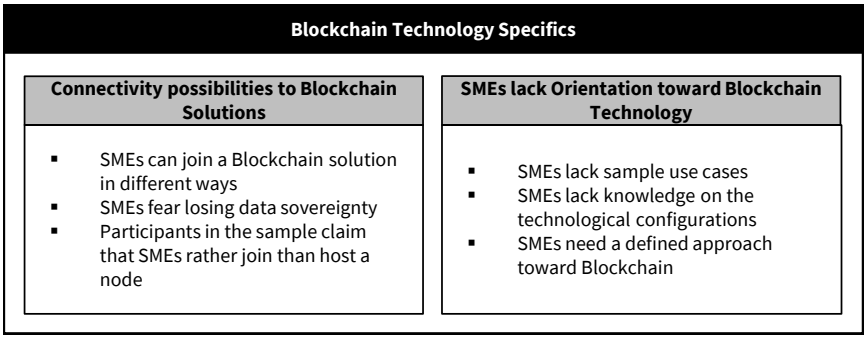

Figure 5.11: Blockchain Technology Specifics for SMEs Blockchain Adoption

to develop collective capability by pooling their resources and expertise." Based on these findings, the following relationship is proposed:

Proposition 11: Cooperators believe that Blockchain projects will strengthen their competitive position even though they are not able to specify how this will occur.

5.2.4 Blockchain Technology Specifics

Certain specifics of Blockchain technology influence its adoption by SMEs. During the interviews, two important specifics were identified: two possibilities for SMEs to connect to Blockchain solutions. With both possibilities, different privacy concerns emerge. Moreover, SMEs lack an orientation toward Blockchain technology, especially with respect to its usability in practice. Figure 5.11 overviews the mentioned specifics, which are then elaborated in subsequent subsections.

5.2.4.1 Connectivity possibilities to Blockchain Solutions

The following quote from an interviewee summarizes the situation regarding Blockchain-based transparency well:

> *"Transparency is a business model; so is intransparency."*
>
> *#11 IT Solutions Provider*

One of the core characteristics of Blockchain is immutability, which means data is saved in the Blockchain without any chance for one to manipulate it (Swan 2015). All data tracked on the Blockchain is available to anyone with access. As elaborated in Section 5.2.2.2 on page 124, sharing data is a prerequisite for achieving the potential of Blockchain. Every entity in the supply chain connected to the Blockchain could hence analyze the data. If and how much of the data can be seen by the individual companies depends on the configuration of the Blockchain network and the connection. From the perspective of an SME, two different paths exist to connect to a Blockchain solution.

The first path to participate as a Cooperator in a Blockchain network involves hosting an own node connected to all other nodes in the network (Pilkington 2016; Swan 2015). However, hosting an own node is difficult for SMEs due to their resource restrictions. If companies host their node, they can directly communicate with the other nodes in the system, which also generates transparency:

> *You can talk directly with your business partners and exchange data in a relatively transparent manner. Of course, some people have noticed that transparency is not necessarily what other companies want to have.*
>
> *#5 IT Solutions Provider*

Depending on the data exchanged on the Blockchain, participating entities could analyze the whole ledger and generate knowledge beyond the intended business case. As elaborated in Section 5.2.2.3 on page 127, SMEs have reservations about sharing data. Data analysis revealed that SMEs fear losing control, as one interview participant stated,

> *Small and medium-sized companies have reservations about sharing any data with a technology that I [SMEs] didn't write myself [themselves] or don't really understand, the fear of losing control. Do I [SMEs] then give data to my [their] competitors? Even metadata – who delivers to whom? – is already interesting for many.*
>
> *#11 IT Solutions Provider*

The second possible path is to use an EDI or a web frontend to connect to the Blockchain solution as a Participant (Samaniego et al. 2016; Wang et al. 2020). With this EDI or frontend, SMEs could interact with the Blockchain solution without hosting their own node. However, they would not be able to interact with the Blockchain themselves; they would need to use the EDI or web frontend. Possible cases involve connecting either to the network of a consortium (via the node of a Participant) or to the network of a single company, for example a global company. Participants explained,

> *However, there is always the option of accessing a web frontend. And then, in the final stage of expansion, via any node of any partner. [...] Of course, you have to trust the node operator whose web frontend you are using to a certain extent that it will pass on the data correctly.*
>
> *#5 IT Solutions Provider*

> *The global company would then provide an implemented solution. In the corporate and supply chain area, SMEs play the same role as an end user in the consumer tech area. They have their interface and do what they need to do.*
>
> *#21 IT Solutions Provider*

Similarly to the first path, in the second path, Participants are concerned about inputting data into a Blockchain solution. Data analysis revealed that Participants fear the loss of their data sovereignty and disclosure of their supplier relationships. In addition to privacy concerns, interviewees also clearly stated that SMEs would rather join a Blockchain solution as a Participant than host a node themselves as a Cooperator:

> *The web application behind it [the Blockchain solution] is actually rather more interesting for the smaller companies than really a separate node.*
>
> *#16 Logistics Service Provider*

The general discussion about privacy in the design of Blockchain solutions in supply chain management is ongoing (Toyoda et al. 2017; Hastig and Sodhi 2020). Most of the work on solving privacy issues relates and is limited to the area of cryptocurrencies (Gonczol et al. 2020), while the privacy issue is still open in the field of supply chain management (Dujak and Sajter 2019; Hackius et al. 2019; Behnke and Janssen 2020; Kouhizadeh et al. 2021). Therefore, through the lens of SMEs and their connectivity possibilities, privacy issues must be discussed in two ways.

First, if a Cooperator hosts its own node in a Blockchain solution (without considering resource restrictions), the Cooperator could interact with all companies in the network directly. Their data would consequently be distributed through the whole network and transparent to everyone if no privacy concept is implemented (Hackius et al. 2019; Dujak and Sajter 2019). If SMEs develop an innovation together in co-opetition, then they must face the challenge of transparency with their partners (Gnyawali and Park 2009; Alvarez and Barney 2001). However, in a Blockchain solution, transparency becomes a permanent instead of a temporary state during the development phase. Based on the current statements and literature, the following relationship is proposed:

Proposition 12: The fear of a loss of data sovereignty and the disclosure of relationships hinders Cooperators from joining Blockchain projects.

Second, if SMEs join a Blockchain solution as a Participant via an EDI or interface, they input their data into an immutable data structure. This connection possibility benefits SMEs because they do not need to host a Blockchain node on their own, and the entry hurdle is significantly reduced (Wang et al. 2019a; Wang et al. 2020). However, SMEs are wary about sharing their data due to the possibility of losing their data sovereignty. This uncertainty is also inherent in other technologies that SMEs adopt, such as

cloud computing (Alshamaila et al. 2013) and e-commerce (Harland et al. 2007), and it primarily concerns "how the data is handled" and "where it is stored." The same questions arise with Blockchain technology regarding where the nodes are positioned. Moreover, Participants must input their data via a gateway into the Blockchain solution and cannot interact with the Blockchain directly. Since Participants must likely insert their data through the node (via an app, API, or web interface) of a node-hosting partner, they must trust the gatekeeper to transfer the data correctly. In summary, Participant SMEs cannot directly access the Blockchain's data; they must use the gateway of a consortium member. Based on these findings, the following proposition is established:

Proposition 13: Blockchain solutions can be negatively influenced by the power cocentration of single gatekeepers.

