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Technologies for transparency

Flexibility in the innovation process of blockchain applications for food supply chains

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Chapter 1

Introduction

"Food safety and traceability in the agricultural supply chain: using the Internet to deliver traceability." With this title, a paper was published in 1998, on how the internet as a system could be used for food supply chain traceability: a system that would be accessible for all actors involved, providing complete traceability through the use of this technology (Wilson and Clarke, 1998). This research does not stand alone, show Gunasekaran and Ngaia in an article on technology in supply chains (2004), in which they reviewed over a hundred studies on the application of information technology for supply chain management. With the growing presence of internet and other information technologies, the integration with supply chains has received increasing attention. Around twenty years after the publication of Wilson and Clark, a new technology promises food safety and traceability in supply chains: blockchain. Blockchain technology (BCT) has the potential to enable tracking, collecting and sharing supply chain data (World Economic Forum, 2019b) and is attracting the attention of the food sector. The Food and Agriculture Organization (FAO) published a report exploring several blockchain use cases in the agrifood sector (Sylvester, 2019), and there is an increasing amount of projects and initiatives that work with BCT to build transparent and sustainable food chains (Kamilaris et al., 2019; Zhao et al., 2019). The food sector is still looking at technologies to solve traceability issues. However, the focus shifted from efficiency and competitiveness of food companies as most important objectives (Gunasekaran and Ngai, 2004), to finding solutions for environmental, economic, health and social issues in agricultural food production (World Economic Forum, 2019b). Blockchain-enabled traceability is expected to provide a sustainable food system through the use of technology.

A call for transparency

The current food system is characterized by the challenge of producing more food in a social, economic and environmental context that is changing fast. Smallholders, the small scale producers that are responsible for nearly 80% of overall food production (Committee on World Food Security, 2016), have to produce more efficiently and more sustainably This while their own food security is not a given: according to the FAO, 75% of all the extreme poor live in rural areas, mostly depending on agriculture for their livelihoods (Food and Agriculture Organization, nda). In order to tackle these challenges in the food system and move towards a more sustainable food system, change on several aspects of the system is needed. Food supply chains, however, are increasingly complex, due to the global context and the increasing varied demands on sustainable food products (Trienekens et al., 2012). A socially, economic and environmentally integrated approach is needed for achieving sustainable food systems, that at the same time protects rural livelihoods, equity and social well-being (Food and Agriculture Organization, ndb). If due to the complexity it is not clear where the problems take place, it is difficult to solve them. It is thus of no surprise that transparency is growing in importance in the field of sustainability (Mol, 2015). A call for transparent food systems is not only about efficiency anymore: transparency is needed to show the products and production processes to expose all economic, social and environmental products that occur in food supply chains.

The attention towards transparency in the food sector is accompanied by a belief in technologies that will achieve transparent food supply chains. There is a potential in improving information systems with use of e-instruments to ensure sustainable and transparent value chains (Wognum et al., 2011). There is an increasing interest in emerging technologies that could contribute to the transparency of food supply chains in the near future, such as the Internet of Things (IoT), big data technologies and the blockchain (Astill et al., 2019; Gunasekaran and Ngai, 2004). The latter has been receiving a lot of attention over the last couple of years. BCT is believed to be important technology for transparency in the food sector: "[It] is said to be the next great thing within the domain of sustainable value chains" (Da Costa Guimaraes et al., 2019, p.8). BCT became known as the technology behind bitcoin and other cryptocurrencies. It has, however, a broader potential application, as it is a distributed ledger technology for recording and sharing information by a community (Deloitte, 2018). Put simply, blockchain can be seen as a sort of database that lets actors share information with each other in a manner that the information is permanently saved and impossible to remove or change. This makes it a promising technology for tracking or storing any-thing of value, including supply chain data and transactions. In the food sector, the potential of BCT is often emphasized as improving supply chain efficiency (Galvez et al., 2018; Caro et al., 2018; Kumar et al., 2020), but also related to ensuring food safety (Kamilaris et al., 2019; Yiannas, 2018), food data integrity (Zhao et al., 2019; Galvez et al., 2018), trust (Kumar et al., 2020; Galen et al., 2018) and waste reduction (Kamilaris et al., 2019). The idea behind using BCT in the food supply chain, is that every step in the chain can be recorded, making food production completely traceable and transparent.

The innovation process of blockchain

The last couple of years, several blockchain studies and pilots have been carried about in the food sector (see for example the blockchain pilot study of Ge et al. (2017) or the overview study on blockchain in agriculture of Sylvester (2019)). Large commercial companies such as Walmart and Albert Heijn have started blockchain projects for their supply chains (Kamath, 2018; Albert Heijn , 2018) and an increasing amount of initiatives and organizations start social impact blockchain projects (Galen et al., 2018). The majority of these projects however, were still in pilot or concept stage (ibid.). BCT is gaining ground in the food sector, but can at the same time be seen as a technology still in the making. There is an increased interest in BCT, but mostly still seen as an emerging technology with potential (Kamilaris et al., 2019) and projects often in pilot stage (Galvez et al., 2018). The question is not if BCT applications will be further developed in the food sector, but how. It is emphasized that blockchain-enabled technology will likely transform food systems, but not necessarily in an inclusive manner (World Economic Forum, 2019b; Van Gils, 2017). BCT is expected to help address environmental and social issues in food supply chains through transparency and traceability (Galvez et al., 2018), but it is not yet clear in what way. To understand how blockchain through transparency can lead to more inclusive, sustainable food chains, understanding the transparency itself is of importance. This study looks at the role of transparency as the blockchain projects are being developed.

