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Sustainable Supply Chain Management
Potential and challenges of implementing blockchain technology in the food supply chain of small and medium-sized companies

Julia Harms

Master in, Management of Service and Technology

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Marketing, Operation and General Management Department

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iscte INSTITUTO UNIVERSITÁRIO DE LISBOA	**Sustainable Supply Chain Management: Potential and challenges of implementing blockchain technology in the food supply chain of small and medium-sized companies**	Julia Harms

BUSINESS
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Department of Marketing, Strategy and Operations

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Resumo

A sustentabilidade é um dos maiores desafios sociais do nosso tempo, por isso a Organização das Nações Unidas implementou 17 objectivos de desenvolvimento sustentável. Soluções estão a ser exploradas no domínio da digitalização. A indústria 4.0, incluindo a inteligência artificial, a internet das coisas, os robôs e a cadeia de bloqueio podem mudar o progresso social e económico. O desenvolvimento no sentido de um novo tipo de consciência e desafios sustentáveis na indústria alimentar força empresas a criarem e implementarem ações sustentáveis. As empresas são confrontadas com novas exigências na sua cadeia de abastecimento alimentar, para não perderem a sua posição no mercado. Para atingir uma solução exequível, foi analisada a ligação entre a tecnologia Blockchain e a sustentabilidade da cadeia de abastecimento alimentar das PMEs. O enorme potencial desta solução é contrariado por riscos que ainda não explorados, especialmente para as PMEs alemãs. A tecnologia Blockchain como DL (distributed ledger) pode trazer uma vantagem significativa para a cadeia de abastecimento alimentar, devido à sua capacidade de rastreio e rastreabilidade, no entanto ainda se encontra numa fase inicial do seu desenvolvimento. A sua influência e importância na indústria alimentar está a aumentar e consequentemente na gestão da cadeia de abastecimento das empresas.

O objectivo desta tese é determinar a importância da gestão sustentável da cadeia de abastecimento das PME's do sector alimentar que contam com a ajuda da tecnologia da cadeia de bloqueio, ao mesmo tempo que é avaliado o seu potencial e riscos no mercado alimentar alemão.

Palavras-chave: blockchain, gestão da cadeia de abastecimento, cadeia de abastecimento alimentar, rastreabilidade, transparência, cadeia de abastecimento alimentar sustentável

Classificação JEL: 023; Q13

Abstract

Sustainability in all areas of life is one of the greatest social challenges of our time. In the course of addressing these challenges, the United Nations has implemented 17 sustainable development goals. To achieve these, solutions are being pursued in the field of digitisation. Emerging technologies like, artificial intelligence, internet of things, robots and blockchain have one of the greatest potentials for changing the social and economic progress.

The development towards a new kind of sustainable awareness and challenges in the food industry force companies to create and implement sustainable actions. Companies are faced with new requirements in their food supply chain in order not to lose their position in the market. As a potential solution, the link between blockchain technology and sustainability food supply chain of SME´s has been analysed. The enormous potentials are opposed by risks that have not been researched yet, especially for German SME's. Blockchain ~~ha~~s a distributed ledger can open a significant advantage to the food supply chain, due to their trace- and track ability, but are still in an early stage of development. Their influence and significance on the food industry is constantly increasing and thus also on the supply chain management of companies.

The aim of this thesis is to determine the importance of sustainable supply chain management of SME´s operating in the food sector with the help of the blockchain technology, and to evaluate the potentials and risks in the German food market.

Keywords: *blockchain, supply chain management, food supply chain, traceability, transparency, sustainable food supply chain*

JEL Classification: 023; Q13

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Glossary of Acronyms and Abbreviations

BCT ..... blockchain
DLT ..... distributed ledger technology
EDI ..... electronic data interchange
ERP ..... enterprise resource planning
FSCM ..... food supply chain management
P2P ..... peer-to-peer
RFID ..... radio-frequency identification
SCM ..... supply chain management
SCs ..... Smart Contracts
SDG´s ..... sustainable development goals
SFSCM ..... sustainable food supply chain management
SME´s ..... small and medium-sized enterprises
SSCM ..... sustainable supply chain management
TBL ..... Triple Bottom Line
TOE ..... Technology-Organizational-Environment

1 Chapter - Introduction

1.1 Theme

By the year 2030, the Unit Nations have set the goal of implementing 17 different sustainable development goals (SDG´s) in order to achieve economic growth, social integration and environmental protection, thereby ensuring the preservation of ecosystems and their strong resilience. A drastically increasing amount of material consumption is the reason that the task "Responsible Production and Consumption" is included in the agenda. It is intended to drastically reduce food loss on both parties, companies, and consumers and therefore to consume resources' in the most efficient way. It should be ensured that the use of materials does not lead to the overuse of environmental resources. For this, measures must be taken to create production more efficient. This is urgently needed, due to a drastically increased amount of the worldwide material consumption. However, the responsibility is not only on the side of the producers but also on a part of the end-consumer. Dietary decisions of the end-consumer have a major impact on the worldwide energy consumption by food production and on the waste generation. Every year nearly 1/3 of the produced food worth $1 Trillion is not consumed. In order to influence consumer awareness, it is important to inform them about origin, processes and their effects, e.g. with special verifications. Only with trustworthy and correct data, customers can be convinced of their social responsibility. This can be done by implementing a traceability technic, which makes it possible to determine the origin of the food, exact locations, or application of an item by means of documented reordered. In addition, through better transparency, there is an opportunity to reduce logistics costs while at the same time improving operational performance over a multi-sided global supply network. The focus of this dissertation is on the food industry, as it is responsible for 30% of the world's energy consumption and for approx. 22% of the world's greenhouse emission (United Nations). To implement all of this in the best possible way into companies, it is necessary to improve the entire food supply chain and to expand with sustainable aspects. Thus, companies work with a sustainable supply chain management (SSCM). Therefore, it is essential to develop the traceability of the whole product flow and to guarantee a better transparency for all parties. Existing traceability tools have the difficulty not to cover traceability for the entire supply chain and are not full trustworthy.

On the other hand, it is not enough to educate only the consumers, it is also important that companies recognize that sustainable food supply chain add value to the customers and themselves. Studies shows that business intention and environmental protection can work together und and is an

important business concept (Shin, van Thai, Grewal, & Kim, 2017). Therefore, companies benefit as much from an improved environment as private individuals. Studies attest that investing in environmental protection is more beneficial than replacing the damage incurred (Siemieniuch, Sinclair, & Henshaw, 2015). Rather, companies that have recognized the importance of sustainable development activities can differentiate themselves from their competitors and reposition themselves in the market, secure competitive advantages and benefit financially (Schaltegger & Synnestvedt, 2002; Wagner, 2009).

For the implementation of the required sustainable food supply chain one of the biggest advantaged for companies is that emerging technologies has been arisen in the market as a result of digitization. The term digitization describes the increasing use of networked digital technologies in our society. Networked systems make it possible to exchange data and thus information and to intelligently can react to one another. The networking of digitization enables an efficient exchange and networking with suppliers, customers and users (Lyytinen, Yoo, & Boland Jr., 2016).

Especially for the food supply chain one promising emerging technology that can promise significant improvement is the blockchain (BCT) technology. In the year 2008 the blockchain technology received the first attention due to the White Paper with the Title Bitcoin: “A Peer-to-Peer Electronic Cash System„ which was anonymous published (Nakamoto, 2008). Since its release, the underlying technology has been considered as the biggest invention since the Internet (Mougayar, 2016b, p. 6).

Major research on blockchain technologies focused mainly on the financial industry. However, the sectors of application the blockchain technology are going beyond to the financial industry. Moreover, it also offers innovative potentials in the areas of education, energy, governance, healthcare, identity, mobility, sustainable supply chain and many others (Hughes, Park, Kietzmann, & Archer-Brown, 2019). Especially for the food supply chain are enormous opportunities to address the concerns of the consumers and producers. The technology as a distributive ledger technology and especially the aspects improving the product traceability, immutability, incorruptible and efficient data exchange are important improvements for the food chain. With the technology there is the possibility to bring together all parties which are involved in the value chain, such as producers’, suppliers, intermediaries, government and the end-consumer (Leong, Visking, & Stewart, 2018).

In Europe, 99% of small and medium-sized enterprises (SME´s) are responsible for food production (Limbourg & Anais, 2019). Germany is one of the most important European markets for agricultural products worldwide. The German market counts as the third largest exporter and the second largest importer (export.gov, 2019). In particular, SME´s can benefit from the agility of the

blockchain and because of the worldwide importance of the German agriculture market; the focus of this dissertation will be on small and medium-sized enterprises in Germany.

1.2 Research problem and research questions

The Deloitte Millennium survey from 2019 revealed that the most addressed challenge for Millenniums and the Generation Z is to protect the environment. Moreover 27% of the participants are convinced that enterprises are responsible for protecting the planet (Deloitte, 2019).

Additional to the growing environmental concerns, there is an increasing quantity of food wastage and food scandals in the global marketplace. Due to internationalization, it is becoming increasingly difficult for the end-user to find out where exact the products came from and what it contains. All these factors complicate the relationship of trust between producer and consumer (Montecchi, Plangger, & Etter, 2019).

This situation reinforces the statement that companies should work with a sustainable corporate policy and could generate an enormous opportunity for market participants. Operating with sustainable practice it not only opens up for a market advantage, but can also serve as a role- model for other companies (Awaysheh Amrou, Klassen Robert D., Dirk Pieter van Donk, & Taco van der Vaart, 2010).

Due to the connection from blockchain with cryptocurrencies such as Bitcoin, Ethereum & Co., it is becoming attention increasingly in the media and scientific discourse. Then, the technology promises a shift for business processes in companies due to its technical attributes. The unique combination of information technology methods is one of the reasons for revolutionary approaches. The core features of blockchain technology are that transactions are immutable, traceable, and decentralized and reliability. The blockchain promises by its decentralized property to make intermediaries superfluous (Hughes et al., 2019). In addition to its potential to revolutionize global payment traffic, the blockchain, in conjunction with its applications and further developments, offers fascinating approaches to a sustainable economy and sustainable food chain. Digitalization and end-to-end transparency create the opportunities to improve the sustainable international trade and food supply chain.

Although acceptance, understanding and finance investment in the technology are steadily rising, a study from Deloitte Insights with 1,386 senior executives from several countries like Brazil, China, Germany, found out that 43% are still convinced that the blockchain is experiencing an overhyped in the year 2019 (Matthew, Blythe, Hurley, Khan, & Gangopadhyay, 2019).

Previous studies and projects have already been able to improve many challenges in supply chain quality management. However, the issue of trust between the individual members involved

and the asymmetrical flow of information in the production process have been not resolved (Chen et al., 2017). In addition, IBM has partnered with Walmart to launch the "FoodTrust" project to achieve full food traceability. The main focus from IBM and Walmart projects are on large multinational enterprises in China and the United States of America (Kamath, 2018).

There is a lack of detailed research on the adoption status, potential and challenges of the introduction of blockchain technology in small and medium-sized enterprises in the Germany food sector, which constitutes to a research gap.

This dissertation aims to expand the previous studies, to address the research gap and to examine the effects and potential applications of blockchain technology for a sustainable and successful food chain, when businesses are small and medium-sized. To identify the impact potential and challenges of utilizing blockchain technology in the food supply chain area in small and medium-sized companies. To build a base for the study, existing scientific literature will be reviewed. In particular, the Technology-Organizational-Environment (TOE) framework is used for small and medium-sized companies operating in the food industry. Thereby, relevant factors for the implementation are revealed. In addition, detailed interviews with blockchain experts will be conducted, which will bring substantiated specialist knowledge into the subject.
In this regard the problem statement will be addressed by the following research questions (RQ):

RQ 1: What are the key challenges of implementing the blockchain technology in the food supply chain of small and medium-sized enterprises?

RQ 2: What are the Sustainable impacts of the blockchain technology for small and medium-sized enterprises?

Derived from these two research questions the following sub-questions are chosen to comprehensively examine the research questions:

RQ1a: What are the motivations for introducing blockchain in the food supply chain?

RQ1b: Which conflicts can arise by applying blockchain in the food supply chain of SME´s?

RQ2a: What are the general and sustainable success factors for applying blockchain in the food supply chain?

Therefore, at the end of the research the above mentioned questions will be answered and discussed.

1.3 Purpose

The objective of this thesis is to examine which impact and potential the implementation of the blockchain technology for a successful sustainable food chain of small and medium-sized enterprises has. In order to achieve that goal and because of the importance for the food market the focus will be on the German market. This choice is reached because Germany has already released a national blockchain strategy in 2019 (BMWI, 2019). Germany is among the first countries in the European Union, giving this technology the platform of a “national strategy”. These new rules provide legal certainty and, with it, a standard fundament to create more dynamics in the public sectors (start-ups, investors, industrial corporations, financial organizations), in Germany and in other Europeans countries through a “follow the leader” business behaviour. Thus, studying the impact of blockchain technology along food sector and supply chains fit perfectly to close the detected gap above referred.

The presented literature review is divided into the definition of small and medium-sized enterprises supply chain, sustainable food supply chain management (SFSCM) and the blockchain technology. With the explanation of the basic technology, a better understanding of the potential impact and sustainable food chain environment is created. The first mention of blockchain technology in the year 2008, defined the starting year of the published literature. In addition, due to the rapid technological advancement of the blockchain and the constantly new findings in the scientific and media discourses, the reader should note that the timeliness of the edited information of this Master thesis can only be guaranteed at the time of completion (approximately July 2020).

1.3.1 Approach

For a qualitative investigation with a multi-methodology approach, data collection techniques, document analysis, case studies, including semi-structured expert interview analysis were used. Using a mixed method research by combining qualitative and quantitative data, the output of the research is more specific, and it is a flexible method to address research questions of all types. The following part describes which research approach is chosen for this dissertation.

For covering, the theoretical part of this thesis there will be a quantitative document review. In these parts the theoretical parts about SME's, sustainable food supply chain management and the basics of the blockchain technology is enclosed. The first part of the thesis will be an introduction to small and medium-sized enterprises. To define sustainability and to find a concept or a form of evaluation, the concept of the Triple Bottom Line is examined. Existing literature is analysed and

qualitative and quantitative methods of empirical research are used to investigate specific factors influencing sustainability in SME´s in the food industry. The qualitative research will be used to gain a first insight into the topic. Existing quantitative studies regarding consumers will be supported. The resulting findings can then be used for further analysis.

The TOE-framework describe the factors which will influence the acceptance of new technology and as and result, the adoption influence factors for small and medium-sized enterprise can be understood. Through the analysis, it shows the potential and the challenge for companies adopting a new technology and for persuading a sustainable environment.

The method of expert interviews is chosen because by preparing the interview and asking questions a broader understanding will be developed. As a Guideline for the in advanced prepared interview question the TOE-framework is used. The origins of the participants are from Germany. The blockchain expert from InnoBlock and the supply chain expert from MHP will be interviewed. InnoBlock is a leading German start-up that consults industrial companies on the implementation of blockchain technology. Their expert assessment will help to understand the current adoption status of blockchain in small and medium-sized enterprises for the German food market and therefore a professional evaluation can be made.

In the last phase the results of the previous sections will be used to answer the research questions. The information from the expert interviews will assessed according to the dimension and factors of the TOE-framework. The result will help to identify the key elements of the blockchain technology which affects food-producing SME´s (Pickton & Wright, 1998).

1.3.2 Scope of the research

The Master thesis considers two broad subject areas, which can be combined to provide new approaches. Therefore, a concrete application area was defined after the first research phase.

Although the blockchain technology offers a wide range of applications, the impacts on food supply chain management were narrowed. This is necessary to ensure a link between the technology and sustainable supply chain management. In particular, the possibilities offered by improved transparency and traceability will be considered. This approach provides a high-quality insight into the blockchain, which can be used for sustainability work.

This type of research is chosen to acquire new insight and conducted to address a problem, which has not been studied yet. More clearly, previous studies have only investigated the impact of

blockchain technology in large global operating companies. Nevertheless, the relevance of the topic is essential because SME´s play a significant role in the economy of a country.

Once, all data has been obtained and the respective analysis is completed, it will be possible to fill the detected gap, which triggered this research. Finally, addressing the issues of what are potential, and challenges of implementing blockchain technology in the food supply chain of small and medium-sized enterprises can be understood. The present research will contribute knowledge to SME´s companies and enlighten them about how they can address the potential of the blockchain technology for their sustainable food supply chain.

1.4 Outline of the thesis

This section provides an overview and summary of the chapters of the following dissertation.

- **Chapter 1** forms the structure of the work. The beginning starts with an introduction and an explanation of the topic and its objectives.
- **Chapter 2** concerns the literature review, which is divided into three subchapters, namely:
    - **Subchapter 2.1** includes an introduction to SME´s. Starting with the definition and characteristics of SME´s in Europe and their particular importance in Germany. Additionally, the impact of the customers is conducted. For understanding the sustainable concept, the approach of the Triple Bottom Line is explained, which consists of the three parts People, Planet and Profit**.**
    - **Subchapter 2.2** gives a detailed explanation of sustainable food supply chain management. It begins with a general overview of the food supply chain followed by sections detailing the sustainable supply chain management and sustainable food supply chain management.
    - **Subchapter 2.3** begins with an overview of the blockchain technology and the concept based on it. In particular, the blockchain technology in the food supply chain is discussed. Then the blockchain paradigm and the challenges are explained. Additionally, the approach behind the TOE-framework will be introduced. This frame here work analyses the factors that are responsible for the successful implementation of an innovation.
- **Chapter 3** follows with an explanation of the methodological approach. A case study, expert interviews and the categorization framework are chosen and will be explained further.