5.2.4.2 SMEs lack Orientation toward Blockchain Technology

The second Blockchain-specific consideration that emerged from the interviews is the SMEs' lack of orientation toward Blockchain adoption. The experts mentioned a lack of Blockchain success stories in the field of supply chain management. One interviewee stated,

> *They all talk about it [Blockchain], but I never have seen a Blockchain in a company, that is working.*
>
> *#27 Manufacturer*

A broad range of use cases are defined in the literature (Casino et al. 2019; Gurtu and Johny 2019; Queiroz et al. 2019), mostly for incumbents or whole supply chains, as elaborated in Chapter 3 on page 31. The discussions with the experts revealed that only a few reports contain enough detail to be helpful. Often, only success stories of large global companies are publicly available, whereas SMEs have difficulty finding the right use case, according to the experts:

> *So I would really need to have an idea on what application area this can be related to or where you can integrate this.*
>
> *#20 Logistics Service Provider*

> *Yes difficult, at the moment we are still lacking a bit of an approach where this really makes sense for our customers.*
>
> *#19 IT Service Provider*

> *To make the use case clear [for SMEs]. The benefit for the company using it. In my view, that is always the challenge.*
>
> *#28 Manufacturer*

On the one hand, SMEs lack use cases, and, on the other hand, little information is available on practical projects and their benefits. This situation makes it challenging for SMEs to identify their company's benefits and approaches toward Blockchain technology. Moreover, some interview participants had difficulty understanding what the different Blockchain configurations mean. For IT solutions providers or Blockchain protocol providers, the situation was clear for logistics, manufacturing, or retail companies, whereas uncertainty was high regarding how to approach a Blockchain solution. Most participants echoed the following statements:

> *This [Blockchain connection] would be done externally. So you would look for a service provider.*
>
> *#20 Logistics Service Provider*

> *With new technologies, I usually get advice from people or external people who already know how to use them, who already have use cases and have already implemented such projects. [...] Because most of the time you don't have the skillset or the use cases or the experience to know if something like this makes sense.*
>
> *#15 Manufacturer*

The literature refers to the lack of orientation in two ways. First, the literature mentions a lack of empirical contributions to overall perceptions and general approaches toward Blockchain in the logistics and supply chain management sector (Wang et al. 2019b; Casino et al. 2019; Hackius and

Petersen 2020). This situation is even worse for SMEs, as elaborated in Chapter 3 on page 31. Moreover, the available online literature markets material or success stories of global companies. These results are in line with Clohessy and Acton (2019), who identified a "lack of specific industry business cases." Second, the literature mentions decision models if a Blockchain is needed (Urban 2020; Pedersen et al. 2019; Koens and Poll 2018; Wust and Gervais 2018). Each decision model concludes with an indication of whether a public or a private Blockchain configuration might be appropriate for a particular project. Through the lens of an SME, the decision models would preclude the need for Blockchain beforehand, and knowledge about the Blockchain configuration might narrow down the needed scope of information. Nevertheless, even with the gained knowledge, SMEs need defined approaches to adopt Blockchain technology. This leads to the following proposition:

Proposition 14: SMEs are more likely to adopt Blockchain technology if they have defined approaches.

5.2.5 Understanding SMEs' Business Models with Blockchain

In accordance with the literature on SMEs' Blockchain adoption and general Blockchain adoption in supply chain management, and based on the current findings as detailed in the previous sections, the interviewees' approaches differed across the sample. Some interviewees started engaging in Blockchain projects, while others discussed use cases, and technology companies offered their Blockchain-based services. However, a lack of cooperation, data sharing, organizational readiness, and relevant use cases hinders Blockchain adoption among SMEs. In the literature, Blockchain-based business models are discussed, especially for IT solutions providers (Du et al. 2020; El-dosuky et al. 2021; Francisco Luis et al. 2022; Kifokeris and Koch 2020; Liu et al. 2021; Miatton and Amado 2020; Kashansky et al. 2021; Nowiński and Kozma 2017; Park and Sung 2020; Poszler et al. 2019; Tiscini et al. 2020; Tönnissen and Teuteberg 2020; Wang et al. 2020; Weisshuhn et al. 2021; Yuyan and Lan 2020; Paliwal et al. 2020; Treiblmaier and Span 2022). These publications show that Blockchain-based business

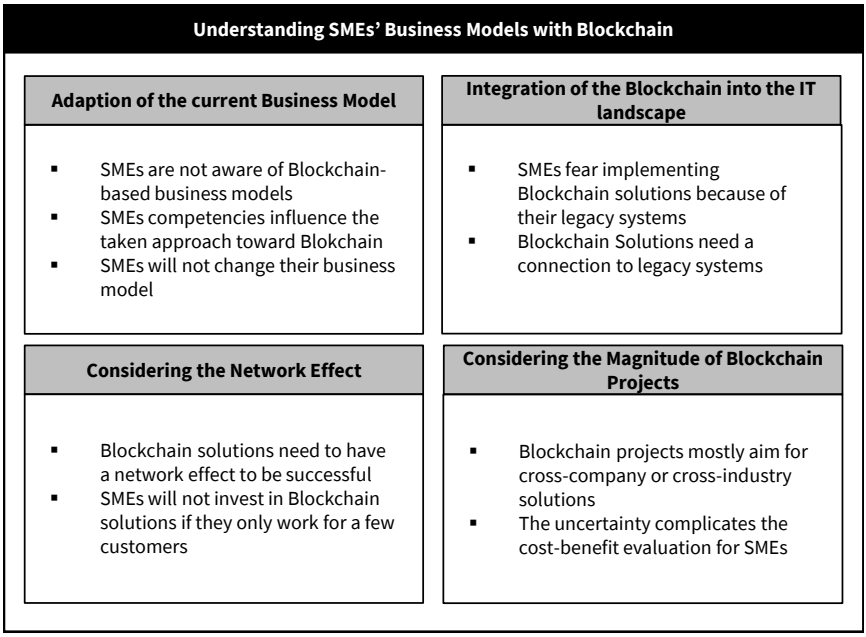

Figure 5.12: Overview of SMEs' Blockchain-based Business Models

models could be revolutionary in supply chain management. Yet, literature dealing with Blockchain-based business models mainly focuses on the possible benefits of whole Blockchain solutions for supply networks (e.g. Wang et al. (2020) and Tiscini et al. (2020)) and theoretical concepts on how to design Blockchain-based business models (e.g. (Huynh 2021; Miatton and Amado 2020; Morkunas et al. 2019)). The literature also reveals that only a few studies are based on empirical data, and only three publications mentioned SMEs in Blockchain-based business models. The understanding of SMEs' Business Models with Blockchain is depicted in Figure 5.12.

Possible benefits of Blockchain solutions are explored at the firm level (Treiblmaier and Span 2022) and the network level (Wang et al. 2020) in academic literature. Both levels have an impact on the business model of an SME (ibid.). To achieve the mentioned benefits, such as fast transactions or

improved customer relationships (Tönnissen and Teuteberg 2020; Morkunas et al. 2019), the Blockchain solution must be implemented and used as infrastructure. From the interviews, it emerged that Blockchain solutions are hosted primarily by incumbents, in sporadic cases, but secondarily also in research projects or joint projects.

Building on the insights from the reviewed literature, Section 5.2.5.1 discusses three relevant parts of an SME's business model. In the subsequent sections, the basic framework of Osterwalder and Pigneur (2010) and the adapted version of Morkunas et al. (2019) are aligned.

5.2.5.1 Adaption of the current Business Model

Different possibilities to improve the value proposition emerged from the interviews, depending on whether the SME is part of a Blockchain infrastructure. If Blockchain is implemented as infrastructure and the SME joins as a Cooperator, new business models could be generated, as a project participant mentioned:

> *Yes, that's what we're currently trying out in our [Blockchain] project. Well, there are a number of, let's say, business models that fit in very well with the digital world. There's pay-per-use, all these stories, subscription models, and so on and so forth, and classic logistics doesn't really know anything like that.*
>
> *#9 Logistics Association*

According to the experts, the current processes (communication and data transfer) would be much faster if all companies were part of a Blockchain infrastructure. Cooperators could reduce their efforts in finding the correct information of the desired quality, as specified in Section 5.2.3.4 on page 142. As Morkunas et al. (ibid., p. 298) propose, "Moreover, Blockchain technology can also provide faster or less expensive transactions than those completed in traditional settings." It would also be possible to integrate services by third parties such as insurance companies or banks, as one participant indicated,

> *And the business model that now stands behind it, there were ideas, namely that one builds this as an infrastructure on which external people can dock value-added services, be it insurance-related, that an insurance company docks on and says, "I get valuable data, and I can then, for example, because I know so well about the transports, also offer insurance-related advantages to individual transports or to individual customers."*
>
> *#H3 Logistics Association*

The literature also discusses new business models, which are only possible due to Blockchain technology (Morkunas et al. 2019; Nowiński and Kozma 2017), such as subscription models and insurance-related advantages through data transparency. Most interviewees described the business models based on a Blockchain infrastructure as relatively vague and hypothetical. Most ideas were generated from Blockchain projects in development or did not move beyond the pilot phase – especially Blockchain projects with SMEs remained in pilot status. Moreover, Service Providers also joined the development of these infrastructures to offer services in the medium term:

> *There were the medium-sized IT Service Providers who saw that this was a technology in which we wanted to build up expertise: This is a technology in which we also want to build up expertise and, let's say, be able to offer solutions in the medium term.*
>
> *#H3 Logistics Association*

In a typical Blockchain solution, as introduced in Chapter 2 on page 5, each Cooperator should be treated equally, share the same data, and host their own node. This system is considered an open basis for everyone to connect to and use. The literature discusses this concept but mainly focuses on Financial Technology (FinTech) (Tönnissen and Teuteberg 2020; Morkunas et al. 2019; Kifokeris and Koch 2020; Wang et al. 2020). Thus, the following proposition emerges:

Proposition 15: Cooperators struggle to identify Blockchain-based business models for logistics that both create structure and fit into the current business.