The innovation process of BCT is working towards maturing the technology and scaling the blockchain projects for transparent food supply chains. It is this innovation process towards transparency that will be the subject of this research: developing BCT applications for transparency. To study this innovation process, I combine two bodies of literature: Science and Technology Studies (STS) for the technological development and Governance studies for the goal of transparency. To analyse the development of blockchain technology, I build upon the work of Pinch and Bijker (1984) on the social construction of technology (SCOT), to form a conceptual framework. The SCOT theory looks at the social shaping of technological artifacts and forms the base of a framework to analyze the evolving blockchain technology. The blockchain projects are still under construction and therefore characterized by their flexibility. At the same time, the projects have a clear goal of achieving transparency and use blockchain as a technology for transparency. To study the concept of transparency, I use the work of Wognum et al. (2011) and Mol (2015) for defining and categorizing types of transparency. In this study, the innovation process of blockchain technology is linked to its goal of transparency in the food sector. This research aims to study the flexibility in the construction of blockchain projects and how this relates to the goal of transparency in the innovation process of the technology. How can the role of transparency be understood in the application of blockchain technology in the food sector? How is transparency shaped by and shaping the development of blockchain projects to enhance inclusive and sustainable food chains through transparency? To study the role of transparency in the development of BCT applications, it is important to understand how the concept of transparency is shaped and used, and how it is reflected in the innovation process of the projects. For this research the organization FairChain was selected to study blockchain as a technology for transparency. FairChain is an organization that works on radical transparency and fair value distribution in food supply chains through the use of blockchain technology (FairChain, 2019). At the time of this research, FairChain was going through the innovation process of developing BCT applications for transparent food supply chains in multiple projects. An ethnography of the innovation process was carried out, as introduced by Hoholm and Araujo (2011), where the focus is on following and analysing the open ended development process. By following the innovation process of blockchain projects within the FairChain organization and the actors involved, the shaping of transparency is studied towards the further development of the technology for inclusive and sustainable food chains through transparency.

This thesis is structured as follows. First, a theoretical framework is introduced building on the social construction of technology, complemented with an exploration of the concept of transparency as basis for analysis. After this, the methodology of studying innovation processes is explained and the chosen case and methods are discussed. Next, a contextual chapter is provided, that goes into wider developments of blockchain applications in the food sector, the relation of BCT with the demand for transparency and how the FairChain projects can be situated in this context. Then, the results of the research on the case study of the innovation process within FairChain will be presented and analyzed in chapters five, six and seven. In chapter five, the goal of transparency is explored based on interpretations, ideas and meanings of the key actors. In chapter six, the flexibility of BCT is studied through interpretations and interactions with the technology by zooming in on a specific series of events. In chapter seven, the previous chapters are brought together and analysed to understand the interaction between technology and transparency in the innovation process of the blockchain applications. And finally, the role of transparency in the innovation process of BCT is discussed and further research possibilities are presented for inclusive and sustainable food supply chains through the use of technologies for transparency.

Chapter 2

Conceptual framework

In order to study blockchain as a technology for transparency, two theoretical elements are of importance: technology and transparency. The development process of blockchain technology (BCT) can be placed into the context where it is taking place, namely the projects for transparency within the food sector. For analysing the application and further development of BCT in the projects, I build on social construction of technology (SCOT) theory. To understand the goal of the projects, the second element, transparency, needs a theoretical exploration. How can transparency be defined and what perspectives on transparency exist in the literature? In this chapter, I will first elaborate on the theory of technology as a social construct and how I will use this theoretical foundation in this research. I will then go into the concept of transparency and identify different types of transparency. The two elements will come together in constructing the conceptual framework for analyzing technology for transparency in the context of the blockchain projects.

2.1 A social perspective on technology

2.1.1 Introducing the social construction of technology

The construction of BCT in the projects is influenced by application in food chains and the goals and interpretations of transparency: the technology is influenced by the social context it is developed in. To study this process, an understanding of the social shaping of technology is needed, as is done in the field of Science and Technology studies (STS) (Klein and Kleinman, 2002). An important theory within STS is the social construction of technology, or SCOT, that came up in the 1980s (Geels, 2007). Introduced by Pinch and Bijker, SCOT is an sociological approach of science and technology that sees technological artifacts as social constructs (1984). The theory is built on a social constructivist perspective, which looks at how technologies develop in society and how they are influenced by social structures. For understanding the development process of technological artifacts, the role and interpretations of the people that shape the technology need to be understood (Lassinantti et al., 2014). The focus of this theoretical perspective is both on the context in which the technology is developed and on the actual technology itself (Hitchin and Maksymiw, 2009).