- **Chapter 4** presents and details the Case Study:
- **Chapter 5** deals with the analysis of the previous results to answer the research question of the thesis and the developed hypothesis. TOE-analysis will be conducted to adequately address the main features of blockchain and seek the advantages and disadvantages for food SME´s of a directly implemented blockchain in food SME´s. Moreover, the triple bottom line is applied to the blockchain in the food SME´s to analysis the sustainable impact
- **Chapter 6** Conclusion and further research sums up the dissertation, tackling the research questions and thoughts to put up for further research and studies.

The first chapter built the background of the research and helps to understand the theme, research problem and the purpose which this dissertation aims. The thesis outline in chapter 1.4 provides and overview about each chapter topics.

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2 Chapter – Literature Review

2.1 Theoretical background about small and medium-sized enterprises

The central observation object of this dissertation is the sustainability of the food industry in Germany and the small and medium-sized enterprises operating in it. To generate a precise understanding of the food industry for the later analysis of the sustainability of these companies, the first step is to define and characterize SME´s. Against the background of the focus on the German food industry, the first step is the economical classification of SME's in the German food industry. This is followed from the analysis of the changed consumer behaviour and its influences and impact of SME´s.

2.1.1 Definition of small and medium-sized enterprises

In scientific literature or in economic policy discussions small and medium-sized enterprises are not always clearly classified. There are country-specific differences to define a corporation as an SME, for example the size of the company or the reached annual turnover. The dimension of “small” and “medium” differentiate from the domestic economy size of a country. This is the reason, which could lead to an underestimation of the overall economic influence of SME´s in statistical comparisons and existing literature.

Besides, the different nomenclature, countries have the common principle that it is necessary to determine companies according to their size or structure. Due to their importance in global food production, the research focus of this dissertation is on SME´s enterprises in Germany. SME´s are known in Germany under the term “Mittelstand”. Germany is chosen because the country is a leader in the organic food production. Germany is a member of the European Union, the classifications of SME´s in Germany classified after the laws and regulation of the European Commission (Günterberg & Kayser, 2004) .

In the EU recommendation 2003/361, the European commission has defined small and medium-sized companies according to the size of the employees and their annual turnover or balance sheet. A company is being categorized as a medium-sized enterprise with maximal 249 employees and a maximum turnover of €50 m or the total balance sheet total is not greater than €43 m. medium-sized companies are followed by small enterprises (European commission, 2018).

For a company to be defined as a small enterprise, the number of employees must not exceed 49 and the annual turnover must be maximum 10 million Euros, or the maximum balance sheet is

less than 10 million Euros. Micro-enterprises have fewer than 10 employees and a maximum annual turnover of up to €2 million or a balance sheet of total up to €2 million (European commission, 2018). Table 2.1 summarized the enterprises classification according to the EU recommendations 2003/361.

Table 2.1 Enterprises classification (Source: Own source adopted to (European commission, 2012))

Company Classification	Employees	AND	Turnover	OR	Balance sheet total
Medium-sized	< 250		≤ € 50 m		≤ € 43 m
Small	< 50		≤ € 10 m		≤ € 10 m
Micro	< 10		≤ € 2 m		≤ € 2 m

The threshold only applies for individual companies. If a company is part of a larger group, the number of employees and the total turnover or the balance sheet total are decisive for the figures of the whole group. Besides to the size of the company, the group of SME´s also differs in terms of the sector, products and services they offer in different markets (Rößl, 2005).

2.1.2 Characteristics of small and medium-sized enterprises

In contrast to large international companies, SME´s differ not only in the quantitative demarcation like in size and turnover but also in their organisational orientation.

In the scientific literature, there are corresponding catalogues of characteristics that serve to distinguish SME´s from large companies. With the help of this catalogue, the same characteristics are determined and identified that SME's have. However, the various catalogues vary in features and characteristics. For this reason, there is no main catalogue of characteristics that can be used to represent all companies. Mugler (Mugler, 2008) defined the following points to determine the characteristics of SME´s in his book “Basics of the business administration of small and medium-sized enterprises”.

- Strategic decisions are made based on human factors
- Companies are often managed by the owner
- Personal responsibility of the enterprise success or failure
- Relations with customers, suppliers or other important company contacts are part of a close company network
- Companies operate with a flat hierarchy between managers and employees
- SME´s offer a high degree of flexibility and can therefore anticipate customer wishes and environmental changes quickly

- The companies have a small market share
- The company is not dependent on a large company (Mugler, 2008).

SME´s are not in the focus of the media nationally and nationwide and therefore not under public pressure. This allows the owner to run their business at their own discretion, with the personal attitude being the same as that of the company (Spence & Rutherfoord, 2003). In managing small businesses it is important to recognize and balance the owner-entrepreneurs intentions, business resources and opportunities and environmental opportunities (Sirec & Mocnik, 2010).

The qualitative aspects are key decision criteria in the choice of the business form, how it is financed, how products are offered and produced and to what extent the companies operate innovatively (Günterbeger & Kayer, 2004).

2.1.3 SME´s influence in the German food sector

The Down Jones Sustainability index reflects an international ranking on the sustainability of companies. In the index, SME´s receive slight attention. Nevertheless, SME´s are responsible for a significant contribution to a country's economy.

Reasons for that are:

- main employer
- size allows responding more quickly to changing market conditions
- have a special responsibility in their region
- the major contributor for value creation (OECD, 2017)

More than 99 % of the German companies are categorized as SME´s, they have a signification impact on the German economic and innovation strength. German SME´s are worldwide known for their high-quality standard “Made in Germany”. One in two SME´s operate internationally and employee around 58 % of the German population who are subject to the social contribution (Bundesverband mittelständische Wirtschaft Unternehmerverband Deutschland, 2020). SME´s are responsible for approximately 35, 3% of the total corporate turnover. The 2013 R&D data report found out that SME´s invest a considerable amount in their Research and Development and show for that, that they are highly innovative (Federal Ministry for Economic Affairs and Energy, n.d.). In particular, the food industry is one of the most critical sectors for small and medium-sized enterprises in Germany. After the automotive sector with 406 billion Euro turnover and the mechanical engineering industry with 219 billion Euro the food and beverage production is the third-largest industry sector with 179,6 billion Euro in Germany (Lindel & Daniel, 2018; Mittermeier, 2016).

Germany`s good food quality is in demand internationally, that is underpinned by the fact that the country is globally the third largest exporter of food products to the world market, from that three quarters of all exports are going to the countries in the European Union. That confirms that Germany is an attractive location in terms of price and quality. A steadily growing importance for import and export in the German food industry can be observed. (Bundesministerium für Wirtschaft und Energie, n.d.; Lindel & Daniel, 2018).

2.1.4 Shift in the German food demand

In the previous section, it became clear how important SME´s are for the German food industry. Consumer prices and household expenditure are other significant elements to provide a picture of the input that consumers contribute to the value creation. This will help to identify interfaces between consumers and sustainable food production. Consumers are increasingly interested in buying sustainable goods. Additional they demand that companies not only act sustainable; they also expect the same from their business partners. For this reason, consumers compare different products online in advance to find out under what conditions their products are produced. For a better understanding of the purchasing decision, Nielsen interviewed 30,000 consumers from 60 countries and asked them about their sustainable purchasing behaviour. He found out that consumers are asking for new product innovations that are affordable, healthy and environmentally friendly. The survey also investigated that the most significant influence on purchasing decisions is trust in the company, which accounts for 62% of the total (Nielsen, 2015).

One question in the survey was: *"How much do you agree with the following statement: I am willing to pay extra for products and services that come from companies who are committed to positive social and environmental impact?".* The results are shown in Table 2.2 (Nielsen, 2015).

Table 2.2 Top sustainability purchasing driver drivers for global respondent vs. those willing to pay more (Source: Own source adopted to (Nielsen, 2015))

	Global Respondents	**Those willing to pay more**
Trusted brand/company	62 %	72 %
Product is known for its health benefit	59 %	70 %
Product is made from fresh/organic ingredients	57 %	69 %
Company is known for being environmentally friendly	45 %	58 %
Company is known for its commitment to social values	43 %	56 %
Packing is environmentally friendly	41 %	53 %
Company is known for supporting my community	41 %	53 %
I saw an ad about the social and/or environmental good the company is doing	34 %	45 %

The survey also found out, that more than 50 % of consumers are willing to spend more money for products of companies which image is environmentally friendly and committed to their social community (Nielsen, 2015). Nielsen sustainability report shows that a demand for sustainable products exists. For a broader understanding about the German market, the following section examines the expenditure of the German population. Considering the consumption and the associated household expenditure for food and beverages of the German population, it becomes apparent that on average about 20% falls into these areas. This means that after rent payment and the associated water and energy costs, food and beverages are the second-highest household expenses in Germany (Rudnicka, 2020). A study conducted between 2004 and 2018 shows that the German population is becoming increasingly interested in how their food products are produced. This is reflected in the following graph (figure 2.1).

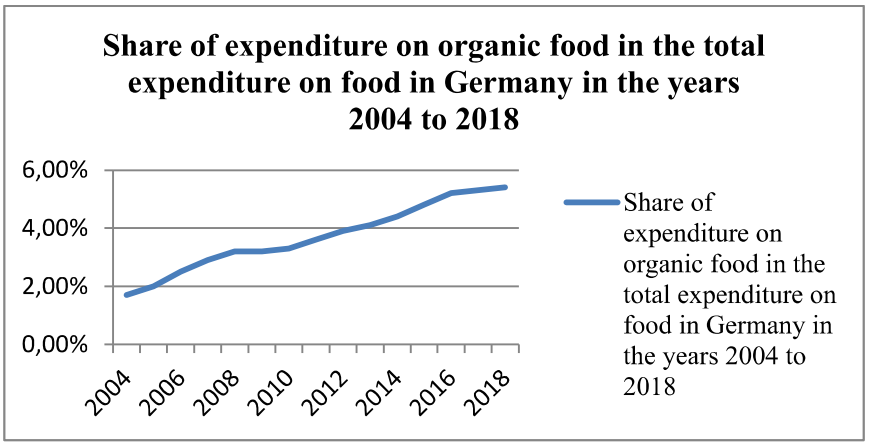

Figure 2.1 Expenditure on organic food in the total expenditure on food in Germany 2004-2018 (Source: Own source adopted to (Henrich, 2019))

Since 2004 exist a steadily growing trend that the German population demand more sustainable produced food. Figure 2.1 demonstrated that, by the fact that there is a clear trend that Germans are spending more and more money on organic food.

2.1.5 Sustainable SME´s and the sustainable food production

For addressing the needs of a sustainable future and the sustainable food demand of the consumers, it is important that different parties, such as companies, governments and other stakeholders collaborate. Various ecological, social, or economic activities are of particular importance. This not only improves sustainability but also preserves business objectives for companies. All this can be done integrative, which means that ecological, economic, and social goals do not exist in parallel within existing management but are brought into harmony. This ensures that companies develop sustainably practices and at the same time contribute to their social responsibility and sustainability operating company does not depend on the company size (Beske, Land, & Seuring, 2014).

Large companies recognized the importance of sustainable management early on, this is reflected in the Down Jones Sustainability Index, but SME´s are poorly represented in this index. Nevertheless, SME´s are becoming more and more aware of their responsibility, but they are still a long way from a long-term sustainability strategy. Like large companies, SME´s are expected to fulfil their social and societal obligations, not only to meet the demand of their consumers-, but also because SME´s contribute a significant share to a country's economy. Due to their size, SME´s underestimate their influence on sustainability. For this reason, it is particularly important to educate them about their impact and influence (Figge, Hahn, Schaltegger, & Wagner, 2002). There is a proven

correlation between corporate value and sustainability. Consequently, it becomes more important for SME´s to understand this connection (Jiang & Fu, 2019).

The challenge for SME´s is to find out which factors are included in the definition of sustainability and how it would add value. In the literature, there are various concepts of sustainability, making it clear that there is no universal definition of sustainability. Each concept places a different emphasis on which dimension intensively should be considered. In this research, the concept of the Triple Bottom Line form John Elkington is chosen and will be explained in chapter 2.1.6.

2.1.6 Triple Bottom Line

John Elkington developed the Triple Bottom Line approach to improve all three dimensions in the year 1994. The "Triple Bottom Line (TBL)" describes the concept of sustainability as a permanent balance between economic, environmental and social performance and is also known as the concept of the three P´s, people, planet and profit. To be truly sustainable, a balance must be struck between all three. In a world that is becoming more and more global and complex, with a lack of respect for social justice and environmental impact factors, it is becoming more evident for companies to integrate these areas in their strategy to survive in the market in the long term (Elkington, 1994; Rambaud & Richard, 2015).

The differentiation from the Triple Line concept with other sustainable concept is that it considers that environmental and human value is added or destroyed.

a) **People:** The people section measures the extent to which companies pursue their social responsibility within their organisation. People are part of the social capital and thus the essential function that promotes social integration and the further development of society. This instrumental function has a normative value of its own, which means that perceptions and evaluations are mostly subjective and therefore subject to constant change. The aim of companies operating within the concept of TBL is to give something back to society. Such companies operate with fair working conditions such as a safe working environment, tolerable working hours and ensure that their employees and partners are treated equally fair (Sargani, Zhou, Raza, & Wei, 2020). Also, they respect and promote the community and the region in which they operate. A concrete example of the people dimension is that a company does not promote child labour and monitor it cooperation partners in this aspect. These companies not only look after their own employees but also give something back to their community. This could be done, for example, by providing health care or promoting education. The people dimension is an intangible nature, which

makes it challenging to grasp and measure (Onyali, 2014).

b) **Planet:** The second-dimension planet (also known as natural capital) is about how a company fulfils its environmental responsibility. Ecological factors include food cycle rounds, climate system and solar irradiation. The ecological chapter could be available directly, either such as solar irradiation-, or indirectly as a service provider to ecosystems (e.g. natural resources). The aim is to estimate the natural order and use it to the extent that no permanent damage is created. The planet part of the Triple Bottom Line leads companies to reduce their ecological footprint. Activities that could be included would be waste reduction, investment in renewable energy and the best possible use of existing resources, improving logistic processes, and recycling processes. Companies operating within the TBL approach do not produce products that harm or destroy anything, such as weapons, or harmful products that damaged the environment. Likewise, practices that cause significant damage to the environment are avoided. An example of that is that they do not support overfishing of the seas or other dangerous practices that destroy natural resources. In contrast to the people dimension, the planet dimension can be better quantified (Hauff, 2014).

c) **Profit:** The profit dimension contains the classic profit and loss account of a company. The economic production capital can be in the form of material, knowledge, and human capital (e.g. patents, qualified employees) as well as resources brought into the economy. The profit aspect must be seen in the context of sustainability, as the actual economic benefit for the society of the operating region. TBL sees it as part of its business plan. Thereby it becomes evident that sustainable acting can be in harmony with the other dimensions. In contrast to the planet and people dimension, the profit dimension is the easiest to measure because it can be determined in monetary units (Kleine, 2009; Sargani et al., 2020).

Figure 2.2 the interconnection of the Triple Bottom Line concept elements according to John Elkington (Source: (Elkington, 1994))

For TBL data determination, companies can collect information at state, province, and national level, but if necessary, information can also be collected at municipal level. Due to different geographical characteristics and different sizes of the project, the measures can be adapted flexibly. For example, a local project would conduct the data on a national level. The flexibility of the TBL makes it possible, that companies can adapt the concept to their specific requirements and needs (Slaper & Hall, 2011).

Essentially, the TBL should represent an easily understandable concept and serve as a guideline and, if pursued, lead to the sustainable development of a company. All those aspects substantiate the existence of the TBL concept.

The differentiation and definition of the objectives of sustainable development on a TBL basis serves as a starting point for the further concretization of the contents. The implementation of the listed sustainable business objectives should be carried out in the entire business environment, as described above. These are prerequisites for a sustainable supply chain, so that sustainable production and its efficient allocation can be achieved. For SME´s means that they need to understand how they can improve, how they can measure and what impact an optimal supply chain can have. Long-term transparent ecological and environmental assessments are supported by sustainable initiatives that emphasize and ensure the sustainable profile of companies (Székács, 2017). Complex partnership's and processes emphasize the need for monitoring strategies that need to be integrated into the system framework. They should deliver decision influencing results while ensuring full transparency (O'Brien, Wechsler, Bringezu, & Schaldach, 2017) .

In the future, only companies which operate flexible and face new challenges and requirements will profit and survive in the market. Especially Industry 4.0, which is emerging as a new technological area, makes clear to companies the absolute necessity to keep up with the new technologies. As supply chains are becoming more and more complex and further data sources are being integrated into the value chain and this integration effort is very complex, a first technology change in supply chain management has already taken place in the past, which will be explained in more detail in the next chapter (Ivanov, Dolgui, & Sokolov, 2019; Pfohl, Yahsi, & Kurnaz, 2015).

Chapter 2 forms the basis of this master thesis. For this purpose, the first step is to classify and differentiate SME´s. Companies with a maximum of 249 employees, a maximum balance sheet size of 43 € million and sales of 50 million fall into this category. SME's in the German food industry is an important growth factor for the German economy. For this reason, their sustainable behaviour is of importance and should not be underestimated. This statement is further underlined by the purchasing behaviour of the German population, which has been more and more focused on sustainably produced food in recent years. To meet the requirements of the German food industry and the German population, the concept of the Triple Bottom Line was taken as a basis. The goal is to harmonize the areas of environmental, social, and economic.

2.2 Theoretical background about food sustainable supply chain management (SSCM)

In the year 2020, companies operate more extensively in a broader environment, which is made up of various variable factors. Any change in economic, political, technological, environmental, or legal conditions will have a drastic impact on the way how enterprises operate. As a result, organizations must implement SSCM practices to respond successfully to these challenges. Successful implementation of SSCM practices is needed (Silva, Guarnieri, Carvalho, Farias, & Reis, 2019).