However, some Blockchain solutions are also hosted by large IT solutions providers or start-ups offering Blockchain-based benefits for companies using an interface. In this configuration, the SME using the Blockchain solution would not be part of the infrastructure. As an expert stated,

> *There are also small and medium-sized companies that benefit from the fact that large companies have developed a pattern or a sample solution that can be used for their products without having to develop, operate, and then maintain something themselves.*
>
> *#11 IT Solutions Provider*

With this approach, Participants could minimize the effort and resources needed to use Blockchain technology and offer their customers Blockchain-based services such as the origin of products (Garaus and Treiblmaier 2021). The literature describes several concepts for the food industry, logistics, or luxury goods (Holm and Goduscheit 2020; Lacity and van Hoek 2021a; Thakker et al. 2021) where companies offer Blockchain as a service without the need for Participants to host their own node. By using the Blockchain solution of an IT solutions provider, Participants could add value to their existing process or product with additional information, such as the origin or sustainability of a product. In short, Participants could currently use the possible benefits of a Blockchain solution in different ways. Depending on their organizational situation, motivation, and core competencies, they aim to reduce actual costs or increase sales. Participants would start to track single products on a Blockchain to generate Blockchain-based benefits for their customers and market the products differently. As a participant stated,

> *But they also wanted to make a green solder, like green tin solder that they can prove came from a responsible source, no human rights abuse, no environment, you know just the tracked and responsible so that they could market it differently. The idea was, you know, you could buy anywhere else but if you buy their green tin solder product then you have confidence and assurance about where it comes from, and so there's a Blockchain traceability.*
>
> *#25 Blockchain Protocol Provider*

Based on the empirical findings, the following proposition emerges:

Proposition 16: Participants starting to get involved with Blockchain technology often exclusively focus on separate products of specific relevance.

5.2.5.2 Integration of the Blockchain into the IT Landscape

Aside from the general business model and the subordinate value proposition, the interview partners commonly mentioned the integration of Blockchain into the IT landscape of a company. This subsection is strongly related to the organizational readiness of an SME, especially with regard to the technological resources elaborated in Section 3.4.3.1 on page 53, and to the connection possibilities in Section 5.2.4.1 on page 145. Based on an SME's existing IT infrastructure and possible connection to a Blockchain solution, the company's investment in the IT landscape differs:

> *The biggest inhibition is always, "Do we need to change our system?"*
>
> *#12 IT Solutions Provider*

> *If the Blockchain now helps me to fulfill this requirement better, or to fulfill it more cheaply, then I ask myself how I can implement it. Either I adapt my existing system to the Blockchain, or I replace the existing system. This question of implementation is then next. How easily do I get this technology, this tool, implemented in my environment?*
>
> *#28 Manufacturer*

Hashimy et al. (2021) mentioned outdated organizational and technological systems and undefined business models as an internal barrier to Blockchain adoption. According to Wong et al. (2020a), the complexity of Blockchain is a significant factor in Blockchain adoption among Malaysian SMEs. Other studies have also mentioned the opposite: Large companies have the problem of onboarding SMEs into their Blockchain platform (Clohessy and Acton 2019; Lacity and van Hoek 2021b). In an ideal Blockchain solution, all necessary information would be provided over the Blockchain infrastructure, requiring all participants to operate a node. If a Participant

cannot host an own node, such a solution would need to be connected to existing legacy systems:

> *In case of doubt, there are API interfaces and web services. Software as a service would actually have to be available, if possible license-free, if possible using open source, and the connection would have to be possible. An interface would also have to go into the existing systems.*
>
> *#3 IT Solutions Provider*

An intervention in existing systems also occurs in other technologies adopted by SMEs. According to Alshamaila et al. (2013, p. 261): "SMEs expect adopted cloud services to be compatible and easy to use." Similar results were found regarding the ease of use and integration of a technology into a legacy system (Gupta et al. 2013; Oliveira et al. 2014; Senarathna et al. 2018). Furthermore, similar situations will arise if a Blockchain solution is integrated through API interfaces or web services instead of through a hosted node. Based on these findings, the following relationship is proposed:

Proposition 17: Due to resource restrictions, SMEs join an existing Blockchain solution as a Participant rather than developing a Blockchain solution as a Cooperator.

5.2.5.3 Considering the Network Effect

According to Osterwalder and Pigneur (2010) and Morkunas et al. (2019), key partnerships, customer relationships, customer segments, and channels are the basic building blocks of a business model. These building blocks are the main connections between suppliers and customers, and they are the means through which a company communicates with other entities. Treiblmaier and Span (2022) stated in their study among Slovenian SMEs, "One of the most striking results of our study was the consistently positive assessment of all companies regarding the impact of Blockchain on their business model." A Blockchain infrastructure must be laid out to achieve this positive impact on a business model. Most interview participants revealed that a Blockchain solution must first have a network effect, as summarized in the following project participant's statement:

> *And we simply need a critical mass in order to somehow make it fly and be able to work with it on a daily basis. It doesn't make sense for our people in customer service or scheduling to work with a system just for one or two customers, because we want to take work off their hands and not create work.*
>
> *#H1 Logistics Service Provider*

The success of a Blockchain solution depends on the number of Cooperators in a consortium. If a small group of SMEs starts a Blockchain project together to optimize their relationships and communication, they only optimize it with their project partners. All communication to customers and key partners outside the Blockchain solution will continue based on the legacy system. Alternatively, Service Providers could host a Blockchain solution to offer companies interfaces, which need a network effect to make the Blockchain solution of the companies competitive.

Ilbiz and Durst (2019, p. 34) mentioned the network effect from a security perspective: "If a small group of companies aims to use Blockchain, they are more vulnerable to the outside attacks due to their computational power can be surpassed by bad outside actors." Aside from the aforementioned security perspective, the number of on-chain business partners must be considered Moreover, Schmidt and Wagner (2019) mentioned that Blockchain needs to reach critical mass for the network effect to occur –

the more entities participating, the more valuable the system. Based on these findings, the following proposition emerges:

Proposition 18: If Cooperators' Blockchain solutions do not generate a network effect, they do not create constant value.

5.2.5.4 Considering the Magnitude of Blockchain Projects

Planned Blockchain solutions for logistics are (mostly) cross-company targeted projects, which entail custom-built systems. Most interviewees imagined Blockchain solutions as cross-company or even cross-industry solutions, like the digitalization of the paper-based bill of lading or complete real-time information sharing in logistics:

> *It is an opportunity, especially if you look at decentralization, that you can standardize certain processes that are used worldwide, especially in maritime logistics. If you can standardize them, and here I'm thinking primarily of bill of lading, the entire order process, then I definitely see opportunities to do that.*
>
> *#3 IT Solutions Provider*

For achieving, for example, a Blockchain-based bill of lading, companies must work together and set up a solution (which should have a network effect, as explained in the previous section). Otherwise, if SMEs only need to connect to the Blockchain solution of a supply chain, they may need to align their data structures and interfaces with the new infrastructure – thus, they do not need to work with other companies to connect to the Blockchain solution. Despite the uncertainty and possible risks (Kersten et al. 2017a), companies must perform a cost–benefit analysis, as the experts elaborated:

> *And in our solution, it is not connected with direct profit or direct additional profit, but our solution is a bit more long term.*
>
> *#12 IT Solutions Provider*

> *Sure, so what you have to take into account is the network effects and issues that are associated with it, so to speak, which you can't explicitly measure in terms of faster, better, or any achievement at all. But I think at the end of the day, it has to be based on somehow a cost-reducing factor or a revenue-increasing factor, or compliance can be better maintained.*
>
> *#17 IT Solutions Provider*

The discussion with experts revealed immense uncertainty regarding whether or not Blockchain solutions will be a valuable investment. Since projects such as the Blockchain-based bill of lading will not generate a direct profit, SMEs struggle to invest in such projects. Moreover, uncertainty about the success of planned projects influences the approach companies take toward the implementation:

> *If I say, okay, in five years I expect to be able to take in x more over that, that it will amortize by then, yes, no, maybe. And if the answer is no, then I have to think about whether I do it at all. Or then, yes okay, or then just decide whether I work with someone or whether I buy something.*
>
> *#16 Logistics Service Provider*

> *[...] the higher the benefit you're hoping to get and the type of benefit you're hoping to get, of course, very much influences the extent to which you make the decision to participate in a consortium or to fly solo, for example, or perhaps to go with a service provider.*
>
> *#18 IT Solutions Provider*

In summary, if a Blockchain project aims to optimize a cross-company or even a cross-industry problem, an SME cannot solve the problem itself and is likely to take a Cooperator approach. This approach is in line with the findings of Gnyawali and Park (2009, p. 323) since SMEs are likely to face "technological risks, management challenges, and loss of control" when targeting a Blockchain solution with a cross-company characteristic. By contrast, an SME will not take the Participant approach to target a cross-company problem, due to its restrictions in shaping the existing system. At the same time, it should be noted that companies with sufficient

market power could initiate such a solution without developing it themselves. Moreover, it might be valuable for Service Providers to provide their Blockchain services to a whole consortium. Based on the empirical findings, the following proposition emerges:

Proposition 19: The greater the magnitude of the planned Blockchain solution, the greater the likelihood that the Cooperator approach is chosen.

5.3 Conclusions to the Qualitative Findings

This study involved a broad investigation of the approaches of SMEs in Blockchain pro-jects. The results illustrate how SMEs can approach projects and what they should consider when joining a Blockchain project. The following section presents implications for research, implications for management, and limitations and further research recommendations.

5.3.1 Preliminary Implications for Research

The study provides several findings that are relevant for research and theory. Since the number of publications focusing on SMEs' Blockchain adoption is relatively low, and SMEs are not often mentioned in Blockchain publications focusing on L&SCM, the implications for research are described in combination with existing literature.

SMEs' Approaches to Blockchain Adoption

Aside from the developed typology, the study revealed two major contributions to the literature:

First, literature on co-opetition mentions two main factors relevant for SMEs' Blockchain adoption when following the approach of Cooperators. (1) According to Gnyawali and Park (2009), Emden et al. (2006), and Morris

et al. (2007), SMEs tend to enter into co-opetition with partners with resource similarity and should integrate a service provider of the same scope and size. The present study's findings are in line with this finding, but research should focus on consortia in Blockchain projects. These projects and the relationships among the partners could be reflected in the Blockchain solution created. Even in a project consisting of only SMEs, power relationships may emerge. Therefore, the governance dynamics in the pilot and trial phase of Blockchain projects requires further investigation. (2) Literature on co-opetition assumes that co-opetition is a temporary phase. However, Granata et al. (2016) state it could be permanent under certain conditions. A permanent state is planned and implemented in a Blockchain solution if the project is implemented successfully. Therefore, the long-term consequences of the Blockchain solution through the lens of co-opetition must be considered.

Second, literature on Blockchain mentions the case of disintermediation (Tapscott and Tapscott 2018; Wang et al. 2019b). Contrarily, Tönnissen and Teuteberg (2020) found that intermediaries are not eliminated; instead, they are likely to be replaced. The present study's findings align with those of Tönnissen and Teuteberg (ibid.) because the integration of Service Providers will generate new intermediaries. Research should focus on the possibility of disintermediation because if companies fear the transparency of a Blockchain solution, they will not join the solution.

Understanding the Situation of SMEs

The current situation of SMEs revealed within the interviews is in accordance with the extant literature on SMEs' Blockchain adoption and general technology adoption. As described in Chapter 3 on page 31, a myriad of studies – including studies on SMEs' Blockchain adoption, such as the work of Hashimy et al. (2021) and Wong et al. (2020a) – have presented resource restrictions for SMEs with respect to technology adoption. In the present dissertation, the same barriers and challenges were found for SMEs due to resource restrictions (Hashimy et al. 2021; Bracci et al. 2021) and top management support (Clohessy and Acton 2019), which have already been described in the literature. The current analysis provides further insight into the barriers and concepts described in research related to

other technologies such as EDI and cloud computing. For example, trading partner readiness, as mentioned by Chwelos et al. (2001) is highly relevant for Blockchain adoption among SMEs. Even if an SME is highly digitalized and has Blockchain competencies, without organizational readiness and a willingness to share data with their trading partners, the possibility of successful adoption is relatively low. Moreover, trading partner readiness should be considered not only between two companies but also in a network. Depending on the type of connection, all participating parties must have a specific level of organizational readiness. Therefore, research should focus on identifying adoption factors relevant to cross-company information sharing.

Moreover, general research focuses on the Blockchain adoption of incumbents and whole supply chains, as elaborated in Section 3.4.2 on page 45. Implementation of a Blockchain solution into a supply chain should also include smaller players, but the power imbalances are scarcely described in existing literature. Studies by Clohessy et al. (2019), Lacity and van Hoek (2021b), and Tan et al. (2018) (aside from some media articles such as one by Corkery and Popper (2018)) indicate power imbalances that are not the main focus of the studies. Therefore, research should focus on power imbalances in supply chains and the resulting forcing of small companies into IT infrastructures.

SMEs' Motivations to Engage with Blockchain

The identified motivations for SMEs to engage with Blockchain technology have implications for research. The motivation to achieve innovative Blockchain-based benefits and comply with regulations has been extensively discussed in the literature (Lu and Xu 2017; Tan et al. 2018; Chabani et al. 2021; Clohessy et al. 2020; Kamble et al. 2019; Saberi et al. 2019; Wamba et al. 2020). The current study could provide further insights into "marketing and public relations," "supply chain partners," and "competitive advantage."

Marketing and public relations were a motivation identified in the sample. SMEs participated in Blockchain projects or offered Blockchain-based services to customers to signal and build an image of innovativeness. Participants from the study intended to reach a variety of customers and

companies with their projects. However, almost no research exists on the marketing and public relations aspect of Blockchain technology – especially with a focus on SMEs. Therefore, the current analysis contributes to the perspective that marketing and public relations are strong drivers for involvement in Blockchain projects.

The relationship with supply chain partners and stakeholders is another motivation for engaging with Blockchain. While the literature has already demonstrated that SMEs must be integrated into Blockchain solutions (Clohessy and Acton 2019; Lacity and van Hoek 2021b,a; Tan et al. 2018; Wang et al. 2020) the way in which relationships motivate companies to adopt Blockchain requires further research – especially when SMEs set up Blockchain solutions together. Research on SME collaboration projects to develop Blockchain solutions does not yet exist. The present study contribution to research is the motivations of SMEs to join Blockchain projects.

Generating a competitive advantage is the last identified motivation. A Blockchain solution needs a functioning, established, and used infrastructure. This infrastructure could help SMEs gain independence from prominent IT solutions providers and market giants and – according to the interview partners – generate a competitive advantage against other SMEs. Competitive advantage is scarcely discussed in the literature: Wong et al. (2020a, p. 15) mention that competitive pressure is the "catalytic force which if improved can fasten [Blockchain] adoption by SMEs." Rejeb et al. (2019) stated that value-creating networks are necessary for a competitive advantage. Research should focus on generating a competitive advantage, especially if companies use the same infrastructure. Some SMEs are motivated to engage with Blockchain technology to achieve a competitive advantage, but they lack a concrete understanding of how such an advantage would translate into value.

Blockchain Technology Specifics

The analysis results show that SMEs have two possibilities for connecting to a Blockchain solution: They could either host a separate node or join via the node of a Participant in the Blockchain solution. These connectivity possibilities are in line with the existing literature (Hackius et al. 2019;

Hastig and Sodhi 2020; Twenhöven et al. 2020; Toyoda et al. 2017) due to the unwanted transparency in business processes. The present study demonstrates that resource restrictions make SMEs more likely to join a pre-existing Blockchain solution than setting up a new one. Therefore, the long-term effects of data inputs into a Blockchain solution must be considered without SMEs hosting an own node.