For this reason, the following chapter provides first an introduction to supply chain management (SCM) in the food industry, which is then supplemented by the potential, effects and challenges of SSCM and particularities related to the food supply chain. To successfully implement the SSCM the Triple bottom line approach is explained in chapter 3.3, it is crucial that the environmental, social, and ecological aspects are added and harmonized to supply chain management.

2.2.1 Supply chain management

There are various definitions of supply chain management in the literature, focusing on different angles. The Council of Supply Chain Management Professionals is a professional association for the supply chain management. The aim of the association is to improve and disseminate research and knowledge about SCM, and for this reason its definition was chosen “The Council of Supply Chain Management Professionals definite the SCM as followed:

Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. Supply chain management integrates supply and demand management within and across companies.” Council of Supply Chain Management Professionals (2013); (Council of Supply Chain Management Professionals, 2013).

It can be said that in SCM are all parties involved within the value chain are controlled, which is the reason why it plays a central important role within the company.

Globalization has made it crucial for companies to make their value chains effective, efficient, and flexible. Due to shorter product life cycles and fluctuating market demands, companies are forced to react to situations at short notice to optimum use of resources and materials. Besides that, changed framework conditions such as increasing production costs, new legal regulations and limited

resources are, among other things, challenges which have to be mastered and are managed in the SCM of a company (Banerjee, 2018).

In the past, a significant amount of companies has decided to relocate their production facilities abroad due to rising energy and labour costs. Asia and Eastern Europe were preferably chosen, because of their lower labour costs. The increasing transports costs and transportation time, through to more extended distribution channels were not considered as a basis for decision making (Vestring, Rouse, Reinert, & Varma, 2005).

The availability of new technical possibilities, such as hardware or application solution in the field of digitization increases the pressure for SCM continuously improve. Many companies pursue the goal of efficient mapping control of the entire value-added chain in terms of technology and processes to stay competitive in the long term. A critical factor for a company is which decides to examine the SCM for further optimization potential, the factors customer, supplier, and processes must be viewed holistically. Customers and monitored supply chain are equalled important to obtain a precise overview of who is involved in the networked value chain (Erceg & Damoska-Sekulowska, 2019).

The more information is available about a supply chain and its influencing factors, the better it can be designed, planned, and controlled. At best, it is possible to react to changing market situations in advance. The Internet has revolutionized the possibilities of global data exchange and has become indispensable for the flow of information. Today in the year 2020 there is a considerable amount of information available, which must be sorted and processed according to relevance. Among other things, the SCM has the task of collecting and evaluating the data necessary for the supply chain and deriving appropriate strategies and actions. As a result of that, manufacturing companies which receive raw materials and supplies can place and adjust orders in real-time. Additional, since it is possible to connect and interact through the internet, customers can place their orders directly with the company. An effective SCM makes it possible to accept orders for their production lines in real time or to accept last-minute requests for changes. Nevertheless, digital networks companies must ensure that customer requirements regarding data security and transparency are met. To ensure further customer requirements with regard to data security and transparency, some technical and cultural challenges have to be overcome (Foerstl, Hartman, Blome, & Reuter Carsten, 2010).

2.2.2 Sustainable supply chain management

The present research examines sustainability practices from SME´s with a focus on the sustainable food supply chain management. Therefore, subchapter 2.2.2 describes sustainable supply chain management in SME´s in food business sector.

The population is becoming more and more aware of environmental issues like global warming, and therefore, companies need to recognize that resources are not infinitely available. Government regulations are passed by public authorities to seize companies in their environmental responsibility regardless of size and business. To counteract this, and meet their sustainable commitments, sustainable supply chain management must be implemented in companies.

With establishing SSCM, the entire supply chain should be sustainably improved in terms of ecological factors. Furthermore, it shall help to expand the firm to an eco-efficiency and sustainable production company. By expanding SCM to SSCM, the goal is not only to remain competitive but also to respond effectively to changing market conditions. In SSCM, all material and information flow as well as collaborations between companies in the whole supply chain will be characterized by the three dimensions of the triple bottom line of sustainability, economic, ecological and social (Shumon, Rahman, & Ahsan, 2017).

A hurdle for the sustainable profile of a company is that not only the directly allocable activities are affected, but also from each individual cooperation partner. Especially in a global supply chain, where many individual instances are involved, controlling and monitoring is demanding. Once a party is associated with unethical aspects, stakeholders take the company to responsibility. That underlines the importance of relationships between each partner. The ecological profile of a company is an essential factor for the long-term success of a company (Azevedo, Carvalho, Duarte, & Cruz-Machado, 2012).

Companies which have not consistently focus on sustainable products are challenged to reduce social and environmental risks in their supply chains to secure reputation and sales , for example, to take social and political developments into account (Schaltegger & Harms, 2010). When a company integrates the supporting factors of a sustainable supply chain into their company, a sustainable profile for the company can be created. It is important that the integration starts from the focal company, which is the hub for all parties involved, leads, manages and is responsible for the supply chain (Liu, Bai, Liu, & Wei, 2017).

To sum it up, it can be said that sustainable supply chain management is the extension of supply chain management with the aspects of sustainable management. For the best possible implementation of the sustainable supply chain practices John Elkington developed the concept of

the triple bottom line, including the economic, environmental, social dimension which will be explained in the next section.

2.2.3 Technology shift in the supply chain management

Worldwide, companies already use software-based enterprise resource planning (ERP) and supply chain management tools to manage and support their internal SCM. With the help of networked manufacturing tools like digital shipping notices and radio-frequency identification (RFID) scans, products can be tracked, and information exchanged along the supply chain on computer-assisted-systems from the beginning of production to disposal (Burmester, Munilla, Ortiz, & Caballero-Gil, 2017). Although if companies have already made considerable investments in their digital infrastructure after the transportation of their products, they often have limited information about where exactly the products are and what happens to them. Despite the ongoing digitalization of SCM, analogue silos continue to exist in corporate infrastructure between the various systems in which data is stored. Individual production steps or the production status can be digitally tracked within the company by using individual shipment number. The challenge is that the assigned shipment number can only identify where the shipment is located and to whom it is addressed. A concrete specification of the contents of the package is not provided. This is particularly important in the prevention of suspected fraud so that the goods cannot tamper. As a preventive measure, companies use an electronic data Interchange (EDI) system and XML messaging to ensure the integrity of information and continuity of information across company boundaries. These so-called "point-to-point" messaging systems face the problem that data is not synchronized on time. As a result, as the information is passed along the entire supply chain, the package can be mistakenly perceived as being in two places at once (Bosch & Penthin, 2018).

Another hurdle with these systems is that they are not technically mature yet. A variety of sizeable internal company data sources, many interfaces and IT systems exist and must be elaborately linked. For example, if legacy systems are integrated, it is necessary to manually import and export data. This is getting more and more complex with increasing data volume and complexity. Furthermore, data sources are continually being added, and the transfer of data across company boundaries forces companies to create new individual interfaces for the non-standardized exchange relationship (Wu, Nystrom, Lin, & Yu, 2006). Moreover, lacking IT-skills and the IT-readiness's of employees limit the potential of implanted ERP systems (CSB, 2020). In the meantime, due to globalization supply chains are no longer one-dimensional supply chains, they are large ecosystems with many possible product variants and interdependent networked suppliers. Moreover, supply

chains are becoming more dynamic, which is due to mass production and the fact that the life cycle of a product is shortening with a greater variety of variants (Ketchen, Crook, & Craighead, 2014).

2.2.4 Sustainable food supply chain management

The core tasks of SCM can be described as the management of processes relating to the distribution of goods and raw materials within a supply chain. In the food supply chain management (FSCM), are several additional factors must be considered. Folkerts and Koehorst defined 1997 food supply chain as *"a set of interdependent companies that work closely together to manage the flow of goods and services along the value-added chain of agricultural and food product, to realize superior customer value at the lowest possible costs." (Folkerts & Koehorst, 1997).* Therefore food supply chain operates in a complex network of organizations, individuals and consists of unique characteristics (Grimm, Hofstetter, & Sarkis, 2014).

FSCM begins with the agricultural processing, followed by intermediate storage through delivery to the food processor, which handles the post-harvest treatment. Then it continues to the food manufacturer, who sends it to the distributor and through an intermediate step it comes to the retailer such as a supermarket which is responsible of the sale until the end, when the end-consumer takes place and buy the product. Between all of the individual parties, individual agreements exist (Costa et al., 2013). Figure 2.3 illustrates an example of a global food chain of a company.

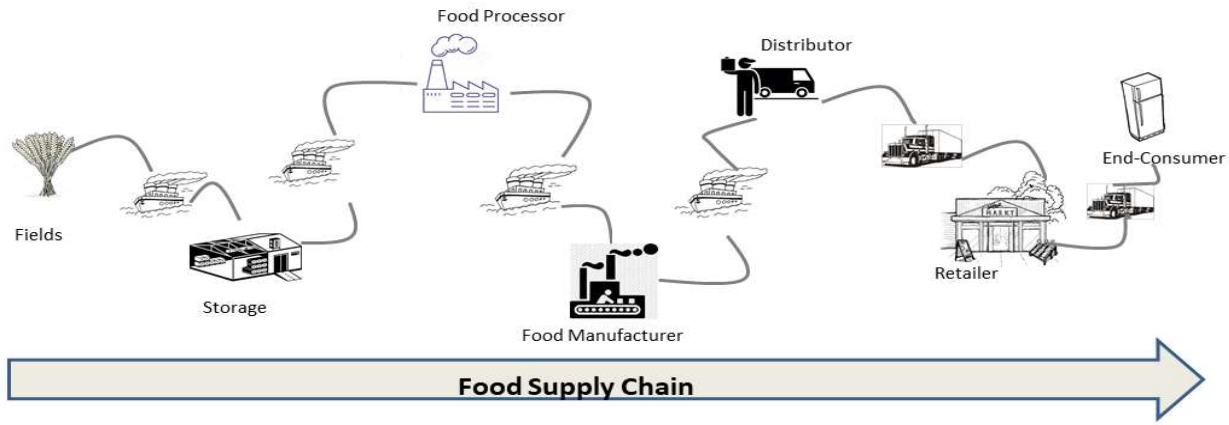

Figure 2.3 Food supply chain (Source: Own source adopted to (CBInsight, 2017))

Throughout the process, various areas and departments are involved and must be informed. This includes, among others, quality control, food security, human rights, environmental protection, cold chain management and resource management. All areas and parties are subject to food supply chain management and must be controlled and managed.

If traditional SCM is compared with FSCM special attention must be placed. The reason for this is that the food subject is underlined to special legal regulations and due to its manifestation there must be special distribution and storage regulations (van Donk, Akkerman, & van der Vaart, 2008).

Other characteristics are because food products have a much shorter life cycle than other products, which leads to quicker processing times and more momentary storage. Food products are also subjected to strict guidelines which may differ nationally and internationally. They require a different cold chain and special transport safety measures to ensure that the products are not destroyed. In the food industry, safety and high-quality standard are significant factors, which underline the requirement for an enhanced tracing and tracking system. All this leads to challenges that are directly related to the food supply chain (Grimm et al., 2014) and will be explained in section 2.2.5.

2.2.5 Particularly in the food supply chain management

As described in chapter 2.2.4., the food supply chain differs from the classic supply chain. For this reason, there are disadvantages that can be traced back to the FSCM.

Transparency

Due to globalization, the international trade of food has increased exponentially. One of the biggest challenges that have arisen from that is the complex and diverse global supply chain characterized by mass production. It is increasingly difficult for companies to identify the exact source of their materials and precursors through the various instances that a good is running throughout the supply chain (Beske et al., 2014; Mithun Ali et al., 2019). Several companies use the complexity of the supply chains to produce under non-jurisdictions. As a result, many workers are exploited, and environmental issues are increased. Improved transparency not only responds to the consumers requests, but also enables individual food guidelines to be created. In the long term, companies should pursue efficient and effective control of the entire chain while increasing trust between producers and consumers. This means for companies not only to provide fully featured transparency but the provided information must be extended with the principles of the triple bottom line (Schiefer & Deiters, 2013).

Traceability

In the FSCM traceability is of particular importance, but not only the internal traceability. The external chain traceability must be addressed. An effective traceability system requires an information connection between the information system and all partner of the supply chain network (Caridi, Moretto, Perego, & Tumino, 2014). Food safety and food standards are special drivers for

traceability in the FSCM, then the concern of the end consumer and producers are identical. The challenge is in complex supply chains. Here, the information is backed up to various servers or storage media, and this leads to are so-called silos where data is lost. A consistent insight and traceability cannot be guaranteed, and therefore the whole system is mainly based on trust. This is illustrated by the case in the United States of America in the year 2006. Contaminated spinach came into the shops, and as a result, three people died, and more than 200 people had disease symptoms. The U.S. Food and Drug Administration was unable to find out from which company the infected spinach came and therefore published a general warning for fresh spinach. In the end, the spinach industry had to accept a loss of about $ 74 Trillion (Seltzer, Rush, & Kinsey, 2009). If the industry or the company had implemented a better traceability system in advance, the damage could have been significantly reduced.

As described in chapter 2.1.4, consumers are particularly interested in buying sustainable produced food, traceability not only enables the visibility for exact ingredients to be identified but also optimize performance across the entire supply chain, especially by dealing with a real-time date. Special attention is paid to the origin of the individual components and if they were processed in an environmentally friendly way. An effective traceability system has the capability to bring new value to the customers and all supply chain actors and provide the right information to the right actors at the right time for an perfect decision-making process (Korpela, Hallikas, & Dahlberg, 2017; Lee, Kim, & Kim, 2014).

The visibility of information can also be transparency. On the other hand, traceability guarantees to track and trace products. Wherever, transparency describes the providing of any for the designed participants of the supply chain (Francisco & Swanson, 2018).

One of the most significant challenges for full transparency and traceability is that all participants in the value chain have to work together (Wonga, Bremmers, Trienekens, van der Vorst, Jack GAJ, & Bloemhof, 2011, p. 74), especially in complex global supply chains with many diverse players. In this case, where an enormous amount of data is exchanged, trust and partnership between all participants is crucial. This is threatened by not having a guarantee that all persons are fully trusted and will collaborate. If the information and data is exchanged via a central storage system, there is also the risk that the information system is hacked, and sensible data is stolen. The risk of an attack is highest with a point of single central instance. Furthermore, every technical innovation involves a large additional financial outlay. As described in chapter 2.1.3, SME´s have a significant influence in the German food production, but they are not as financially well-positioned as multinational companies and prefer to invest their financial resources in process optimization or

production. Tracking and tracing products is fundamental to improve supply chain efficiency, product safety, controlling cost management and improve the partnership.

For that reason, companies must have flexible IT-infrastructures so that they can align processes and operate flexibly. Important business drivers for SME´s are that information of the supply chain can be integrated, and service automation exists (Korpela et al., 2017). From the market perspective, social performance information and communication are key attributes. These features can be ensured by transparency regarding to the producers. To meet the needs of the consumers, the visibility and trustiness can be used to demonstrate the quality and distinguish from the anonymous and disconnected global food supply chain participants. New security requirements and technology innovations lead to supplementary expectations for environmental protection and improved resource use in companies. All of this underlined the need for an advanced technology sustainable food supply chain management (Kirwan, Maye, & Brunori, 2017).

Benefits come from the fact that new invention like the availability of digital innovations such as artificial intelligence, 3D-printer or blockchain technology enables the business to enhance their FSCM in the long run and create a sustainable FSCM (Qiu, Tan, Yan, Chen, & Liu, 2018). Especially the blockchain technology has great potential to improve the FSCM. It can be a valuable tool to fight against corruption and distribute resources (Khosla, Sharma, Sharma, Budhiraja, & Singh, 2019). For that reason, in the next section, an introduction to the blockchain technology will be made.

Chapter three describes that supply chain management deals with the planning, management and controlling of all activities in the whole supply chain. Increasing globalization and constantly increasing environmental issues forced companies to extent their supply chain management with sustainable management. A complex supply chain is exposed to a level of uncertainty and risk when dealing with multiple stakeholders of products and processes that rely on high-quality standards and data. Food supply chains are responsible for providing society with safe and quality healthy food and the challenges of transparency and traceability are key elements to guarantee this. New technology makes it possible that there is a first improvement in the sustainable food supply chain management. Although new technologies improve the provision of real-time information, this is not yet perfect. Underdeveloped technology and incompatibility with existing systems limit the exchange between producers and consumer

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2.3 Introduction to the blockchain technology

2.3.1 Blockchain basics

In the year 1993 Bill Gates, the founder of the Microsoft technology company titled the invention of the Internet as hype (Haunhorst & Raffel, 2012). Twenty-six years later, in 2019, 57% of the world population has access to the Internet (Hootsuite, 2019). As well as the drastic development and spread of the Internet, the BCT promises extensive revolutions that can affect entire industries and business models. For all areas in which transactions take place between producers and-/-or consumers of intangible or digital goods, institutions act as intermediaries due to their special trustworthiness. Distinguished from the financial sectors many other industries deal with the application potential of BCT (Mougayar, 2016b). In her book “Blockchain - A Blueprint for a New Economy”, author Melanie Swan describes the blockchain as one of the other classes of the Internet in terms of comprehensive information technology with graduated technical levels and multiple types of applications for each form of registration, inventory, and exchange, beyond the limits of purely financial transactions. Furthermore, she titled it as the fifth revolutionary computer paradigm that represents the next step in the development of computers, internet and smartphones in a networked world (Swan, 2015).

To create a basic understanding, the following sub-chapters will analyse the BCT, starting with its development and a definition of terms. The underlying technological concept of the blockchain will be analysed followed by its possible application in the food supply chain. Finally, the attributes that make blockchain technology innovative are summarized.