Understanding SMEs' Business Models with Blockchain

The reviewed literature on Blockchain business models highlights the possible advantages of a Blockchain-based business model with a focus on the business model canvas (Osterwalder and Pigneur 2010), but publications largely presuppose that a complete Blockchain infrastructure exists (Tiscini et al. 2020; Morkunas et al. 2019; Treiblmaier and Span 2022). The development of Blockchain solutions and the required network effects are mostly neglected. The analysis of complete Blockchain projects revealed the relevance of this situation. In particular, factors such as the necessary network effect, perceived benefits, technological compatibility, limited knowledge, and resource requirements become relevant. SMEs struggle to invest in a Blockchain solution, which might only work for a few companies, without including their own customers. The research based on Blockchain-based business models might not apply to SMEs.

5.3.2 Preliminary Implications for Management

The current study also provides relevant findings for SMEs, supply chain managers, and practitioners in charge of Blockchain efforts. Since the findings are derived from qualitative data, the author assumes that the results are applicable to companies. In summary, this study derives six implications for management, which are contextualized within the work in Figure 6.1 on page 181.

(M3) Consider the organizational environment and supply chain partners: First, the analysis revealed that SMEs must consider their situation concerning their organizational readiness, core competencies, and position in the supply chain, and they must prepare their IT landscape. Their

environment (key customers and partnerships) requires investigation to identify possible dependencies. On the one hand, if SMEs supply a large company (or are dependent on its orders), they could easily be forced into a Blockchain infrastructure. On the other hand, if supply chain partners or stakeholders set up a Blockchain solution, SMEs could receive participation requests. Therefore, SMEs must possess organizational readiness and core competencies. Depending on their competencies and IT infrastructure, they might also need to train their staff to operate new interfaces or arrange their data structure to respond to membership requests or inquiries.

(M4) Prepare to share data: Second, since Blockchain technology is a cross-company or cross-industry technology, SMEs should prepare to share data with their supply chain partners. Data sharing is a prerequisite for establishing a real-time data exchange environment without seeking the right information of the right quality. Upcoming regulations require companies to rethink their data sharing behavior, which is a necessary step toward digitalized logistics. Interview participants mentioned that sharing data is a prerequisite for staying competitive, especially when Blockchain solutions are used.

(M5) Prepare to work with competitors: Third, SMEs must be prepared to work with competitors to achieve the benefits of Blockchain technology. Setting up a Blockchain solution requires the effective cooperation of the supply chain actors involved in the targeted process. Especially SMEs usually do not have the market power to force other companies into their project or the resources to develop a Blockchain solution until implementation. However, collaborative behavior is currently lacking, both up- and downstream of the supply chain – especially among SMEs.

(M6) Prepare for a long time till value creation: Fourth, SMEs should consider the magnitude of a Blockchain project if they attempt to set up a Blockchain solution themselves. If SMEs need to join a Blockchain solution or buy a Blockchain product from a large IT solutions provider, the integration process will be relatively fast. The analysis underlines that Blockchain projects have a complex governance structure and development processes. Many projects did not reach the implementation stage and lacked members for the necessary network effect to occur. The value for those projects will arise if enough companies are on the Blockchain solution and if the

solution is frequently used. Therefore, SMEs must prepare to wait a long time for value creation.

(M7) Choose appropriate partners: Fifth, choosing the right partners is crucial for SMEs' Blockchain adoption, especially when piloting a solution. According to the literature, SMEs are most likely to cooperate with partners of similar sizes and with similar resources (Gnyawali and Park 2009). The analysis shows that power imbalances exist in Blockchain projects, even when a Blockchain project only consists of SMEs. Therefore, SMEs must consider the choice of their partners when they start a Blockchain project or receive a participation request. SMEs must also evaluate the advantages and disadvantages of a project consortium and consider the likelihood of power imbalances occurring. This risk is an important consideration for SMEs because if they find themselves in a power imbalance, they might not be able to influence decisions in their (potentially disadvantaged) favor.

(M8) Allow for experiments: Sixth, SMEs should – if possible – allow experiments with data sharing and Blockchain technology. Several interviewees mentioned the knowledge gained from participating in a Blockchain pilot and improved business relationships. Blockchain projects offer discussions about governance, data sharing, and shared problems and opportunities. Even if the Blockchain solution is not implemented, discussions regarding a shared problem can bring other technological solutions into focus.

5.3.3 Limitations and Further Research

The selected GT approach for this analysis provided rich data and meaningful insights into the topic of SMEs' Blockchain adoption. SMEs' approaches to Blockchain adoption could be identified, and general propositions could be derived. Nevertheless, the study's limitations must be considered. This dissertation employed theoretical sampling, which provides valuable insights but is not representative of all SMEs. Notably, the dissertation aimed to identify adoption strategies in an industry that has not yet fully adopted the technology. The interviews were conducted with interested partners who have already adopted or were attempting to adopt the technology. Furthermore, the SMEs in the sample are not only companies in logistics, manufacturing, and retail but also companies providing software and those

focusing on Blockchain technology. The IT solutions providers often had a strong understanding of the challenges facing SMEs. These interviewees' distance is a clear limitation of this study.

In this study, standardized survey questions were not asked, and the sample size was limited. Moreover, the qualitative data did not allow for statistical analysis, and the propositions were not statistically tested. Furthermore, the study sample was located in Germany and hence could offer no insights into possible differences in other parts of the world. The timing of data collection should also be considered because the study was completed during the COVID-19 pandemic. Therefore, interview participants' general situation was possibly more stressful than usual, and all interviews were carried out via web calls or telephone. Finally, the general research topic must be considered: Blockchain is a fast-moving technology with short development cycles, and the field is young; therefore, the approaches taken by companies are still prone to change.

The study was intended to provide an overview of how SMEs approach Blockchain technology and what they should consider when choosing an approach. Table 5.5 summarizes the findings in the form of observations. These observations provide opportunities for further research. Thus, several suggestions for further work are made.

Table 5.5: Propositions resulting from the qualitative Research

#	Proposition	Page
SMEs' Approaches to Blockchain Adoption		
1	Power imbalances in Blockchain projects influence decisions, which can be translated into the infrastructure. This may have negative consequences for smaller partners.	p. 112
2	A permanent state of co-opetition emerges between Cooperators if a Blockchain project is successfully implemented.	p. 113
3	Blockchain adoption generates new intermediaries when Service Providers are engaged.	p. 115

continued on the next page

(Cont.) Table 5.5: Propositions resulting from the qualitative Research

#	Propositions	Page
	Understanding the SMEs' Situation	
4	The higher the readiness of trading partners is, the more likely SMEs are to take the Cooperator approach.	p. 127
5	The lack of data sharing between SMEs in logistics could result in Blockchain solutions not being considered in a valuable way.	p. 129
6	The distribution of market power across the supply chain influences the specific Blockchain use case and approach for SMEs.	p. 132
	SMEs' Motivations to Get Engaged with Blockchain Technology	
7	Governmental regulation is a stronger motivation to engage in Blockchain technology for large companies than for SMEs. However, the uncertainty surrounding regulation and its long lead times are perceived as impediments to successful Blockchain projects.	p. 136
8	Generating public visibility is a strong motivation for Cooperators to adopt Blockchain. Blockchain projects address a variety of different stakeholders.	p. 138
9	Participants are (often) forced into Blockchain projects by large supply chain partners.	p. 140
10	Public funding strongly motivates Cooperators to engage in Block-chain technology.	p. 142
11	Cooperators believe that Blockchain projects will strengthen their competitive position even though they are not able to specify how this will occur.	p. 144

continued on the next page

(Cont.) Table 5.5: Propositions resulting from the qualitative Research

#	Propositions	Page
	Blockchain Technology Specifics	
12	The fear of a loss of data sovereignty and the disclosure of relationships hinders Cooperators from joining Blockchain projects.	p. 147
13	Blockchain solutions can be negatively influenced by the power concentration of single gatekeepers.	p. 148
14	SMEs are more likely to adopt Blockchain technology if they have defined approaches.	p. 150
	Understanding SMEs' Business Models with Blockchain	
15	Cooperators struggle to identify Blockchain-based business models for logistics that both create structure and fit into the current business.	p. 153
16	Participants starting to get involved with Blockchain technology often exclusively focus on separate products of specific relevance.	p. 155
17	Due to resource restrictions, SMEs join an existing Blockchain solution as a Participant rather than developing a Blockchain solution as a Cooperator.	p. 156
18	If Cooperators' Blockchain solutions do not generate a network effect, they do not create constant value.	p. 158
19	The greater the magnitude of the planned Blockchain solution, the greater the likelihood that the Cooperator approach is chosen.	p. 160

Propositions 1, 2, and 3 address interactions of SMEs in Blockchain projects with a focus on the development process of the Blockchain solution. Case study research may be a suitable approach to investigate the interactions between companies when developing a Blockchain solution. The interac-

tion between collaboration and competition is highly relevant because the partner relationship could be represented in the Blockchain infrastructure and could result in a permanent condition. Moreover, a quantitative approach might be helpful for Proposition 3.

Propositions 4, 5, and 6 are suited for further research on identifying relevant adoption factors for Blockchain technology among SMEs. To this end, case studies on Blockchain implementations might be applicable to generate a holistic view of relevant adoption factors. These factors could be quantitatively tested to shed light on the differences between different actors. Moreover, the significance of factors could be surveyed.

Propositions 7 to 11 require follow-up research on SMEs' motivations to engage with Blockchain. These propositions are well suited to evaluation in a large-scale quantitative study, possibly even in different industries and countries. Analysis in different countries could be valuable, especially for Proposition 10, due to the work of Huggins et al. (2012). Further insights into the motivations of SMEs could reveal the influence of the different motivations on SMEs' Blockchain adoption. Furthermore, Proposition 8 presents an opportunity to analyze the public image of an SME using Blockchain in terms of signaling theory.

Propositions 12 and 13 address SMEs' privacy concerns and are a starting point for in-depth research into the implementation of Blockchain solutions. Case studies focusing on the implementation of a Blockchain solution might be suitable. Only a few concepts focus on managing companies' privacy needs in a Blockchain solution in logistics. Since no data is available in case studies, it might be useful to work on technological concepts to allow data sharing – without data disclosure. Researchers should focus on zero-knowledge proofs and off-chain data-saving concepts.

Proposition 14 addresses possible approaches of SMEs toward Blockchain solutions. An empirical verification of Proposition 14 might clarify SMEs' possible approaches. A quantitative approach could generate a defined picture of possible decision models.

Propositions 15 and 18 are suitable for in-depth research into SMEs' Blockchain projects. For companies, it would be beneficial to determine how proposed Blockchain business models (Morkunas et al. 2019; Park and

Sung 2020; Liu et al. 2021) can be applied in practice. A case study or qualitative research approach might be suitable to identify beneficial business models and the necessary size of a consortium for companies that have decided to join a Blockchain project of any kind.

In the case of Proposition 16, further research should focus on different products supported with Blockchain-based traceability information. The effect of additional information (e.g., information about a product's provenance) could be benchmarked for different products. Behavioral experiments might be a helpful research approach to investigate the effect of Blockchain-based information on consumer behavior.

Finally, Propositions 17 and 19 warrant further quantitative research. To this end, behavioral experiments could shed light on how SMEs decide on a Blockchain adoption approach, depending on the magnitude of the planned Blockchain projects.

Chapter 6

Integration of Findings and Implications, and Conclusion

6.1 Summary of Findings

Section 3.4 on page 41 broadly described the current discussion in the literature regarding SMEs' Blockchain adoption. In the course of the literature review, it became clear that the number of publications on Blockchain adoption among SMEs is surprisingly scarce, whereas general Blockchain adoption for L&SCM has been researched extensively. The results from general Blockchain adoption are only conditionally valid for SMEs due to the specificity of an SME; however, these results are still relevant. The general differences between SMEs and large companies were outlined to ascertain the transferability of the results – which is not a given. As a result of the literature analysis, the following research goal could be derived:

Research Goal: Gaining a better understanding of small and medium-sized enterprises' roles and approaches in adopting Blockchain.

The research questions were addressed with two methods. First, a preliminary, exploratory, web-based survey was administered to 80 participants familiar with Blockchain technology. The web-based survey was divided into two parts: general experience with SMEs from logistics, manufacturing, and retail and general perceptions toward Blockchain technology.

This study questioned the actual situation of Blockchain projects with SME participation and the role of SMEs in Blockchain projects and put forward their importance. Second, an inductive, qualitative study was performed to deepen the understanding of SMEs' approaches toward Blockchain adoption. The qualitative study entailed conducting and analyzing 37 interviews and additional data. Two Blockchain projects, namely Release Order based on Blockchain and HANSEBLOC, were considered to gain insights into Blockchain projects and their structure. The gathered data yielded a rich context of approaches and considerations, and a large number of observations were consequently derived. Results from the web-based survey were analyzed to answer the first research question:

Research Question 1: How do companies perceive the role of SMEs in Blockchain projects?

The first part of the survey questioned the role of SMEs from logistics, manufacturing, and retail in Blockchain projects. To investigate this role, the competencies that SMEs contributed to such projects were chosen in two different ways: Since only a few SMEs had participated in Blockchain projects, survey participants who had not worked with SMEs in Blockchain projects were asked to assess the possible contribution, juxtaposed with actual SME participation experience in Blockchain projects. The following competencies were surveyed: (1) contribution of technical competencies, (2) contribution of process knowledge, (3) contribution of financial resources, (4) exclusive contribution as a user, and (5) contribution to the development of new business models. For each of these competencies, SMEs' actual participation was rated lower than their potential contribution. The results indicate that logistics, manufacturing, and retail SMEs are not the knowledge carriers in the technical or business model-related context.

Moreover, the technical knowledge is concentrated on a small part of a consortium. Consequently, technology companies at the other end of the spectrum have knowledge of technology and Blockchain-based business models. This finding is in line with the findings of Tönnissen and Teuteberg (2020) and Lacity and van Hoek (2021b). Moreover, SMEs play a role in Blockchain projects, which leads to the following research question.

Research Question 2: What approaches do SMEs take toward the adoption of Blockchain technology?

The second research question was addressed through a qualitative Grounded Theory (GT) study. The findings of the qualitative study revealed two central and interrelated aspects. First, SMEs choose a new approach for every Blockchain project. The four (ideal-typical) approaches (see Section 5.2.1 on page 104) are that of the Observer ("wait-and-see" approach), the Participant (joining a running Blockchain solution), the Cooperator (developing a Blockchain solution together with other companies), and the Service Provider (offering Blockchain-based services). These approaches are not mutually exclusive since an SME could adopt more than one approach simultaneously; for example, an SME from logistics could join a Blockchain solution as a Participant and, in parallel, develop a Blockchain solution with a consortium as a Cooperator. Second, the most valuable approach differs for each SME depending on its organizational readiness, top management support, market power and position in the supply chain. Under certain circumstances, SMEs cannot choose their approach.

Research Question 3: What should SMEs consider when choosing a particular approach?

The third research question was addressed through the results and implications of the web-based survey and the qualitative GT study. SMEs are confronted with diverse barriers and challenges to consider when approaching Blockchain technology. First, SMEs must consider their organizational readiness, their information systems and data sharing behavior, and their position in the supply chain. Their current situation, especially their key partners and customers, greatly influence their choice of Blockchain approach. Second, an SME's motivation to engage in Blockchain technology requires consideration. All identified motivations (see Section 5.2.3 on page 132) could apply to a single company, possibly simultaneously. A Blockchain consortium might have a company with an innovation- and marketing-orientated mindset. While marketing- and public relations-oriented goals could be easily fulfilled, fulfillment of innovation and value-add goals might be more complicated. Third, SMEs should consider the

Blockchain technology specifics. For example, the chosen connectivity possibility has consequences for an SME's co-determination right in a Blockchain solution or for the company's privacy concerns. Fourth, companies should consider their current business model and its components. The chosen (or requested) Blockchain project must fit into the business model and generate value. Without consideration of key supply chain partners and customers to generate a necessary network effect, the successful implementation of a Blockchain project is threatened. Sixth, when choosing an approach toward Blockchain projects, SMEs should consider the consequences of each approach. If an SME always chooses the approach of an Observer, it risks of being left behind.

Overall, there is strong evidence that SMEs are currently adopting Blockchain technology; in Germany, this occurs through publicly funded Blockchain projects, large partners from L&SCM, and market power. To better integrate the findings, implications for research and management are embedded into the overall context of innovation theory and management practice next.

6.2 Implications for Research

The starting point of this thesis was the observation of the phenomenon that start-ups and incumbents use Blockchain technology, whereas SMEs do not. Two separate studies shed light on SMEs' Blockchain adoption, focusing on their approaches toward the technology. This section integrates the implications for research into the overall context. The findings and implications of the previously mentioned studies are located in the field of technology adoption in innovation theory. As elaborated in Section 2.3.2 on page 18, this dissertation follows the definition of the technology adoption process by Matta et al. (2012).