2.3.1.1 History of blockchain

Since the late 1970s, research in distributed ledger technology (DLT) has been taking place. It took until November 2008, when an unknown person using the pseudonym Satoshi Nakamoto published an implementation concept (White Paper) for a cryptocurrency named Bitcoin on the "Cryptography Mailing List" (Nakamoto, 2008). The website www.Bitcoin.org was set up two months before the publication of the White Paper. It should serve as a reference page for users and protect against frauds. Also, it should enable better networking between programming and at the same time serve as a neutral source of information about Bitcoin (bitcoin.org, n.d).

One year after publication, in 2009, the underlying software for the exchange of the virtual currency Bitcoin was published. The software was published as an open source file. If the software is

released as open source, this means that the source code is freely available for everyone. All technical details of a program can be read from the source code. This situation has the advantage of motivating developers to improve and develop the core technology (Zhauniarovich, Boshmaf, Jawaheri, & Sabah, 2019). Nakamoto key motivation for the invention of the Bitcoin was to create a decentralized virtual currency that acts entirely and independently of institutes and banks. The Bitcoin software operates based on the first public distributed blockchain and has been the most popular virtual payment method since its implementation. The peculiarity of the invention is its underlying technology. The Bitcoin blockchain creates the possibility to make direct transactions or payments without relying on intermediary institutions. Instead, the collective computing power in a peer-to-peer (P2P) network and cryptography encrypt the transactions. Regardless of the financial industry and virtual currencies, blockchain gained relevance for a variety of applications (Schütte et al., 2017).

The technology gained that much importance for several industries; then the Bitcoin software is the result of decades of research. The Bitcoin comprises the following four key innovations:

i. decentralized peer-to-peer network (Bitcoin protocol)
ii. public transaction logbook (blockchain)
iii. decentralized mathematical and deterministic currency output (distributed mining)
iv. decentralized transaction authorization system (transaction protocol) (Antonopoulos, 2017)

2.3.1.2 Technical background about blockchain

The blockchain technology is the result of years of research in the fields of cryptography, mathematics, algorithms economic models in a peer-to-peer network using a distributed consensus algorithm to solve distributed synchronized problems. Therefore, it can be said it is a multi-field infrastructure construction. The blockchain is a meta-technology because it influences other technologies and is itself composed of several technologies (Mougayar, 2016b). In the overall system, the elements of the distributed network structure, cryptography and consensus algorithms are combined, which will be examined in more detail in the following section.

In total, the technology contains six main key elements:

1) **Decentralised:** All data of the blockchain are stored decentral. The information is managed on a distributed controller and with no central instance.
2) **Transparent:** The entire blockchain is entirely transparent. Everyone has the authorization to read the stored data.

3) **Autonomy:** The whole network organizes itself autonomously. The consensus algorithm helps the network to make decisions.

4) **Immutable:** With the help of cryptography procedures, it is ensured that the blockchain cannot be manipulated afterwards. The whole network is controlled by all participants. The chain of blocks is therefore unchangeable, forgery and manipulation proofed.

5) **Anonymity:** Each transaction can be read out on the blockchain, but the user can decide whether if his identity is revealed. For the other users, only a unique 30-character long address appears. Transactions take place based on the blockchain address.

6) **Open Source:** The blockchain framework is published open, so the source code is open to further development and improvement (Cachin, Sorniotti, & Weigold, 2016; Lin & Liao, 2017).

Since the publication of the Bitcoin white paper in 2008, the blockchain technology has been further developed, and the blockchain can be classified in different development phases. Blockchain 1.0 as the basis for digital currencies, followed by blockchain 2.0 for the realization of virtual contracts such as financial derivatives and smart contracts in the economic and financial sectors. Blockchain 3.0 comprises the entirety of the applications in decentralized, autonomous organizational units. These are used beyond the (financial) capital market, e.g. in the public sector, healthcare or cultural sectors (Kenichi & Lee, 2018). In the year 2018 the SEELE platform proposed a whitepaper about blockchain 4.0 (Seele, 2018). The proposal has some very ambitious and promising features, but they have not been published in different sectors. Additional the technology can be divided into three different types: Public blockchain, private blockchain and consortium blockchain (Kenichi & Lee, 2018). A further explanation of the different types of blockchain will follow in subchapter 2.3.1.3.

The term blockchain can be examined more closely for its different characteristics. From a technical point of view, the blockchain is a database that makes it possible to publicly manage a general ledger (Distributed Ledger) in a system network. The methods used for this have been known in the field of computer science for more than thirty years (Burgwinkel, 2016, p. 5).

Like the World Wide Web, blockchain can be understood as part of the Internet because they use the infrastructure of the Internet as a protocol with their own technological standards. If the Internet is a platform for the exchange of information between participants, the BCT enables an exchange of values based on this (Hofmann, Strewe, & Bosia, 2017).

If the BCT is used, transactions are protected against manipulation, fraud, and errors. This is possible, and then in the blockchain, all transaction data are combined into a block in chronological

order and will be encrypted. Each individual block contains a reference in the form of a cryptographic hash value to the previous block. With each transfer, existing blocks are merged with the new block. This sequence creates a chain, the so-called blockchain. Before the chain is extended, each individual block must be verified. Cryptographic signature is used to ensure that the blocks are appended to the end of the chain and not to another position within it. This system also guarantees that old blocks cannot be removed or manipulated. After adding the new block, the updated chain is distributed to all nodes. This allows each individual transaction to be tracked since the original blockchain was created (Burgwinkel, 2016). The following figure 2.4 shows a transaction within the blockchain.

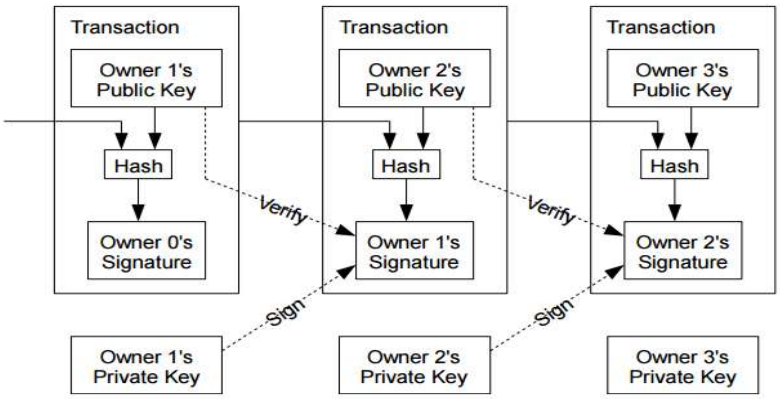

Figure 2.4 Transaction within the blockchain (Source: (Nakamoto, 2008))

Another great advantage of the blockchain is that all movements can be traced. If an attempt is made to manipulate the blockchain, for example, launching a double-spending attack, all participants in the network would notice this and could prevent it. As soon as a block in the chain is changed, the entire blockchain is torn apart. The older a block is, the greater the effort to solve the cryptographic mechanism. Due to this mechanism, the blockchain is considered to be very secure and resistant to cyber-attacks and manipulations (Morabito, 2017). A special feature of blockchain technology is that trust in the system is completely accomplished without the use of any central instance. The trust is based on all network participants; this means that each transaction must be confirmed by the whole network users. Therefore, no central instance is needed (Drescher, 2017).The verification process is referred as the consensus mechanisms. As the number of subscribers increases, the network becomes safer. On the other hand, this means that the whole system is only secure as long as there are enough participants. Another advantage is that by eliminating an intermediary, transaction costs are drastically reduced (Xiao, Zhang, Lou, & Hou, 2020).

This means, for users who want to use this technology, that blockchain software provides the program code through which cryptographic procedures can be performed. It can be accessed and used either as a commercial or a public open source variant. blockchain applications enable the

implementation of various application scenarios using blockchain software or operational blockchain platforms that can be provided as an open P2P network or commercial service, for example, and used by users or organizations (Burgwinkel, 2016).

2.3.1.3 Smart Contracts

As described above, the blockchain technology is published as open source software, which enables further development. The crypto currency Ethereum is a result of such further development (ethereum.org, 2020). In 2014, Vitalik Buterin published a “White paper” that allows developers to create consensus-based applications that are standardized, scalable, easy to build and interoperable (Buterin, 2014). Thereby the Ethereum technology construct is based on the blockchain technology, and his further development is known under the concept of "Smart Contracts" (SCs). These smart contracts are "if-then-conditions" written in computer code, which are stored on the data blocks of the blockchain (Dannen, 2017). The aim is to create logical steps according to fixed clauses and rules. The basic properties of the blockchain are used, thus the information is redundant, transparent and cannot be manipulated. Exemplary, what could be used as an “if-then-conditions” are contingencies that could occur at any time.

Regarding the food supply chain, possible contingencies could be delays, prices, guidelines or liability conditions. This means that a Smart Contract can make automated decisions based on this construct and then lead to subsequent steps (Pinna, Ibba, Baralla, Tonelli, & Marchesi, 2019). Previously, supply chain processes were too complex to be completely automated. With the help of the blockchain, it is possible to run business processes between parties fully automatically by using the application. The special feature here is that the contract parameters cannot manipulate, and the application is always available. Furthermore, a written fixation of the contract on paper or in a file is superfluous. Proponents of SCs say that many types of contract clauses thus become wholly or partially self-executable or even unnecessary. The goal of the technology is to offer a higher level of contractual security compared to traditional contract law, this is especially important when dealing with many contractual partners, and at the same time, the transaction fees should be drastically reduced. As a result, manual contract processes with documentation gaps can be avoided, and the speed and quality of the basic business processes will be increased (Dolgui et al., 2019). An application of how it would work the food supply chain it that deliveries and financial transactions are independently authorized or reject if agreed target values are not met or are even rejected. In addition, extra manual controls can be dispensed since the transparency of the audit-proof recording is located on the blockchain and extends throughout the entire supply chain. It can also be ensured that error-prone manual transfers at interfaces no longer occur. At the same time, it is possible to

improve the purchasing process sustainably with Smart Contracts. The systems can independently trigger repeat orders to guarantee optimized inventory management and thus reduce food waste and costs. Especially for automated operative processes, the extension with Smart Contracts offers great potential (IBM, 2017a).

In summary, there are three main elements, which distinguish Smart Contracts from conventional contract forms and improve processes.

(1) **Autonomy**: SCs requires no further intervention or manual action after it has been set up. The execution is guaranteed independently.

(2) **Self-sufficiency:** Smart Contract carries out the management of resources independently.

(3) **Decentralization**: SCs are anchored in blockchain, are distributed across all participating nodes and validated by them, thus eliminating the need for intermediate parties (Hofmann, Strewe, & Bosia, 2018).

This enables companies to improve transparency, efficiency and agility along the supply chain.

Blockchain has a very big influence on the development and advancement of companies. The implementation and successful support take place mainly in large companies.

2.3.2 Blockchain in the food supply chain

Various studies have already dealt with the issue of how to solve the trust problem of individual participants within a supply chain. Still the current technology has not been able to find a solution yet. In particular, challenges such as asymmetric information distribution and the self-interest of individual participants have not been solved so far (Musa, Gunasekaran, & Yusuf, 2014).

Like supply chain traceability, the concept of supply chain transparency comprises information that is easily accessible to end-users and companies in a supply chain. Improved traceability and transparency can lead to cost reductions and improved operational performance (Nakasumi, 2017). A better traceability system leads companies to be more willing to adopt socially responsible practices because they are assets by their customers and stakeholders. Also, the purchase decision process of customers is influenced by qualitative information provided (Awaysheh Amrou et al., 2010).

The blockchain technology, as a distributed ledger technology is a promising solution and enhancement to the food supply chain of a company. The blockchain stores and collects all information about a product or precursor, and a copy of all the data is stored and available for each involved party. Access to sensitive data is regulated by the fact that only the relevant personal data is visible. Having this access has the advantage for all business customers that they can gain insights

into the upstream process steps and identify optimization needs more effortlessly. Accordingly, warehousing and transportation needs can be linked to expected deliveries; thereby it is possible to reduce delays and construct transportation more effective with a high-quality standard (Leng, Bi, Jing, Fu, & van Nieuwenhuyse, 2018). Another advantage is that transactions which are made will be available in real time. In the event of discrepancies, for example, in the cold chain of a product, each person involved is informed immediately, and the exact source can be determined. It can be fast identified which products are affected because the product information such as the company of origin, delivery and processing details are stored on the blockchain (Casino, Kanakaris, Dasaklis, Moschuris, & Rachaniotis, 2019). This identification and tracking is particularly important, as in the case in the United States of America, when a food was contaminated and thereby harmful to the population. Instead of banning the whole sale of food, the product can be taken out of production and sale immediately and the spread of pathogens can be cushioned (Duan, Zhang, Gong, Brown, & Li, 2020).

However, not only food safety is a major driver of blockchain in the food industry. Conscious nutritional awareness promotes sustainable food chain management. An implementation example of the blockchain in the FSC could be QR or RFID codes printed on products. The sensor layer would be a unique digital cryptographic identifier, linking the physical product to the virtual systems (Abeyratne & Monfared, 2016). Customers could access all relevant data of the products with the help of an app. Initiatives such as local production can be increasingly supported. In addition to the food information, it is also possible to deposit the sales cash flows on the blockchain. This would make it possible to prove that every person involved in the supply chain , such as the farmer, the packaging staff and all the other employees involved, will be paid in the interests of fair trade (Wamba & Queiroz, 2019).

The technology not only offers potential for large enterprises, but also small retailers could benefit from this by being able to independently integrate the system to their food supply chain with a reasonable fee. The following figure 2.5 shows the Dataflow combining the blockchain in the food supply chain of company.

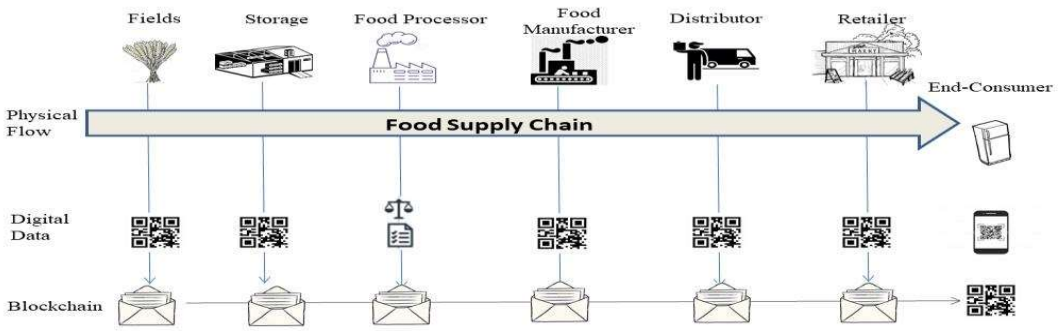

Figure 2.5 Blockchain in the food supply chain (Source: Own source adopted to (G. Baralla, A. Pinna, & G. Corrias, 2019))

As mentioned in the previous part, it is increasingly important for consumers to obtain information that will influence and support their purchasing decisions. The challenge for customers is the companies practising green washing. Companies that green wash give the impression that their products are sustainably produced by providing misleading information. Consumers have to find out by themselves if even products are declared with sustainability certificates, whether they can be sure or not about their absolute authenticity (Pizzetti, Gatti, & Seele, 2019). New novel technologies make it easier for consumers to receive trustworthy production and product information. In the case companies do not operate with sustainable concepts, they can put pressure on the companies. The data flow in figure 2.5 shows, how the blockchain can be used to ensure consumer confidence. For the consumer, transparency, and traceability are improved and information flow can be ensured throughout the entire process, from the origin of the ingredients to procurement and the point of sale.

By facilitating the provision of the desired data, such as quality, food safety, ethical working conditions, and environmental factsheets, this strengthens the relationship between companies and consumers to become more authentic. In the long term, this will help to improve the business results of companies by responding to changing customer demand.

Other potential applications for a sustainable and improved food supply chain are discussed in the next section (2.3.3).

1. **Monitoring the cold chain**: Especially in the food industry, it is essential that the cold chain between the upstream suppliers and consumers will not be interrupted to maintain high quality and safety standards. For example, if special temperature sensors are placed in the sealed containers, temperature protocols can be created and recorded on the blockchain and support the monitoring of an uninterrupted cold chain. This allows companies to ensure that temperature-sensitive foods, are correctly cooled throughout the whole chain, and their integrity is confirmed. An effective food cold chain management reduce by keeping products fresh as long as possible. As a result, not only consumer confidence is improved, the profit

margin increases as well (Abeyratne & Monfared, 2016; Ndraha, Hsiao, Vlajic, Yang, & Lin, 2018).

2. **Sustainable production and responsibility:** As described in chapter 2.4.1, there is a growing interest among consumers in how their food is produced. Companies can meet this social responsibility with the blockchain. The new technology makes it possible to prove the exact origin and authenticity of the food. This statement is also supported by the Global Corporate Sustainability Report, which found out that 66% of the population would spend more on their food if it came from a sustainable and transparent production brand. It is particularly important for a consumer to have a secure source of information that shows them what is in their food, where it comes from and whether it is produced ethically and sustainably (Nielsen, 2015). The blockchain enables the food chain to be traced from the origin to the consumer and guarantees that the food is treated and produced in a sustainable and humane manner (Potma, 2018). This field of application is not only interesting for the food industry. Another field of application could be the purchase of jewellery. It can be verified whether the gemstone originates in a conflict-free area, and valuable factors such as carat size and authenticity can be guaranteed.
3. **Food and production safety:** The blockchain enable the food to be traced back in seconds. IBM has already successfully carried out a test for this. IBM made it possible to find out where a mango came from within minutes. The motivation for IBM in the first place was that each year around 420.000 people die due to contaminated food (WHO, 2015). This would have been very helpful, as in the case of contaminated spinach in the United States of America, where it took weeks to find out the original origin. In addition, companies could use the blockchain to determine the exact affected charge and stop its further consumption. This makes it possible for retailers to intervene faster than ever before, remove the affected products from the shelf, and stop a rapid spread (IBM, 2017b; Kamath, 2018).

SME´s due to their enormous competition need to stay one-step ahead to ensure they meet the expectations of their customers as quickly as possible. Never has there been such a need for technology that promotes trust, security, and visibility. Blockchain technology can be a key element for a sustainable successful strategy and brand position.

That the blockchain user cases can be successful implement, the requirements from to the SFSCM will be explained in the next section.

2.3.3 IBM Food Trust

In 2016, IBM launched the "IBM Food Trust" project. The motivation of the project and the software solution is to create a system for improvement and control of transparency within the food industry. For this reason, IBM collaborates with Walmart Food Safety Collaboration Centre and started several pilot projects to quickly and easily find out the exact origin of the product in case of contaminated food and to guarantee food safety for the consumers. In selected Case study the IBM Food trust IBM, Walmart Tsinghua University Beijing collaborated (Kamath, 2018).

For their pilot project, the three chose the blockchain technology. To ensure that companies can define in advance who can upload, view, and control the stored information, the participants decided to use hyper ledger blockchain. This ensures that an intelligent and sustainable food ecosystem is made available to all participants (Ng, 2019). By digitizing all transactions and data, the work processes will be made more efficient, and all participants such as producers, suppliers, retailers, and consumers will benefit. By using the blockchain, the pre-authorized users can access reliable and trustworthy data of the whole food supply chain (Lu et al., 2019). The exact movement and history of each product and product-specific information such as authenticity certification, inspection data can be retrieved in real time. This improves food quality, reduce food waste, and provide easier access to shared information through the Food Trust platform. The advantage of this for the expanding food industry is that it can ensure transparency and trust. Moreover, each participant can individually define which information can be made available and used (IBM, 2020b).

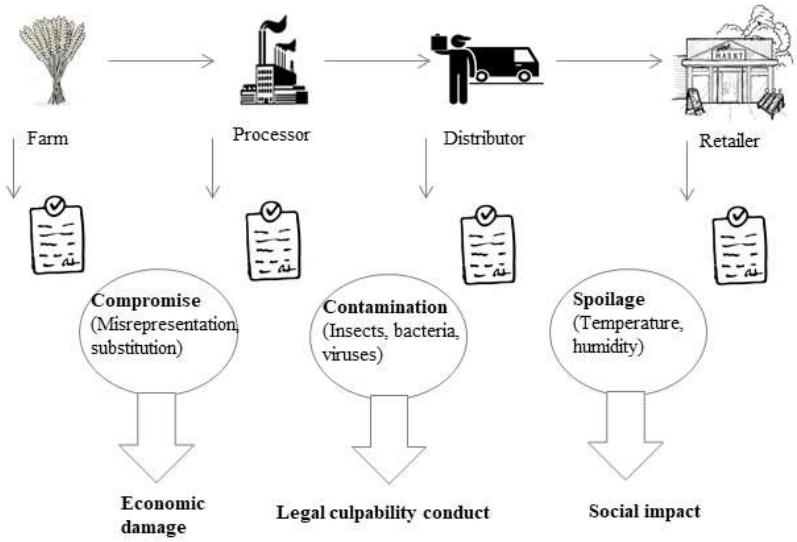

Figure 2.6 IBM Food Trust mechanism simplified and expected operational Impact (Source: Own source adopted to (Hughes, Archer-Brown, Park, & Ketzmann) (IBM, 2020a))

In one of the first attempts at the Walmart store, IBM Food Trust was able to reduce the tracing time significantly. The lead team managed to follow every single step of the mango supply chain and reduced the time from 7 days to 2.2 seconds (Kamath, 2018). As described in section 3.5, in the case of contaminated spinach in the U.S., the exact source of the outbreak could be identified and removed from the market within seconds. Thus, companies can save money by not having to remove all potential contemned food products from the market. Other companies such as Dole, Unilever, Nestlé, and Tyson Foods have already decided to use the platform. In addition, they are working with government entities, which is a critical factor in the success of the project. With the help of many participants, not only can food safety be increased, but through continuous feedback the eco-system can be constantly improved. Therefore, supply chains can be made more efficient, which leads to saving money and reducing food waste. However, the pilots' goals go further than just leveraging the blockchain technology; they are also aiming to increase safety in the food industry for consumers (IBM, 2018).

2.3.4 Technology-organization-environment framework

For the successful adoption of a new technology, such as in the case chosen in this work, the BCT in an organisation can be affected from several influencing factors. The term adoption refers to the decision to fully exploit the added benefit of an innovation. According to Tornatzky and Fleischer (1990) there are three main factors which affect the integration of a brand-new technology.

The research contextual areas identified in the TOE-framework are: (a), technology context; (b), organization context; and (c) environment context, which influence the implementation and adoption of new technologies in companies. The TOE-framework is an elementary element of the analysis. It is designed that it examines the three main influencing areas, whether a new technological innovation will be successful used and adopted in a company or not (Tornatzky & Fleischer, 1990). The T stands for all **technologies** that are relevant for the implementation of the blockchain. These can be existing or novel technologies. Moreover, it will be used to identify technological challenges and to show how companies can advantageously use them or develop them further (Chiu, Chen, & Chen, 2017). The **organizational** level refers to the resources and structures of the applied company. For the introduction of new technology in a company, the support and understanding from the top management are critical. Information intensity, resource availability, size of the organization, absorptive capability is other important influencing factors. The third level contains the **environmental** context, as presented in figure 2.7.

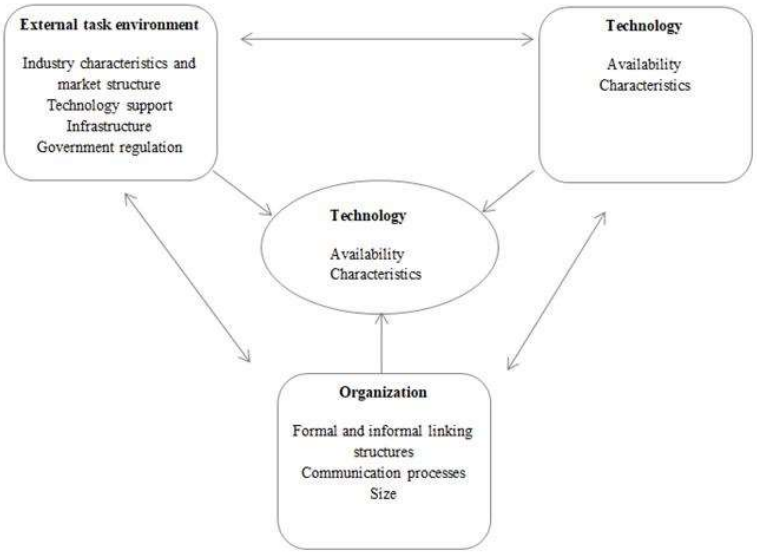

Figure 2.7 TOE-framework (Source: Own source adapted to (Tornatzky & Fleischer, 1990))

Existing, non-existing legal regulations or different structures in an industry can exert significant influence on a successful introduction. An additional factor that can influence the third level is the competition in the market. An active competitive environment can dominate the introduction of new technologies into the market. In addition, business relationships and external support, such as governmental authorities, may have significant input (Govindarajulu, Lippert, & Govindarajulu, 2006). In summary, the TOE-framework should analyse and identify all relevant technical, organizational, and environmental faculties that have influence the adoption of blockchain technology for small and medium-sized companies.

2.4 Conceptual Framework

The food industry has to overcome different challenges; therefore the suggested solution could be the blockchain technology. For understanding the potential and challenges it is important to gain insight in the technology, Food SME´s and the sustainable supply chain. Subsequently a conceptual model was developed to research the impact of the blockchain in the food supply chain of SME´s.
The designated research design, course, and scope are outlined subsequently in figure 2.8.

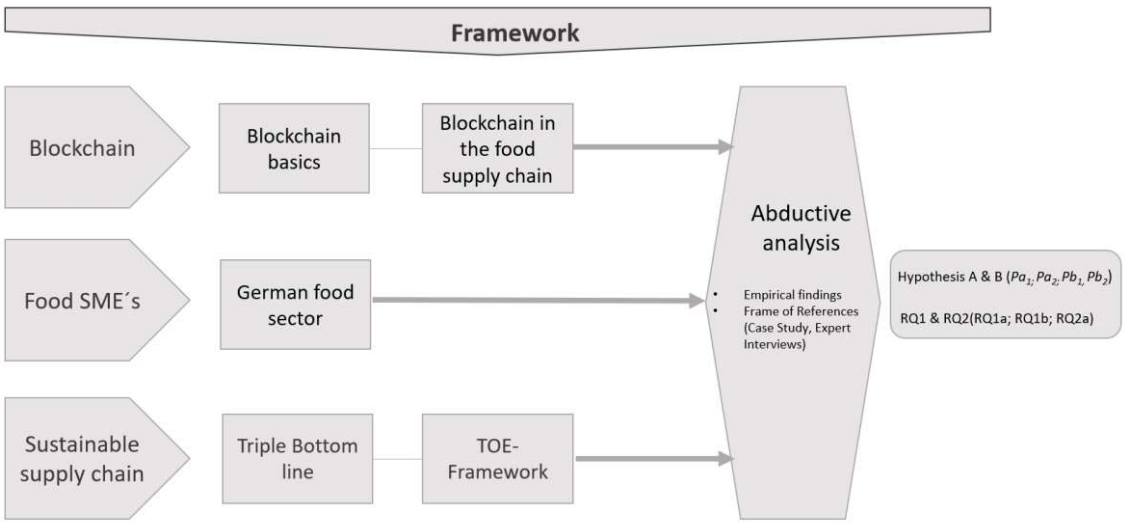

Figure 2.8 Conceptual Framework (Source: Own source)

Model in figure 2.8 is used to connect the different research areas and finally to sum up and answer the developed hypothesis and research questions.

In this chapter, it can be noted that the blockchain technology consist of a distributed ledger structure. Numerous of participants operate in a P2P network and the public ledger record every transaction synchronously on all computers of the network participants digital. The consensus mechanism makes it possible that all data is trustworthy, reliable and do not need any central instance. The blockchain can be divided into public, private or consortium type. While public BCT is accessible and transparent to everyone, private and hybrid blockchains restrict access to the network and data to selected participants. The novelty of the technology and the extension of smart contracts are some of the reasons why companies are motivated to integrate blockchain into their business. Due to the uniqueness of the new technology, it is confronted with technological, organizational and environmental challenges. Technological challenges such as scalability, and data security, have not yet been solved. Due to their complexity, many people have not recognized the potential yet and possible incompatibilities with existing systems can be assigned to the area of organizational challenges. Additional environmental issues arise from the fact that the states have not defined legal guidelines for the use of blockchain technology. Implemented the technology it offers improvements especially in sustainable food supply chain. The blockchain functions here as a public distributed reliable ledger by storing all information. Ideally, it will serve as a database and register all information generated during the whole FSCM. With the addition of Smart Contracts, agreements that are determined between a large numbers of actors are automatically executed. All over it is worthy that the blockchain can add value, that the technology is, traceable, confidential, and trustworthy and performance secure. Finally, the designed research concept is visualized.

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3 Chapter - Methodology

In order to scientifically analyse and answer the scientific research questions including its sub-questions, different qualitative methods are applied. The Multi-methodological approach is used to connect to existing research and to obtain new knowledge and research results specific to SME´s. The first step is a theoretical literature analysis, followed by qualitative expert interviews to generate holistic insights about potential conflicts and motivation for the implementation of the blockchain in SME´s. The resulting findings are then used to fully answer the research question in the discussion chapter. Thus, the research design and process above described, as well as the specific reasons and scope of the research that fit to our objectives was applied to enlighten the research questions. The outlined research was previously presented in section 2.4.

3.1 Research approach method

After the development of a theoretical conceptual model obtained from the literature review, a case study strategy will be used to both collect and analyses data related to the second level of reception system.

Though the research approach of this study is based on a conceptual model derived from the literature review, nevertheless, contrarily from what is usually done following a deductive approach, the framework derived from the literature will not be confirmed with the case studies. In fact, it will be used as a guide with a theory development purpose.

Therefore, the approach to be used in this research will not be exclusively deductive or inductive. The deduction comprises five sequential steps: (i) deduction of hypothesis from the theory, (ii) expressing the hypothesis in operational terms, (iii) examining the operating hypothesis, (iv) examining the result, and (v) possible theory modification. The induction consists in gaining experience in a specific context to better understand the nature of the problem being analysed.

In this study, an abductive approach was chosen (Dubois & Gadde, 2002). In fact, a deductive approach may not be able to provide further and/or additional explanations to the research questions examined, as the topic to be analysed is characterized by a significant lack of prior knowledge due to its different nature (Saunders, Lewis, & Thornhill, 2009). In contrast, the inductive approach is not the most appropriate choice since the theoretical background about blockchain allowed the development of a framework that can be re-evaluated according to the case study analysis and which might also be used as a guideline in a case study research.

3.2 Research strategy

In order to answer the presented research questions, and derived sub-questions qualitatively and scientifically, the deliberate research strategy is explained.

Case studies are classified according to empirical research methods. The advantage of this is that the case has a reference to real life, and therefore it can be analysed from several perspectives. A useful approach for choosing case studies is when contemporary events cannot be manipulated (Rowley, 2002). Barely information sources imply research questions as how and why. Therefore, why and how questions are asked about contemporary sets over the investors has no or only a few controls. The choice of the research strategy is determined by the limited sources of current knowledge about the blockchain technology in the food supply chain in SME´s (Yin, 2009).

3.3 Critical literature review

The literature review represents the first step conducted to have a clear understanding of the context in which the research questions arose. Therefore, an investigation about blockchain, SME´s, sustainable food supply chain is carried out through an extensive literature review, based on data collected from different sources, broken down as follows: (i) institutional websites, (ii) scientific publications, (iii) white papers, (iii) policy reports, (iv) books. Therefore, various scientific information sources were consulted, including “Research Gate”; “O´Reily”; “Springer Link”; and Science Direct”. Derived from the research field the key words as “blockchain”, “food supply chain”, “Small and medium-sized enterprises”, “German food market”, and so forth are used. The key word was reviewed and evaluated for their relevance. After that, the theoretical background was explored, related to sustainable development goals, emerging technologies, industry 4.0, global supply chain, sustainable concepts, operational improvement, globalization, and the German food market. In this way, an overview about what is expected to characterize the influencing factors for a sustainable food supply chain for SME´s is obtained. Accordingly, a conceptual model was developed and used as a guideline for the case study analysis.

3.4 Case study

Considering the purpose of this investigation, the most appropriate research strategy is the case study, which, according to (Yin, 2009) makes use of interviews. It strongly depends on verbal reports and direct observation as primary data sources. As a result, the case study tends to use research

methods that provide qualitative rather than quantitative data, which enable to apprehend the complexity and dynamics of organizational environment and organizational networks. Furthermore, case studies are better suited for qualitative research (Yin, 2009).

This is the approach chosen in the present work and it has an exploratory purpose; addressing and discussing the impact of blockchain technology in the sustainable food supply chain in the German market, regarding Western Europe (see Annex "1"[1]). Consequently, the research pursued is contextualized in the framework of the European Union (EU), following the guidance of European Union Blockchain Observatory and Forum that aims to accelerate the innovation and development of the blockchain ecosystem in the EU and consequently strengthen Europe as a world leader in this new transformative technology. Finally, the research also reveals the challenges for blockchain application. Situations such as: (i) the complex dichotomy of blockchain, because, while a blockchain is a database, a database is not a blockchain – they are not interchangeable in a sense that though they both store information, they differ in design; and (ii) the way how digitization handles technical and social innovation process - it could decide whether blockchain potential can be used for Society as a whole, or whether it can act as a catalyst for economic and social polarization processes, will be discussed. Further explanation of the case study will be presented and explained below (chapter 4).

3.4.1 Data collection

For case studies, informal conversations, observation, review of archive sources, collection of objective data, and interviews are conducted to collect reliable and trustworthy data that fulfil the purpose of the study. In the semi-structured in-depth interviews, regularly used in qualitative research, the setting is formal, or semi-formal, since it consists of a conversation between researcher and participant, guided by a flexible interview protocol and complemented by follow-up questions, probes and comments. The method allows the collection of open-ended data; explore participant thoughts, perceptions, and beliefs about a particular topic.

In fact, the exploratory purpose of the study needs this kind of in-depth interviews, as they can lead to discussions into subjects not previously covered, but that are significant in addressing the research questions and objectives.

A useful approach for data collection is supported by a case study protocol. It is suggested that the protocol include an overview about the studied project, an outline about the different source

[1] https://www.eublockchainforum.eu/initiative-map

information and arrangement to these sources, and lastly the case study questions that the researcher needs to keep in mind (Rowley, 2002).

3.4.2 Data analysis

Data analysis is an activity that takes place not only after the collection of data but also during it. This analysis helps to shape the tendency of data collection. Particularly, it will focus on developing a theory that is reasonably based on the qualitative data collected.

However, because of the diverse nature of qualitative data, there is no standardized procedure for analyzing them (Saunders et al., 2009). There does not exist a general process of the analysis of the case study results.
According to the interviews, the following steps were pursued:

(1) Worldcloud.com was utilized as a qualitative data analysis tool to identify the main and most related concepts

(2) Considering the propositions derived from the literature these concepts were related among each other

(3) Finally, the defined concepts are included in the final framework, which will resume the outcome of the research (Voss, Tsickriktsis, & Frohlich, 2002)

For analyzing the results in a scientifically manner, a categorization inspired content analysis by Mayring (2000) was conducted. Significant quotes were coded and subsequently brought into context (Mayring, 2000). By summarizing the coded results some distinctive categories crystallized within these building block of “Motivation for introducing blockchain in the food supply chain”; Motivation for introducing blockchain in the food supply chain; “Conflicts by applying blockchain in the food supply chain of SME´s” ; “General success factors for applying blockchain in the food supply chain of SME´s”. The whole coding agenda can be seen in annex C.