Blockchain adoption by SMEs is currently still in its infancy. Media articles report on behemoth corporations, such as Walmart and A. P. Møller-Mærsk, applying Blockchain to their supply chains and including and integrating SMEs. Although SMEs' gain experience with the technology and start single-pilot projects or offer Blockchain solutions with the help of IT solutions providers, SME-driven projects in practice are scarce. Therefore,

the findings from this dissertation are in the stages of initiation and experimentation in the sense of the technology adoption process proposed by Matta et al. (ibid.). The implementation stage is outside scope because, to date, the pilot projects are incomplete.

The first theoretical implication is the identification of possible approaches for SMEs toward Blockchain adoption. In conformity with the sound practice of theory-building research, all four identified Blockchain approaches among SMEs emerged from data analysis during theoretical coding without a predetermined theoretical lens. Existing research highlights several potentials, barriers, and risks of Blockchain for SMEs, but it does not provide in-depth insights, and most importantly, it emphasizes problems instead of paths toward a solution. The present dissertation contributes to this area by providing insights into different possible approaches of SMEs toward Blockchain adoption, along with their respective requirements and implications. Further research should not only explore the strengths of these approaches but also qualitatively explore whether additional approaches exist and which approach is suitable for which SME.

A second contribution is an interrelationship between the – hitherto disconnected – research streams of co-opetition and (SMEs') Blockchain adoption. In the literature (to the best of the author's knowledge), only Narayan and Tidström (2020) mentioned co-opetition combined with Blockchain and a circular economy in their conceptual study. They contributed to existing co-opetition research by relating co-opetition to circular economy models with Blockchain applications. This dissertation contributes to SME co-opetition literature with a (probably) permanent state of co-opetition if a Blockchain solution is successfully implemented. Literature assumes that co-opetition is a temporary state since the value of innovations developed in co-opetition is usually captured by the participating companies (Gnyawali and Park 2009; Alvarez and Barney 2001; Ketchen et al. 2004). Co-opetition partners develop a Blockchain solution together, and they are thus linked until they stop using the solution. Therefore, co-opetition is a permanent status until a company leaves the consortium.

Moreover, an important insight from the literature is the observation that SMEs are more likely to enter into co-opetition with companies of similar sizes and with similar resources (Gnyawali and Park 2009). Power imbalances (i.e., with a larger company) could negatively influence co-opetition

partners due to possible appropriation (Alvarez and Barney 2001). In co-opetition relationships involving the development of a Blockchain solution, power imbalances are hazardous for SMEs because these imbalances could be transferred into the infrastructure.

The third contribution of this dissertation to Blockchain literature is the identification of an adoption factor with a focus on SMEs. The literature identifies several adoption factors and barriers for SMEs (see Section 3.4 on page 41); these factors primarily address company-internal factors such as resource restrictions (Hashimy et al. 2021; Wong et al. 2020a), missing knowledge (Bracci et al. 2021), and top management support (Clohessy and Acton 2019). A further important adoption factor, trading partner readiness, was mentioned Chwelos et al. (2001) in a study on EDI adoption. Bouchard (1993) described trading partner readiness in the context of critical mass theory, where a sufficient number of companies must adopt the sample technology broadly. Even if an SME has proper organizational readiness and is willing to share data with a Blockchain solution, it might lack partners with a sufficient level of digitalization. In contrast to EDI (Chwelos et al. 2001) or cloud computing (Alshamaila et al. 2013), Blockchain solutions need a whole network of participants with sufficient organizational readiness. Research should focus on cross-company adoption factors for Blockchain solutions.

The final contribution is the recognition that SMEs are not the knowledge carriers in Blockchain projects, neither in a technological nor in a business model sense. The web-based survey revealed a concentration of Blockchain-related competencies in a consortium. The literature also underlines SMEs' limited degree of knowledge (Hashimy et al. 2021; Bracci et al. 2021), which is held by a technically proficient company at the other end of the consortium. The qualitative study revealed that Service Providers could act as intermediaries, offering all-inclusive services for the use of Blockchain solutions. The work of Tönnissen and Teuteberg (2020) support this finding since their data sample also shows the introduction of replaced intermediaries.

6.3 Implications for Management

General supply chain research indicates that integrating SMEs into the information flow of a supply chain improves performance (Harland et al. 2007; Newell et al. 2000; Ke and Wei 2007; Poon and Swatman 1999). Yet, to date, large firms must build appropriate information integration bridges (Harland et al. 2007) to include smaller companies effectively. Large firms offer turnkey systems to integrate supply chain partners into their IT infrastructure, and the same is observed with Blockchain solutions. Moreover, as elaborated in Section 5.2.1.3 on page 110, a few companies collaborate with one another in a co-opetition relationship to start Blockchain projects.

Although the lack of quantitative testing of observations limits the managerial implications, several implications are still relevant for managers and practitioners. Since the knowledge in SMEs about Blockchain is relatively low (Bracci et al. 2021) the identified approaches from the qualitative study offer directions for future projects. Since not every approach is valuable for each SME, managers must understand the advantages and disadvantages of the four identified approaches and the circumstances in which they might be appropriate. Managers should also consider the complexity and magnitude of cross-company Blockchain solutions (see Sections 5.2.5.3 to 5.2.5.4 on pages 157–158). Before SMEs choose a Blockchain approach, they should consider the categories identified in the qualitative study; such consideration may aid in weighing the advantages and disadvantages of each approach.

In light of the heightened need for companies to exchange data safely and securely, SMEs must prepare themselves to share data. Moreover, experimenting (if possible, due to resource restrictions) with new technology in trials and pilots is an ideal step to gaining experience, as other technologies may be more beneficial for an SME's problem. Therefore, SMEs should find the right use case to implement Blockchain solutions and choose the right approach suitable for their business model (see Section 5.2.5.1 on page 152).

The approaches developed in this dissertation provide managers with Blockchain technology directions. If managers engage as Cooperators in a Blockchain trial or pilot project that might be successfully implemented,

they should consider possible power imbalances. When power imbalances are transferred to the infrastructure, companies find themselves in a predefined system that is difficult to change. In summary, the implications for management derived in Section 4.3.2 on page 79 and Section 5.3.2 on page 164 align with the technology adoption process of Matta et al. (2012) in Figure 6.1 on the facing page. While this thesis covers Blockchain technology, which is most suitable for cross-company cases, the relationships with a consortium or larger supply chain partners are relevant. Therefore, SMEs must consider what larger partners in their supply chains and existing consortia do. The identified implications for management are divided into those for consortia, company-internal, and large supply chain partners. Through the lens of an SME, most implications are relevant to both the company internals and their environment.

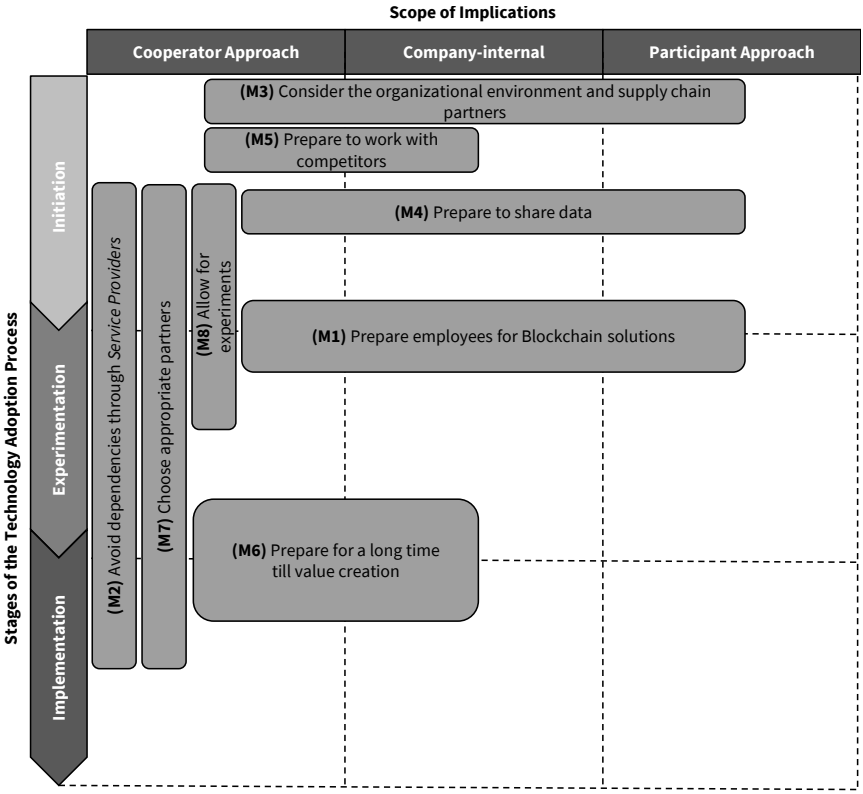

Figure 6.1: Matching the Implications for Management with Theory (adapted from Matta et al. (2012))

6.4 Conclusion

The Blockchain space has evolved rapidly, especially in FinTech, focusing on cryptocurrencies. Overall, this research indicates that SMEs have not yet adopted the fast-evolving Blockchain technology. In supply chain management, however, multiple behemoth corporations have set up their Blockchain solutions: Walmart (Corkery and Popper 2018), Starbucks (Warnick 2020), and Carrefour (Carrefour 2019). These solutions allow the companies and their customers to obtain insights into their supply chain and show the provenance and origin of their products. To present this information and ensure transparency, these corporations must also include their suppliers. Many start-ups also work on Blockchain solutions to ensure better traceability, measure emissions, or fight against the violation of human rights. These start-ups work with large corporations (and in some cases also with SMEs) to collect data securely and offer services based on this data.

Furthermore, in logistics, large companies set up Blockchain projects to optimize their processes, for example A. P. Møller-Mærsk (Carlsen 2021) and Kuehne + Nagel (Kuehne + Nagel 2018). These projects allow companies to reduce customer information requests and paperwork. Aside from the two aforementioned examples, SMEs have also begun to with Blockchain technology in logistics. A few publicly funded projects, such as HANSEBLOC and Vinturas, started with SMEs collaborating on a Blockchain solution. These solutions aim to address current pain points in actual logistics, such as secure data sharing of information at the right time and of the required quality. Moreover, some SMEs have added Blockchain-generated information to their product using traceability services from IT solutions providers.

The long-term vision of Blockchain solutions is an IT infrastructure providing transparency to customers and all participating companies. Blockchain technology could ensure the verifiability of the required information for third parties. The data of all participants in the targeted system should be considered – especially that of SMEs – to achieve this long-term vision of Blockchain solutions. In supply chain management, SMEs will either be integrated as Participants to input data into the focal company's IT infrastructure or use a Service Provider's product to offer Blockchain-based

information. Alternatively, SMEs could collaborate and build their own system, although it might be challenging to adopt due to existing structures and power relationships in a supply chain. However, in logistics, SMEs could join larger companies' existing Blockchain solutions as Participants to receive Blockchain-based benefits. As in supply chain management, SMEs could also collaborate in logistics to set up a Blockchain solution, although this might also be challenging. In contrast to supply chain management, the opportunity to set up a Blockchain solution in logistics is more accessible for SMEs due to the highly fragmented market.

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Appendices

Appendix A

Scales for the web-based Survey and Questionnaire

Scales (7-point Likert Scale)

- Scale I: 1 = very little to 7 = very much
- Scale II: 1 = not at all probable to 7 = very probable

Questionnaire

Table A.1: Questionnaire for the web-based Survey

#	Question	Scale
Demography		
1	In which industry is your company mainly active?	Multiple Choice
2	Approximately how many people are employed by your company?	Multiple Choice
3	What is the annual turnover of your company approximately?	Multiple Choice

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(Cont.) Table A.1: Questionnaire for the web-based Survey

#	Question	Scale
4	Has your company already participated in a Blockchain project involving a manufacturing, logistics, or retail SME?	Single Choice
With SME Project Experience		
5	What best describes the use case of this Blockchain project?	Multiple Choice
6	How many organizations were involved in this project?	
7	Do you agree with the following statement? "An SME from logistics, production, or trade has contributed its technical expertise in the Blockchain area to the project."	Scale I
9	Do you agree with the following statement? "An SME from logistics, production, or trade has contributed its understanding of the work process to be mapped to the project."	Scale I
10	Do you agree with the following statement? "An SME from logistics, production, or trade has contributed its financial resources to the project."	Scale I
11	Do you agree with the following statement? "An SME from logistics, production, or trade has supported the project exclusively as a user."	Scale I
12	Do you agree with the following statement?	Scale I

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(Cont.) Table A.1: Questionnaire for the web-based Survey

#	Question	Scale
	"An SME from logistics, production, or trade has contributed to the development of a business model in the project."	Scale I
13	Do you agree with the following statement? "The project would have been just as successful without the participation of an SME from logistics, production, or trade."	Scale I
14	Do you agree with the following statement? "The technical expertise in the project is concentrated in a small part of the consortium."	Scale I
15	Is the project still running at the current time?	Single Choice
16	What form of organization was used in the project?	Multiple Choice
17	How is your share of the project funded?	Multiple Choice
18	How much did the following contribute to your motivation for the blockchain project?	Scale I
Without Experience with SMEs in Blockchain Projects		
19	Do you agree with the following statement? "An SME from logistics, production, or trade can bring its technical expertise in Blockchain to a project."	Scale I
20	Do you agree with the following statement? "An SME from logistics, production, or trade can bring its understanding of the work process to be mapped to a project."	Scale I

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(Cont.) Table A.1: Questionnaire for the web-based Survey

#	Question	Scale
21	Do you agree with the following statement? "An SME from logistics, production, or trade can bring its financial resources to a project."	Scale I
22	Do you agree with the following statement? "An SME from logistics, production, or trade could support a project as a user."	Scale I
23	Do you agree with the following statement? "An SME from logistics, production, or trade can collaborate in the development of a business model."	Scale I
General Questions		
24	Have you already decided against implementing a Blockchain idea?	Single Choice
25	For what reasons did you decide against implementing a Blockchain idea?	Multiple Choice
26	Do you agree with the following statement? "My company wants to deploy a turnkey Blockchain system without having to deal with the technical design."	Scale I

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(Cont.) Table A.1: Questionnaire for the web-based Survey

#	Question	Scale
27	Do you agree with the following statement? "My company would like to make its own contributions to the technical and organizational design in order to influence the development of a Blockchain system."	Scale I
28	How likely is it that a Blockchain project will succeed without the involvement of a large company?	Scale II
29	Do you agree with the following statement? "Blockchain technology has reached the necessary maturity for enterprise use."	Scale II
30	Do you agree with the following statement? "Blockchain has real use cases and offers tangible benefits for businesses."	Scale II
Wrap-up		
31	Anything else you'd like to share about our survey?	Free text
32	We welcome any other comments about our survey and related topics!	Free text
33	Thank you for participating in our survey! Would you like to be informed about the results of this survey?	Free text
34	We will be happy to inform you about the results of this survey by email.	Free text

Appendix B

Interview Guideline (Final Version)

Part A: Introduction

1. What are your duties and responsibilities in the company?
2. Which department are you assigned to, and what is its role in the company?

Part B: SME-specific questions

1. How do you/your customers plan to use the Blockchain technology in your company? If there are no plans to use the technology, do you see potential in Blockchain technology?
2. How do you see the chances for logistics SMEs using Blockchain technology?
3. Where do you see challenges or barriers for logistics SMEs when using Blockchain technology?
4. What regulatory influences have an effect on the introduction of Blockchain technology?

Part C: Wrap-up

1. Do you have any issues that I haven't addressed?
2. If you could wish for three Blockchain projects that your company should push forward, what would they be?

Digitization is shaping logistics and supply chain management (L&SCM) and impacting processes. Key tasks such as tracking goods and combating counterfeiting require robust information structures. Blockchain promises improvements in L&SCM, but SMEs are struggling compared to large enterprises. This dissertation explores SMEs‘ adoption of Blockchain in L&SCM through two studies. Study 1 surveys practitioners‘ views and finds that SMEs lack expertise. Study 2, using grounded theory, identifies a typology of SMEs‘ approaches to Blockchain adoption via 37 interviews. In summary, SMEs play a role in Blockchain projects, requiring further research. Case studies are essential to define the role of SMEs and understand the implications of passive participation. Collaborative efforts among SMEs to build a dedicated system or a logistics Blockchain solution are plausible, despite challenges. The latter, with market fragmentation, may offer a more feasible solution than supply chain management for SMEs.