Chapter 3 describes the used methodological structure which was adopted to achieve the research needs. Therefore the chapter starts with a clarification of the used methods and a further explanation of the case study. Moreover, chapter 3.5 gives further insights of the Case Study approach.

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4 Chapter – Case study

The present chapter presents and details the case study: *Potential and challenges of implementing blockchain technology in the food supply chain of small and medium-sized companies.*

As previously mentioned, (section 1.3), this research has the goal to examine which impact and potential the implementation of the blockchain technology for a successful sustainable food chain of small and medium-sized enterprises has. All the taken actions and used methods and strategies to assess the information that will be used to address the adequate research questions resolutions are presented and explored in this section. The main research questions that promote the orientation of this study, as was noted previously in the section 1.2, concerns the adequacy of blockchain implementation in food supply chains, in view of the demands for a sustainable supply chains placed both by the current context in EU and enterprises from the food sector, tackling issues as impacts, challenges and sustainability. Thus, recalling what is present in chapter 2.2.4, the main objective is to look the impact and potential application of blockchain technology for a sustainable and thriving food supply chain, considering the case of small and medium-sized enterprises.

A series of secondary research questions are also addressed, the clarification of which is relevant to the discussion of the primary research questions, as follows:

- RQ1a: What are the motivations for introducing blockchain in the food supply chain?
- RQ1b: Which conflicts can arise by applying blockchain in the food supply chain of SME´s?
- RQ2a: What are the general and sustainable success factors for applying blockchain in the food supply chain?

4.1 Methodology adopted

The theoretical potential of implementation the blockchain in the context of SME´s operating in the food industry analysed by blockchain and supply chain experts offers the opportunity to compare the theoretical results from the literature review with the problems in a real case scenario. The goal is to find out how the blockchain is perceived in practice and which potentials are opened up. It should be emphasized whether blockchain technology is only an attempt or really has the potential to bring about relevant sustainable improvements in practice.

Expert interviews with specialists and entrepreneurs carried out primary data collection. These are blockchain and supply chain experts in order to extend the broad of the scope. For the realization

of the interview a semi-structure approach is applied. In the conversation open questions will be asked, so the information content is higher, and it can be responded individually to the answers. The semi-structure approach allows the interviewer additional to the prepared questions the ability to ask further questions (Bell, Bryman, & Harley, 2018, p. 211). The advantages are that through the same established questions, the interviews are still comparable but at the same time it is possible to react and interact with the experts. Moreover, the method of individual interviews helps to gather detailed expertise and obtain constructive information (Wilberg, Schäfer, Kandlbinder, Hollauer, & Omer, 2017). The focus of the interview is on the expertise of the respondent.

The process will be done in 4 steps:

Step 1: Creating a guide for the expert interview with the support of the TOE-framework

Step 2: Acquire blockchain and supply chain experts from Germany

Step 3: Data collection and recording

Step 4: Evaluation and data analysis of the expert interview

The research context will be about the potential and challenges of the blockchain technology and specialised to the German food market, as explained earlier in chapter 2.1.3 and 2.1.4. The Interviews should provide professional assessment about the potential and challenges of the blockchain technology. Additionally, it will be discussed how they experts personally evaluate the impact of a sustainable blockchain for enterprises operating in the food industry. For designing the research questions, an interview guide is created with the support of the TOE-framework. That it can be ensured that all important data will be collected the interview will be recorded electronically and transcript. For analysing the expert interviews, the recorded interview will be transcript. There nonverbal communication will be not taken into account and only important relevant parts will be transcribed (van Audenhove, 2007). The interview evaluation will be represented in chapter 4.5.

The expert interview is conducted as a semi-structured interview. For selecting the interview partner's different backgrounds were considered. This helps to increase the contribution towards the wide range of the investigation. Compared with qualitative interviews, the focus is not on the interviewee, it is on the expertise and interpretation of the analysed research area (Meuser & Nagel, 2002). In preparation for the interview, it is necessary to define interview questions and therefore develop a guideline. As mentioned above, the TOE framework was used to support this. The developed guideline forms the basis for the interviews and covers all topics that are to be discussed in the interview. (Lamnek & Krell, 2010). Additionally, the guide serves as a knowledge resource for the interviewer. To structure the interview, the guide uses a list of haptic and sub-questions, which serves as an approximate sequence. The guide is divided into an introductory section, a main section

with question blocks including sub-questions, and a concluding section (Mieg & Näf, 2005, p. 14). A significant indicator for the successful execution of the expert interview is when the personal interest and curiosity to investigate and discuss with the Interview partners is fully developed (Meuser and Nagel, 2002).

4.2 Case selection

For finding suitable participants, information about the potential interviewee's information was gathering through the internet. Additionally, current contacts to the blockchain industry were used. After contacting the interviewees via mobile phone and providing first insight information about the research topic, and receiving their agreement for participation, first information about the research design was provided to them. In the final sample was it possible to connect the knowledge and experience from specialist of the field of supply chain in the German market and a blockchain expert.

Namely, the first expert is the supply chain expert Recep Poyraz. After graduating with a Master double degree in the field of Engineering he joined MHP - A PORSCHE COMPANY in the beginning of the year 2018. Since them he is working for MHP as Consultant for various projects. MHP is one of the leading Management and IT-Consulting companies in Germany, and a sub-company of Porsche AG. The special consulting approach of MHP is the symbiosis of management and IT consulting. As digitisation experts, they optimise and digitise the customers' processes along the entire value-added chain with the service areas Management Consulting, System Integration, Managed Services and Digital Services and Solutions. Currently, over 2,800 employees at 16 locations in Germany and England (Birmingham), the USA (Atlanta), China (Shanghai), Romania (Cluj-Napoca) and Israel (Tel Aviv), they advise and support over 300 customers worldwide. On a national and international level, we support companies both strategically and operationally. With comprehensive international project experience, an established partner network and our international locations, the role is to support their clients in (inter)national projects and globalization plans.

The second expert is Phuong Nguyen. Phuong Nguyen is one of the founders of innoBlock UG. In the year 2018 he founded with two other friend the Startup innoBlock, an Industrial Blockchain consulting and software company based in Mainz, Germany. The business idea of them is to identify suitable industrial use cases and develop blockchain networks so that companies and their customers can benefit from each other based on increased trust. The first idea behind founding the innoBlock was the idea is to identify suitable industrial use cases and develop blockchain networks so that companies and their customers can benefit from each other on the basis of increased trust. Additional to running his blockchain Start up, Phuong Nguyen is working as a Technical Solution

Specialist at Cisco Systems. Cisco is an American multinational leading telecommunication company. He is specialist in networking hardware, software and telecommunication equipment. Table 4.1 illustrates an overview about the conducted expert interviewees.

Table 4.1 Overview of the expert interviewees (Source: Own source)

Name of Interviewee	Interview ID	Organization	Current Position	Date of Interview
Recep Poyraz	RP	MHP - A PORSCHE COMPANY	Consultant	07.07.2020
Phuong Nguyen	PN	innoBlock and CISCO Systems	Founder and Technical Solution Specialist	14.07.2020

The interviews were recorded with an audio dictation toll and subsequently transcribed. A transcription of the interviews can be founded in Annex B.

4.3 Data collection

During the preparation of the interview, it is also necessary to become familiar with the expert's field of expertise (Mieg & Näf, 2005).The literature research carried out in advance serves as a basis for this. Subsequently, the acquired knowledge was structured and with the help of the TOE-Framework a first concept was created, based on of this a concrete interview guideline was created.
It is divided into three main topic blocks and varies in the number of questions and sub-questions. The guide is sent to the interviewer in advance and helps him or her to prepare for the topic and to prevent possible mistrust.
In the Annex B the questions blocks and theme categorization for the expert interviews can be seen

All expert interviews were held between June and July 2020 with duration between 30 to 60 minutes. Due to the different locations of the interview partners the conversations were held virtual and recorded. For analysing the results in a scientific manner, the approach of Mayring (2000) were used. According to Mayring a suitable way to categorize empirical findings is either developing inductive categories or applying deductive categories (Mayring, 2000). The coding for motivation, conflicts, and success factors were performed by inductive categories. The expert interviews answers were clustered. Subsequently, the relevant quotations were brought into context and codes were given to create categories. Finally, the categorized findings are described in chapter 4.5.

4.4 Categorization framework

Subsequently to the evaluating expert interviews, the results are brought into context together with the results of the literature review. The framework will help to link theory and the evidence. This is choice is made to derive the effect of the blockchain in the respective dimension.

This research aims to investigate the degree of suitability, usefulness, and sustainability of BCT to be integrated into food SME´s, both theoretically and empirically. A hypothetical-deductive approach has been applied. The American philosopher and logician Charles Sanders Peirce introduced the approach into the scientific debate. According to Peirce, abduction is the process by which an explanatory hypothesis is formed. Through final procedures, the approach of deduction and induction is expanded by the knowledge gained. By applying the deductive and inductive approach, is a constant movement from empirical to a theoretical analysis of the dimensions. The abductive approach is a three-step know plan. The first step is to find a hypothesis by means of abduction from the scientific knowledge process and the cases studies, simultaneously. Then a hypothesis is derived from the predictions. This is called the deduction. In the last stage, the third, factors are sought that verify or refute the assumptions (Ho, 1994; Sober, 2013). This is an induction. In this case, the author has decided to obtain the primary part by semi-structured expert interviews.

Concerning the dynamics and adaptability of the framework, both are advantageous for the categorization of the results obtained in the exploratory research developed in this work.

Following a comprehensive description of the selected methodology, the following part serves as a descriptive presentation of the findings obtained from the expert interviews.

4.5 Data analysis

In the following part, the results of the conducted expert interviews are descriptively outlined, categorized, and numbered. Insights are provided on the motivations for introducing blockchain in the food supply chain in section 4.5.1, followed by the potential conflicts, which could arise. The third building block of this chapter deals with general success factors and sustainable success factors of implementing the BCT. The results are subsequently discussed and hypothesises put afterwards are answered.

4.5.1 Motivation for introducing blockchain in the food supply chain

Empirical data on the reasons why food SME´s integrate the blockchain into their sustainable food supply chain were collected. The following table classifies the individual reasons for motivation and is explained in more detail afterwards.

Table 4.2 Motivations of applying blockchain in the food supply chain of SME´s (Source: Own source)

Categorization number	Motivation for introducing blockchain in the food supply chain
6.1-1	React to changing customer demand
6.1-2	Traceability & Transparency
6.1-3	Competitive advantage
6.1-4	Innovative
6.1-5	Stay competitive

Recep Poyraz (RP) and Phuong Nguyen (PN) emphasized in the interview that one of the main motivations for food SME´s is, why companies should implement blockchain technology into their food supply chain is to the **changing customer demand**. PN highlighted how customer demand has changed "*From the consumer side. There is the demand that they wanted to know about the food chain. What do I need, what is given, where does it come from and then the ethical awareness* "? This is underlined by RP's statement, which is also mentioning that customers are showing a changing buying behaviour over the last years. Customers are increasingly asking for sustainably produced products that demonstrate, at the same time high quality.

A second point mentioned by the respondents is the exact **traceability and transparency** of the whole food supply chain. In times of increasing sustainability awareness, this is a decisive motivating factor for companies. PN underlined the importance of the demand for sustainable and produced goods due to the increased awareness of the customers. This can be guaranteed by the traceability and transparency made possible by the blockchain. This statement overlaps with the attitude of RP, who stated that uncertainties of the population due to food scandals enhanced the motivation for complete traceability. Thus, PN explained: "*With the blockchain you can proof where it comes from. And is there is a scandal you can go back in time and see what and where it happened. That's the benefit of blockchain you can get in the food industry. You can proof people engagement, and you can look backwards to react to the scandals*".

Poyraz and Nguyen agreed that the integration of blockchain in the food supply chain could create a **competitive advantage** for companies and thus be a motivational driver. RP pointed out that SME´s, have a lot of potential for improvement within their companies. He emphasized that

companies that improve their supply chain by using the blockchain can gain a competitive advantage over their competitors. On the other hand, PN underlined that the technology is still improvable at its current state but is continually evolving and for this reason has not received much attention from SME´s yet. This could be an advantage for food SME´s who are pioneering the application of blockchain into their SFSC.

PN noted that although the technology is slowly evolving, companies begin to pay attention to the development. Moreover, it should be realized that the awareness of the technology is important for all companies and as a result SME´s should be **innovative**. He added that SME´s could use the innovativeness of large companies as a motivator and supporter. The advantage is that multinational companies are building a platform and make it usable for every kind of companies. Food SME's can benefit out of it and use it to drive innovation for their own company.

Staying competitive was also cited as a resultant motivator for closer examination of blockchain in food SME´s. As PN mentioned earlier, multinational companies have already started first pilot projects with the blockchain technology. Moreover, he marked that the specificity of food SME´s is that they are often dependent on larger companies. For example, if a multinational company uses BCT it can force the smaller ones to integrate BCT as well. To remain competitive in the market they are asked to deal with the technology as well. RP also highlighted that there are many areas within the food SME´s that could be improved. Directly related to PN statement that SME´s should be motivated to implement blockchain to stay competitive, RP agreed on that and said: "*I would say they have to improve their efficiency and the storage management. They need shorter distribution ways, and, I would say that they must improve their communication. If food SME´s don't work on these points, it's going to be difficult to stay in the market".*

4.5.2 Conflicts by introducing blockchain in the food supply chain

The second part of empirical collection dealt with the application of blockchain in the food supply chain in food SME´s and possible conflicts that could arise.

Table 4.3 Conflicts by applying blockchain in the food supply chain of SME´s (Source: Own source)

Categorization number	Conflicts by applying blockchain in the food supply chain of SME´s
6.2-1	Compatible with existing technology
6.2-2	Monetization and management of data / Data Security
6.2-3	Technological maturity
6.2-4	Business readiness
6.2-5	Resource poverty
6.2-6	Benefit vs. Risk evaluation
6.2-7	Partnership dependency
6.2-8	Missing framework structures
6.2-9	Customer motivation

To begin with, RP and PN made it clear that the introduction of a new technology in the company must be **compatible** with the existing technology. RP stressed that at some point there comes the moment where a new technology must be integrated with the current technology. Another conflict that PN highlighted is that in a global supply chain system with many different parties many data is continually exchanging. The challenge for the technology is that the blockchain must provide security. In fact, all data must be **managed and monetized securely**. This argument leads to the next huge challenge that PN sees when introducing the blockchain in a company. Before the successful introducing of a new technology, a technology is successful introduced, the same technology must achieve a certain **technological maturity**. Thus, PN stressed "*Big point it has to be vulnerable for the company. That the technology reaches a critical mark, there are enough users. This means only if the technology reaches a critical mark, there must be enough users*".

RP and PN agree that the internal motivation of the companies is crucial in determining whether a new technology is successful introduced into a company or not. If **business readiness** prevails, this arises as huge conflict factor, so PN says: "*Blockchain is not in the awareness of many people, only to a view and delivering the end solution is challenging*". Concerning the lack of awareness of the technology, Recep Poyraz stated that the missing understanding of the technology adds to the lack of internal motivation. Nguyen (PN) spoke from his experience in working with SME´s that the difficulty is that SME´s do not focus on blockchain technology, but instead emphasises on other novel technologies such as Artificial intelligence.

The point **resource poverty** in SME´s is mentioned as a critical subject, both RP and PN agrees on this point. Resource poverty can be observed from different angles. Due to their size, the number of employees is smaller and fewer resources are available. Therefore, PN referred directly to the lack of IT-specialists. SME´s have fewer or no IT-skilled people or employees who have already had initial contact with the blockchain technology. In addition, RP exposed that the missing resources are not only a lack of knowledge but also the limited financial resources. The probability that food SME´s will have sufficient financial resources to deal and start pilot projects with the blockchain is much lower than within multinational companies like IBM with their Food Trust Project.

The agreement of the **benefit vs. risk evaluation** for food SME`s is a further hurdle proposed by PN. He criticized that the benefit regarding risk evaluation is relatively high and extends over a more expanded period. SME´s must first go into advance performance to invest in blockchain projects. Moreover, he said, "*They spent a lot of money with the product and then it is maybe not profitable and that is not good for SME´s*". This argument underpins the above mention point that SME´s have fewer resources available than larger companies do.

According to PN, the partnerships with other parties in the food supply chain in connection with the application of blockchain can be a challenge. Mainly due to globalization, food SME´s operates mostly in multi-party relationships environments. In this context, RP talked about the challenge posed by the global Covid-19 pandemic, which has highlighted the extent to which companies around the world are interconnected and dependent. PN stated: "*In terms of sustainability combined with food they really rely a lot on others*" certified that many companies are highly dependent on partners, such as a supplier for larger companies. In course of this, **dependency** is not only a motivating factor but can also be a hurdle.

The **missing framework structures** of blockchain are a challenging area depicted by the interviewees concerning the application into a food SME´s. This is particularly relevant in the food sector, as emphasised from RP. In the German market exists high quality standards in the food industry, which must be brought in line with the blockchain technology. Furthermore, PN stressed the point that there are no uniform legal frameworks for the blockchain technology in the market, and therefore companies are facing further challenges.

As motivational drivers, RP and PN put emphasize the changed demand for sustainably produced food. However, it was also important for RP to highlight that ultimately the end customer is sensitive to price. Customers expect high quality at an affordable price. However, the pandemic caused by Covid-19 has resulted in many people losing their jobs and consequently need to pay more attention

to their household expenditure. In the end, people who have less money will not ask for sustainably produced products, rather the **customer motivation** will be with the lowest price.

4.5.3 General and sustainable success factors for applying blockchain in the food supply chain

Within the third building block of empirical data collection, the questions of what the success factors are, complemented by sustainable success factors for food SME´s, who are implementing the blockchain in their food supply chain. The results are shown in table 4.5 and table 4.6 and are outlined in chapter 4.5.3

Table 4.4 General success factors for applying blockchain in the food supply chain of SME´s (Source: Own source)

Categorization Number	General success factors
6.3-1	Improving business processes and efficiency
6.3-2	Reliability and data security transparency
6.3-3	Organizational size
6.3-4	Team and Management support
6.3-5	Training and education of employees
6.3-6	Market dynamic
6.3-7	Framework structures

To begin with, the experts referred to the **improvement of business processes and efficiency.** RP clarified that there is a need for improving the technologies in food SME´s. The blockchain technology can either replace an old system or be integrated in the existing one. A general success factor for introducing a new technology is that business processes and/or efficiency can be improved. With the introducing the blockchain technology into the food supply chain of SME´s, the companies can improve not only the efficiency, processes but also the quality of the products.

For the experts, **reliability and data security transparency** are a fundamental factor for the general success of the blockchain technology. PN mentioned that big players like IBM and Amazon are already working on the technology and building platforms that the blockchain will be useable and reliable for all companies. Especially the food supply chain is an area with many sensible data. BCT can help in the supply for bringing more data security transparency, more data liable and making processes leaner in terms of data and triggering. Additionally, huge companies working on the blockchain technology makes the technology more mature and useable for food SME´s which can utilize the advantage of the technology for themselves.

Another success driver for the introduction of BCT into the food SME´s is the **organizational size** of small and medium-sized enterprises. Expressly PN emphasized that due to their size, small and medium sized companies can also be very independent. This means that if they decide to introduce new technology, they do not have to deal with other arrangements. Moreover, decision-making process is entirely up to them. RP also mentioned that SME´s have a smaller number of employees due to their organizational construct. As a result, the working relationship between colleagues is closer and the companies are more specialized in their product. Through the company structure it is possible to have the advantage of clear structures and responsibilities for the individual employees, which lead to a successful implementation.

A further relevant factor for organizations to successfully implement may be the commitment and **support of the team and management.** PN stated that:

"…a successful adoption is company oriented. It is up to the management."

To apply a new technology, top management must support and spread the information and knowledge into the relevant departments. RP laid emphasis on the importance of role model towards all involved parties. The resulting advantage for SME´s is that they due to their size have a good relationship and communication between their employees. Especially smaller companies do not see their employees only as a number. Moreover, they are convinced that every one of the companies is responsible for the success of the company.

Closely connected to the management sphere mentioned above, the **training and education of employees** can be seen as equally important according to the expert statements. Agreeing to PN, a fundament understanding and awareness of the blockchain technology must be promoted at all employees. With this background it should be company standard to educate and train their own employees and new ones. RP ascribed the great importance in participating and power to the employees in participating in the training. Therefore, the company structure, internal motivation, willingness to learn and the culture of the company is fundamental of promoting new technology. The proper education of young entrepreneurs, innovators, and developer who are dealing with the blockchain is a big task.

Special attention was paid to the changing **market dynamics.** To be successful in the market, it is getting more and more important to react fast to the changing market dynamic conditions. Phuong Nguyen proposed that especially food SME´s who are implementing the blockchain technology into their food supply chain can respond faster to changing market conditions. The customer will always go for the company who are consciously improving and add a plus to their products. Through particularizes of the blockchain, it has the potential to react fast to the changing market dynamics.

The changing market dynamics is closely related to the general success factor "competitor pressure". PN mentioned that other companies who have already successfully implemented new technology into their company, motivate food SME´s to do the same for themselves. So, he made it clear that "*If you don´t do it, they will do it. Not going with the time, the time goes without you*". That drives food SME´s to be successful and utilize the potential of blockchain technology.

Further measures to promote the correctness of blockchain in the food supply chain of SME´s are existing framework structures. This endeavour is a fundamental factor in ensuring the adoption of the blockchain in the food supply chain. Nguyen has the opinion that the leading innovative companies can go forward. In his opinion, those big players like Microsoft and IBM have the power to provide the general framework structures for blockchain technology. Existing **framework structures** are essential success factors for the blockchain technology.

In addition to the general success factors, the sustainable success factors were analyzed. Table 4.6 provides a better overview and is explained in more detail afterwards.

Table 4.5 Sustainable success factors for applying blockchain in the food supply chain of SME´s (Source: Own source)

Categorization Number	Sustainable success factors
6.3-8	Societal awareness
6.3-9	Customer engagement and education
6.3-10	Controlling and transparency
6.3-11	Sustainable company culture

Another implication mentioned by the interviewees was the relevance of **societal awareness** for sustainable operation in companies. The external pressure of society on companies is relatively high, regardless of the specific topic. RP stated that from the consumer side, the pressure is steadily increasing. Customers are more and more demanding about the food chain, regarding what is given and where the products are from. Companies with blockchain in their supply chain are better prepared and can provide the needed information. Additional to that, PN deemed the engagement potential that people who are looking on business activities will use and support companies with a sustainable profile, which can be achieved through the blockchain.

Special attention was paid to **customer engagement and education** related to sustainable food production by the experts interviewed. Trust can be evoked by authenticity, transparency, and clear communication towards customers. No matter what issue, Poyraz recommended to use the new possibilities within IT to steadily inform and educate the consumers regarding the degree of sustainable production. He emphasized that sustainable perception is an important factor for the consumers and therefore, they use their own possibilities to educate themselves. Within the

blockchain companies gain a competitive advantage to provide secure data about the origin of the products. The value of customer insights can outweigh the initial efforts on the company side and be a preparation for the future. Therefore, not only the responsibility of companies, but also a general understanding and awareness at the customer side are required.

As a further approach, **transparency** was deemed to be a good starting point for delivering sustainable impact through blockchain. Transparency should be a basic principle for ensuring compliance with sustainable behaviour. Controversially Phuong mentioned the discussion about the high power and data consumption through the blockchain use. But on the other hand, blockchain has the characteristics, like the transparency to make data more visible for all parties. In the opinion of Recep Poyraz this is a critical sustainable success factor for companies. In the past, due to food scandals and consequently lost in trust, blockchain has the possibility to recreate a trustworthy relationship. Regarding food SME´s, this reliable link would generate into extensive benefits. Moreover, this reliability brings the transparency advantages not only for companies, but the provided monitoring and controlling helps the end-user for his purchasing decision.

The long-term **sustainable position in the market** was a further point of considerations for the experts. Companies who focus on short-term profit maximization through leveraging profit and may currently have advantages compared to counterparts would struggle to exist in the long-term view, especially in the case of trust and scandals, through rejection of their customers. "*Companies who are working with sustainable concept the change are higher to be long term successful*" (RP). In the long-term companies with a sustainable profile will be further ahead and are the better alternative. Phuong Nguyen is convinced that the motivation of a company is not just external pressure but also results from developing internal motivation. Companies have their own sustainable motivations to create a responsible food print.

After comprehensively describing the findings which were gathered by the conducted expert interviews, the following chapter discusses and interprets the presented results and subsequently derives essential information to finally answer the research question, provide practical implications, as well as research limitations and future research possibilities.

This chapter includes the case study structure and provides a review on the conducted expert interviews. Explicitly, it presents the set of data analysis to answer the questions, **RQ1a:** What are the motivations for introducing blockchain in the food supply chain? **RQ1b:** Which conflicts can arise by applying blockchain in the food supply chain of SME´s? **RQ2a**: What are the general and sustainable success factors for applying blockchain in the food supply chain?

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5 Chapter - Discussion and finding

Chapter 5 aims to examine the motivations, conflicts, success and sustainable success factors regarding the application of blockchain in the food SME´s. In this chapter, hypothesis-based evaluation of the relevant expert interviews is used in the following to examine the incentives of blockchain in food SME´s. Based on the previous theoretical foundation and the preceding IBM Case Study hypotheses to the central research question 1 and research question 2 to this thesis have been developed. In the following table, 5.1 Hypotheses are presented visually for a better understanding.

Table 5.1 phenomenon to be studied and research guidelines (Source: Own source)

Phenomenon to study	Sustainable supply chain: potential and challenges of implementing blockchain technology in the food supply chain of small and medium-sized companies		
Gap	The integration of the blockchain technology into the food supply chain of German SME´s and the associated sustainable positive and negative effects are not revealed yet.		
Questions	**Qi_1**	What are the key challenges of implementing the blockchain technology in the food supply chain of small and medium-sized enterprises?	
	Qi_2	What are the sustainable impacts of the blockchain technology for small and medium-sized enterprises?	
Explanatory hypothesis	**Hypothesis A Regarding Research Question 1**	The perception of all parties involved, and this perception depends on the content of the newly created sustainability work, given the value of the importance in correlation with the associated risk, workload, and complexity of BCT introduction.	
	Hypothesis B Regarding Research Question 2	The sustainable added value, and the impact and influence experienced is supported by all food SME's employees and the customers long-term recognition	
Consequences, in the form of propositions	**For Hypothesis A**	Pa_1	The TOE factors are critical factors for decision making in the implementation of BCT
		Pa_2	Consumers and SME´s desire blockchain in the supply chain, because there is a convergence of interest of improving the food supply chain
	For Hypothesis B	Pb_1	Blockchain promote the requirements for sustainable operating in food SME's
		Pb_2	Food SME's who integrate the blockchain into their SCM can meet the principals of TBL

Hypotheses ***Pa_1*** and ***Pb_2*** have been built directly into the basic framework of the interview guide. At the end of the work, all conclusions are critically questioned.

5.1 Potential and challenges of blockchain in food SME´s

Chapter 4.5 examined the motivations, conflicts and success factors regarding the application of blockchain in the food SME´s. This Chapter 5.1 links the previous findings to the TOE-framework, and therefore the question what the potential and hurdles of the blockchain in the food supply chain are can be answered.

As outlined in chapter 2.3.5, the TOE-framework of Tornatzky and Fischer (Tornatzky & Fleischer, 1990) was utilized to assign the results of the technology, organizational, and external environmental factors of implementing blockchain in the food supply chain of SME´s.

Pa1: The TOE factors are critical factors for decision making in the implementation of blockchain technology

5.1.1 Technology dimension

From technological perspective important considerations which influence the adoption decisions are the possible received relative advantage which can be achieved through the blockchain. In the long term to operate successfully, it is important that companies continuously improve and expand their processes. The interviewee Recep Poyraz supported this statement in point (section 4.5.1). He mentioned that especially food SME's in Germany have a still a lot of potential to increase their existing business processes and efficiency. Furthermore, potential technology drivers that should bring competitive advantage to food SME´s with the help of blockchain are an improved traceability, transparency systems, reliability, and accessibility for all network participants (section 4.5.2; 4.5.3). Particularly, in the sustainable food supply chain where companies operate in a multi-party value chain, participants need a trusted shared system. Scalability is an important supporting factor, as it allows the organization to store and provide all data related to the whole supply chain within seconds, thus guaranteeing company growth to an efficiency level and gain competitive advantage (Vukolic, 2015).

The technological maturity of the blockchain is a major technological challenge. During the interview with Phuong Nguyen, he mentioned that the blockchain is not full developed yet. That makes is more challenging for companies to simply implemented BCT into the company. From his point of view, this is the reason why most food SME's have not addressed the issue of blockchain technology (section 4.5.1, 4.5.3). Due to the relatively new technologies, there are still no uniform legal regulations and framework conditions (Millard, 2018; Song, Sung, & Park, 2019). The introduction of the BCT technology is classified as very complex. In order to implement BCT in the

best possible way, technical expertise is required to generate the full performance (section 2.3.3). Nevertheless, especially smaller companies must improve their internal technology according to Recep Poyraz (section 4.5.1). The lack of technology knowledge leads to another technical hurdle. Moreover, the full blockchain technological maturity is not given yet. That is the reason, that food SME´s cannot implement easily into their food supply chain.

The table 5.2 provides an overview about the blockchain technical supporters and challenges, which influence the technology dimension.

Table 5.2 Technical supporters and challenges of blockchain technology in food SME´s (Source: Own source)

Technical blockchain supporters	Technical blockchain challenges
Improving business processes and efficiency	Technological maturity
Reliability and Data security transparency	Uniform legal regulation and framework
Reliability and Technology mature	Complexity
Scalability	Compatibility with existing technology, values and needs
Competitive advantage	Monetization of Data / Data Security

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Food SME´s must overcome the technological challenges in their company. Table 5.2 provides companies a guidance to overcome their technical challenges and the potential technical supports when implementing the blockchain technology into their company.

5.1.2 Organizational dimension

Tornatzky and Fleischer refer primarily in the organizational dimension to characteristics of the companies. Organizational drivers include the size of the company, its complexity, structure and process organization and hierarchical structures (Tornatzky & Fleischer, 1990) For the introduction of a new technology, it is important that a technology can be integrated into the organisational processes BCT has to align within corporate strategies and improve the resource allocation and increase the company performance (section 6.2-4). Integration a new technology, the implementation duration is an essential consideration part, to ensure the company can still operate effective (Ariss, Raghunathan, & Kunnathar, 2000).

Poyraz and Nguyen share the assessment that the support of the manager, the training of employees and the best possible utilization of organizational structures are crucial organizational factors for the successful implementation of the blockchain in food SME´s (sections 4.5.1, 4.5.3).

Clohessey et al. investigated in 2018, which organizational factors support the adoption of a new technology. The study confirms that especially for smaller companies it is important that the innovation decision is supported and promoted by the top management of the company. The support of the top management has a decisive influence on this, as small and medium-sized companies typically have flat hierarchies so that information can be exchanged directly and informally. This study found that organizational culture is one of the main obstacles for the implementation (Clohessy, Acton, Godfrey, & Houston, 2018).

Additional due to their organisational size, the managing director has a great influence on his employees and can therefore strongly influence the commitment of his colleagues and employees when introduction the blockchain technology. Especially by training and educating, the employees can better understand the real value of the blockchain in terms of innovation ability contribution to the successful adoption (Clohessy et al., 2018) (sections 4.5.1, 4.5.3). In addition, the support of top management underlines the company's commitment to the technological progress. A high level of IT innovation leads to a long-term company vision, commitment, and optimized management and shows that the company is dedicated for a change (França, Broman, Robert, Basile, & Trygg, 2017).

This is used as an explanation by Nguyen. In his opinion, the Blockchain technology is not yet widely used in food SME´s, because top management is putting its priorities on other technologies (section 4.5.2).

The findings show that distinct methodological knowledge is not available in SME´s yet, but it is important for the correct implementation of BCT. A special particularly that needs to be considered is the size of SME´s, which is not only an advantage (section 4.5.3). Due to their characteristics, SME´s usually have fewer resources available. On the one hand, these resources are reflected in a small number of employees and correspondingly less technical know-how with smaller financial options. SME's must also weigh up the benefits of blockchain against the risks involved. On the other hand, larger companies have a larger number of employees, skills, experiences and thus the option to take the risk. A beneficial value proposition may not be delivered to customers as the risk of creating disadvantages for the individuals could be too high.

The majorities of SME´s are family-run and therefore have a strict hierarchical structure that supports organizational readiness. Especially in the food industry, SME´s often depend on larger companies (section 4.5.3).

Table 5.3 Organizational supporters and challenges of blockchain technology in food SME´s (Source: Own source)

Organisational supporters	Organisational barriers
Management support	Organisational readiness, resource poverty
Complex existing business process	Organisational size, financial constraints
Inefficient existing business processes	Business readiness
Training of employees	Technology readiness
Organisational size	Benefit vs. risk evaluation
	Dependency

Table 5.3 provides an overview about the organisational factors which have to be taken into consideration. Nevertheless the organisational factor depends mainly on the characteristics of a company. Therefore, it is necessary to evaluate the influencing organisational factors for each unique SME.

5.1.3 External task environmental dimension

The whole-time companies are environmental influenced by social norms, values and expectations. They have the need to fulfilment this request for a long-lasting competitiveness.

Legal requirements for sustainable corporate responsibility and subsidized from new technology like the blockchain initiatives can have a positive impact on decision makers for technology adoption. Especially for the BCT exist no standardised legalisation policy. Without any external education and government initiatives, companies will rethink the financial costs and arsing risks of adoption an innovation (Pelkmans & Renda, 2014).

The blockchain maturity and therefore the constantly further development of the technology refer to the market dynamics. Food SME´s are forced to rethink and review their existing processes to analyse how they can assess the blockchain as a technology differentiator compared with their competitor (Angelis & Ribeiro da Silva, 2019)(6.1-3). Mimetic forces are an important external task driver, when it comes to implementation of BCT in food SME´s (Teo, Wei, & Benbasat, 2003). Moreover, with an increasing demand from stakeholders and organizations in terms of sustainable and productive operations, companies are forced to fulfil the needs of their stakeholders (Chang, Kettinger, & Zhang, 2009).

Phuong Nguyen supported the statement of Teo et al, by giving the example of the technology leaders IBM and Microsoft. Both companies provide the structures, that smaller companies can take advantage from it (6.3-7).

External pressure on an organisation, such as the continuous demand for sustainably produced products, supports the need to change the business environment by introducing a new system or revise existing ones. Another external environmental influence is the consumers. Especially in the food industry, where products run through a complex supply chain with several intermediators consumers are asking for more transparency and safety. SME´s are forced to provide transparent information in order to gain a reliable long-lasting producer-consumer relationship. By integration, the BCT into their SCM companies can guarantee transparency to their consumers and influence positive the BCT adoption process (Costa et al., 2013) (section 6.5.3).

In the course of globalisation, food SME´s cooperating with various companies from all over the world. Different culture, work and quality standards make a successful BCT implementation difficult for all parties. The different legal framework conditions were mentioned in the literature and experts as external task environmental factors. A uniform legal framework must serve as a baseline for the development and advancement of the blockchain, as referred by Millard (Millard, 2018) .

In addition, companies are unwilling to share their own data, which leads to information asymmetries and reduces transparency (Sabari, Kouhizadeh, Sarkis, & Shen, 2019).

Table 5.4 Environmental supporters and challenges of blockchain technology in food SME´s (Source: Own source)

Environmental Drivers	**Environmental hurdles**
Competitors pressure	Cultural differences
Government support	Compliance with legal regulations
Market dynamics	Different regularity environment
Industry pressure/customer demand	Information asymmetries

As a conclusion for **Pa1** it can be said that, at the micro level, it can be said that the TOE-framework provides the critical advantages and disadvantages for successful implementation. To make the blockchain technology a wider spectrum available and to create a lead cluster, it is recommended to perform a complementary analysis on the macro level.

5.2 Customer and SME´s blockchain supply chain motivation

Pa2: Consumers and SME´s desire blockchain in the supply chain, because there is a convergence of interest of improving the food supply chain

For companies it will become more and more important to have a sustainable corporate strategy and work with sustainable concepts as described in the triple bottom line chapter 2.1.6. External pressures from stakeholders such as supplier partners, legislators and customers have a positive influence on the decision-making process. All supply chain partners demand a transparent and secure supply chain. Therefore, it is valuable of food SME´s that the physical product flow is positively influenced by the blockchain, which enables a faster and more transparent food supply package, which leads to savings in the company and reduces food waste. The German SME´s have the intention to implement the blockchain more over a longer-term horizon. In the short term the companies have no quick/urgent motivation to implement the new technology. At the current stage of development, the technology is not mature enough yet and due to various entry barriers, like no general framework conditions, German SME´s have no urgent need to integrate the blockchain into their food supply very fast. Thanks to the excellent characteristics of the blockchain, especially the transparency and trackable, the adoption hurdle can be interrupted. As soon as the blockchain has reached its full potential and a secure legal framework exists, the decision would be influenced positively.

In the interviews with the experts and in addition to the literature analysis, it has become clear that the end-consumer prefers sustainably produced food. Study Nielsen 2012 has shown that customers are willing to pay more for their food if they can be sure that it is produced sustainable. This statement is supported by the experts who also emphasized that customers are increasingly focusing on the origin of their food choices. However, it should be noted that consumers are asking for sustainable, safe and trustworthily produced food, but do not explicitly refer to the blockchain. At this current state concept of blockchain is only clear to a minority of consumers.

In this regard, it can be said that Consumers and SME´s desire sustainable produced food, but at this level of development of the technology, both are not explicit asking for the blockchain technology.

5.3 Blockchain as a driver for sustainability

Pb1: Blockchain promotes the requirements for sustainable operating in food SME's

The introduction of a new technology in the food industry requires a comprehensive knowledge of the potential possibilities and effects not only on the economical side but also in sustainability work. Food safety and security are always the top priorities in the food industry. The movement towards sustainable business development is subject to various factors. Due to the scope of this thesis the author has concentrated on two sustainable success factors.

The two major areas of importance for sustainable business management in the food industry are traceability and tractability, incomplete data, lack of communication and lack of transparency are among the biggest hurdles to be overcome in sustainable SFSCM. Through exact traceability, the best possible food safety, food quality and food standards are guaranteed. The blockchain technology enables a complete traceability. With attached sensors in combination with the blockchain technology, data records can be retrieved in real time and a digital verification network can be established. This makes supply chains more transparent. The data generated is not only generated by the sensors but is based on the entire network. The sensors make it possible to combine physical raw materials with digital data. A central instance is no longer necessary. This not only saves costs, but also strengthens the trust between all parties. Every participant from producers to manufacturers stores the information on the block chain. The data is stored forgery-proof and the data can be viewed by a pre-defined group. The addition of smart contracts to the blockchain allows the execution without the involvement of a human intermediary.

As a sustainable success factor, the technology creates the necessary long-term trust between all trading partners. It also creates trust between producers and end consumers. The end consumer receives the certainty that the product he buys has been produced sustainably.

For this reason, it can be said that the blockchain technology not only operationally improves food SMEs, but also influences the sustainable performance of food SME´s.

Pa2: Food SME's who integrate the blockchain into their SCM can meet the principals of TBL

As analyzed in chapter 5.1, the introduction of blockchain technology into food SME´s leads to challenges and hurdles. For further analysis, the Triple Bottom line John Elkington was chosen as a sustainable framework to investigate the sustainable impact of BCT in food SMEs (Elkington, 1994).

Profit: If the blockchain is correctly introduced into the food supply chain, the technology can enable to safe significant costs in terms of optimized business process. The blockchain allows providing data in real time. This means that production can be more efficient, resources can be better used, and companies save money. In addition, efficient production in line with demand not only reduces food waste, but also saves money through lower storage costs. In the interviews with Recep Poyraz and Phuong Nguyen, both mentioned what a dramatic change in customer demand for sustainably produced products have taken place. This means that for food SMEs to be profitable in the long term, they need to be flexible and responsive to changing customer demands and expand their supply chain to include sustainable supply chain. With a positive sustainable brand image, it also allows food SME´s to charge a higher price and sell products with a high-quality standard.

People: Transparency and traceability are crucial factors that the blockchain brings to the food supply chain. The transparency gained enables trust between all food supply chain partners and is therefore an important factor. By implementing blockchain, companies can guarantee that every single participant in the supply chain works under fair working conditions and consequently child labor. Human rights are respected, and corruption is excluded. By using the Blockchain a working atmosphere is created which consists of fairness, honesty and transparency. This not only helps the companies but also enables them to meet the societal awareness of their customers. The trust is gained by the technology forming a secure, data integrity and anti-fraud framework. In addition to this, food safety can be gained through traceability. The blockchain can help to build an agri-food supply chain base. Food safety can be significantly improved through improved tracking. Accordingly, the block chain can enable the demand for a safe food chain, increase trust and at the same time guarantee the high-quality standards in the food industry. By educating and informing all stakeholders, the sustainable development goals are supported for a more responsive consumption and production.

Planet: Especially in the planet improvement area, blockchain offers great potential in food SME´s. Using the blockchain the sustainable ecological footprint can be improved by reducing the environmental logistic footprint. By using the blockchain and SMART contracts, the efficiency of the product can be increased sustainably. As a result, energy consumption, material consumption and CO2 exchange can be reduced significantly. Especially in the food industry, where perishable food is handled, it is important that the cold chain is not interrupted and that an optimal storage management exists. The blockchain allows improving the cold chain through its traceability and traceability and an efficient supply chain for an improved storage management. Especially the possibility of real-time data collection and efficient resource allocation makes this possible. The

output of the food wastage will be significantly reduced and at the same time a resource optimization will take place.

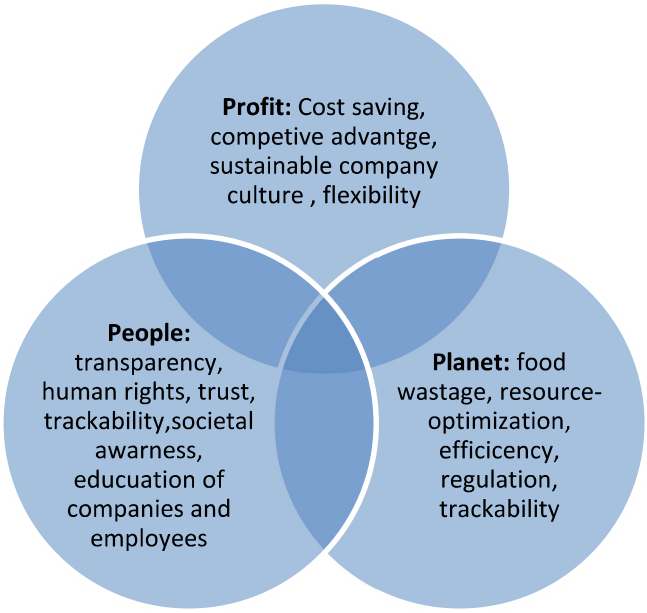

Figure 5.1 Triple bottom line blockchain model for food supply chain in SME´s (Source: Own source)

In section 5.2, the effects of the blockchain on the sustainable food supply chain of SME´s were comprehensively analyzed. By applying the blockchain into the triple bottom line framework, it was found that blockchain technology is a promising paradigm for the sustainable food supply chain for food SME´s. However, it should be noted that sustainability advocates criticize that in a functioning ecosystem, the protection of the ecosystem should be a top priority, rather than bringing all three P´s in balance.

5.4 Relevance and contribution

After examining the potential impacts of the blockchain technology into the sustainable food supply chain of SME´s, this section aims to provide the reader with practical implications and essential take a ways for food SME´s that approach blockchain technology for their company, based on the empirical research results of this work.

Section 5.1 should serve as an orientation and open the discussion about the influencing factors when approaching the Blockchain in SME´s. It is recommended that companies which want to work with Blockchain to engage with the presented TOE-framework and triple bottom line and primarily assess the impact to their own, section 5.1 and section 5.2 will help organizations to

comprehensively survey and understand their existing innovative and sustainable invectives. Moreover, it will support them for their future company strategies decision.

The questions for motivation, conflicts, and success factors can help assess the specific impacts on the own sustainable food supply chain and may even complement the results proposed by this work. By applying the explorative research design of this thesis, some dimensions have shown to be more impacted than others are. The sustainable value added and are essential for the success of BCT and should, therefore be the centre of attention.

Concluding, the discoveries of the result show that a general perspective is required to full translate the principle of sustainable supply chain into a broad organizational context. Societal awareness, changing customer demand, management support, education, internal motivation, and structures can influence the successful adoption. People, Planet and Profit might have to be scrutinized for a holistic application process. Nevertheless, principals of the triple bottom line and success factors of the TOE-framework can be aligned and work as the new paradigm for food SME´s.

Consideration of the introduction of blockchain in food SME´s may have a significant economic impact. Companies are facing the challenge of balancing the benefit vs. risk evaluation. For companies, this can lead to losses or a competitive disadvantage. On the other hand, the trust created, and the reputation gained could lead to a sustainable long-term increase in profitability. Social demand and the degree of technological maturity show that social awareness and attention to technology is increasing and is therefore critical to the long-term success of food SME´s. If food SME´s would show engagement and pioneer in this area, the awareness might increase, and a fist-mover advantage can be obtained.

After providing practical implications about the application in the examined research and orientation the following chapter informs about the reflection and future research.

5.5 Limitation and suggestions

The investigation of the research question has revealed that blockchain as a technology, when used correctly, has the potential to improve the sustainability of food SME´s in Germany. It should be noted, however, that the scope of the research is limited to a small area and can be further expanded. The major limitation of the study is that the author has referred to Germany in geographic terms, and for further investigation it is recommended that the scope of the study to extend to the European Union to obtain a better overall picture. It must be noted that, due to the relatively small size of the research sample, that the findings of this work cannot fully be generalized. As further result researches could tie-up with the findings and conduct to broader investigations to extent the output.

Due to the holistic (deductive) and explorative investigation, sources of error may occur. Although an extensive literary review, case study including expert interviews were analysed during the study, there is always the option that decisive points were not mentioned. However, it is important to emphasize that the intensive research has provided deeper insights into and identified the clear potential of the blockchain technology for collaboration between the partners and thus improved transparency and tractability in sustainable food SMEs.

Although the study has shown the clear potential of the blockchain the German food industry, it is important for the future that SME´s need to educate themselves about innovative potential. The food industry is an important area where it is especially important to work with sustainably concepts. It is significant to note that not only SME´s but all operating companies in the food industry are continuously educating themselves and recognize and understand the potential of new technologies and leverage it. Especially the blockchain technology should receive special attention and be further developed. To integrate the Blockchain technology in the food industry nationwide and globally, it is important to create a clear legal and political framework

As the aim of the study is a description of challenges and potential of the sustainable food supply chain in SME´s, it may serve as a good starting point for further direct research.

To sum up the discussion and the finding of the research, chapter, 5.1, 5.2, 5.3 endorses to a discussion and understanding of the research questions. Chapter 5.4 highlights relevance and contributions. The last chapter, 5.5 explains the limitations during the research and places interest for further researcher on the topic.

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6 Chapter - Conclusion

During the study it became clear that companies should attribute importance to their sustainability work. The examination of operating SME´s in Germany has shown that small and medium-sized companies are responsible for a large part of employment, sales and value creation of the economy. Moreover, the food industry is an integral part of the manufacturing sector. In particular, it is importance for the German market, because it has a special contribution to daily nutrition and special safety standards as well as meeting the ethical and individual expectations of consumers. The German market is particularly important, because of its predominant market power and in the course of this, its motives for sustainability aspects are of particular importance.

Examine the technology, organisational and environmental dimension brought closer understanding in the topic. It is significant for companies to recognize and constantly educate themselves about the possibilities that the integration of a new technology like blockchain brings. Also, the influence of external factors such as the consumer has also been identified as a critical success factor. Although studies have shown that customers ask for sustainably produced food, in the end the consumer is price sensitive and not every price is payable. Especially due to the spread of corona-virus, many consumers have less financial aids at their disposal. The results of the workplaces special attention, that to achieve more sustainability, the tracking and transparency of the food supply chain is a key factor

On the other hand, the market for the blockchain will grow even faster due to the coronavirus. In the financial sector the blockchain already plays an essential role. For the food industry, it is also becoming increasingly central attentiveness. In the future, the blockchain will play an important role, either alone or in connection with other technologies. The technology will function as a basis to store all data and information of the food supply chain and prove transparency and will be manipulation safe. Furthermore, it will be possible to make the processes more effective and efficiency. Those are all achievements which are already in demand and will be more and more in needed during the coronavirus pandemic.

To sum it up it can be said that the blockchain technology is a powerful tool for the decision makers in food SME's. Food SME's which leverage the full potential of BCT, will not only operate sustainable but also gain a significant competitive advantage. For the future, companies who are working with the foundation of sustainability and innovation will be leading companies of tomorrow. Thus, it can be clearly stated that the integration of blockchain is a promising tool to achieve the sustainable development goals of the United Nations.

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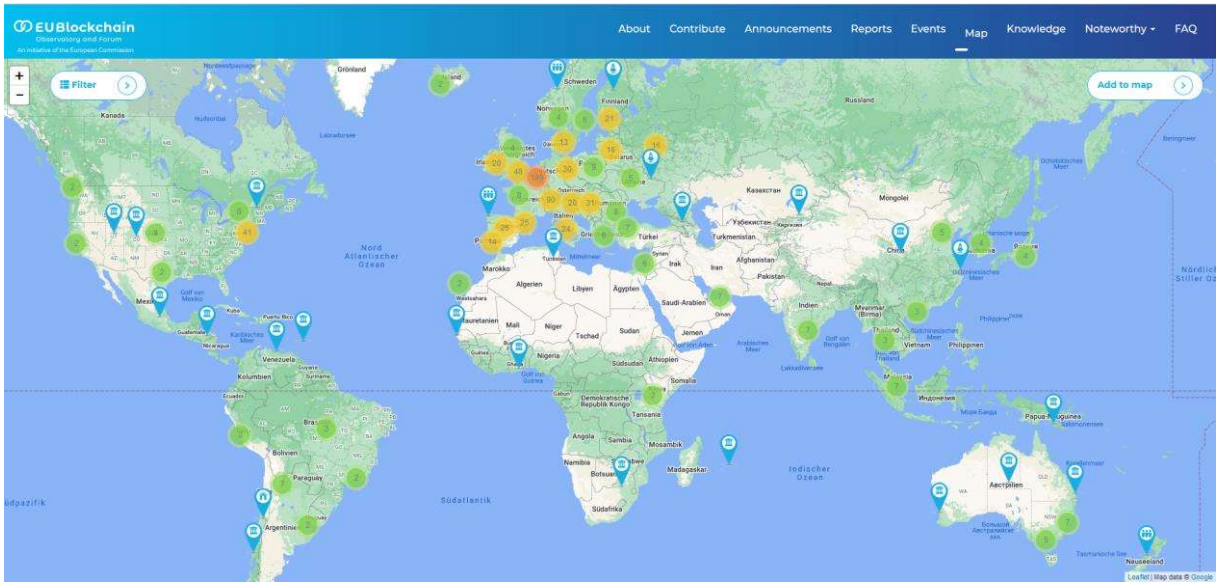
Annexes

Annex A: EU Blockchain landscape



Annex B: Categorization Framework of Expert Interview

Theme categorization	Theme explanation
Block 1: SME´s operating in the food industry	
Motivation	▪ Structural hurdles in the food industry ▪ Market dynamics in the food industry ▪ Important areas for FSCM
Block 2a: Blockchain technology	
General success factors	▪ Successful user cases ▪ Global companies vs. small companies ▪ Main benefits ▪ Main barriers ▪ Influence of the end-user ▪ Sustainable value
Block 2b: Introducing blockchain in SME´s operating in the food industry	
Sustainable success factors	
Block 3: Influencing technology adoption factors - TOE	▪ Main Organizational factors ▪ Main Technology factors ▪ Main Environmental factors ▪ Impact of the economy and populations
Technology / Environmental / Organizational	

Annex C & D can be accessed via:

https://drive.google.com/drive/folders/1p4qRodVUcbGijw-2WniEepo-EYzowFGb?usp=sharing

Annex C: Transcriptions of the expert interviews

Including:

RP_ Expert Interview with Recep Poyraz

PN_ Expert Interview with Phuong Nguyen

Annex D: Coding Agenda