As I take SCOT theory as a starting point to study BCT, it is important to understand both the original theory and the critiques and additions that followed. The original work on SCOT of Pinch and Bijker introduces four elements: interpretative flexibility, relevant social groups, closure and stabilization, and wider context (1984). The first concept, interpretative flexibility is an important starting point in SCOT (Yousefikhah, 2017), as it defines the development of technology as a process that is influenced by the social context around it (Klein and Kleinman, 2002). There is flexibility in the way different people interpret artefacts, but also in the design of these artifacts. This means that the design of technological artifacts is open and can develop in multiple directions, based on the social conditions they are designed in (Pinch and Bijker, 1984). This leads to the perspective of technology as not only an artifact, but also the embodiment of the knowledge, institutions and social construction on how to use the artifact (Van de Ven, 2005). The development process of the technological design is thus flexible. This flexibility is influenced by the relevant social groups involved, the second element of SCOT. Relevant social groups exist of people that share their view on a technological artifact and are related, for example as users, to the technology (Pinch and Bijker, 1984). These groups are "the embodiments of particular interpretations" of a certain technology (Klein and Kleinman, 2002, p.29). The development and shaping of a technology is subject to negotiations between different groups, to what problems are thought relevant (Yousefikhah, 2017). A technology is under development until the different relevant social groups agree on that it works for them. This process of negotiation is described in SCOT by the third element: the concepts of stabilization and closure (Pinch and Bijker, 1984). In the technological development, the flexibility in interpretations leads to controversies and conflicting images of artifacts (Klein and Kleinman, 2002). The design continues until closure is reached: there is consensus of the social groups on the working of technological artifact (Oni and Papazafeiropoulou, 2014). This process towards closure is the stabilization of the technology, when its flexibility fades. The fourth and final element is the wider context (Pinch and Bijker, 1984): the sociocultural and political context in which the social groups are situated and where the development of technological artifact takes places.

The four original elements of SCOT have been subject to debates and additions. A concept that was later added by Bijker himself, is the technological frame (Klein and Kleinman, 2002). This is the cognitive frame that members of a relevant social group share, which can include for example goals, key problems, theories and rules of thumb that structure the way of thinking within a group (ibid, p. 31). Klein and Kleinman argued that, even though this addition of frames made the theory more aware of structure, the theory is too agency centered (2002). According to them, the capacity of actors to shape the technology is influenced by the context they are situated in. Another point of discussion has been the use of social groups. Pinch and Bijker explain relevant social groups in a manner that focuses mostly on users or consumers of the technology (1984). This not only is a simplistic perspective on technological development (Clayton, 2002), but also does not recognize the complexity of societies. It is unlikely that social groups can be seen as uniform groups that all have access to the design process (Klein and Kleinman, 2002). To open up the concept to contextualization and ensure all relevant actors are taken into account, Humphreys presents an addition to SCOT of four meta-categories for identifying social groups (2005): producers, advocates, users and bystanders. These groups are based on their relationship to the technology, they are unequal and people can move between groups. Oni and Papazafeiropoulou go a step further and suggest to search for stakeholders rather than social groups (2014). The stakeholder approach helps identifying relevant actors and allows attention to the context and (political) relations between stakeholders, which is overlooked in the categorization of social groups. A last point of criticism in need to mention here is the emphasis on closure. While Pinch and Bijker recognize that there are degrees of stabilization (1984), the concept of closure as reaching the end of technological development is problematic. As Clayton puts is, since definitions of an final artifact are open to interpretations, closure itself is characterized by flexibility just as social groups and technological frames are (2002). Even after technological development, people redefine and reinterpret the application of a technology (Orlikowski, 2000). Technologies are subject to change, through their use in practice, which implies that full stabilization does not really exist. Together, these discussions and additions on the the original work of SCOT show that the five elements are emphasized and interpreted differently by various scholars.

2.1.2 Flexibility and technological frames

In studying blockchain technology as a social construct, an important notion is that the projects are still under development. This implies that stabilization and closure have not been reached. The focus in this research is on the flexibility of the blockchain development process itself and the actors involved. How is this process influenced by the actors through interactions with the technology? Therefore, the main concepts of SCOT used for analysis are *interpretive flexibility* and *technological frames*.

The design of the project is subject to flexibility in how actors see and deal with the blockchain application. For defining this flexibility, I extend the interpretative flexibility of Pinch and Bijker (1984) using the categorization of Humphreys (2005). According to Humphreys, there are three forms of flexibility in the social construction of technology: flexibility of language, flexibility of use and flexibility of structure (2005). The first is closest to interpretative flexibility and describes the different interpretations and meanings that people give to a technology. Flexibility of use states that an technological artifact is open for more than one possible use. Actors do not only shape the technological by their interpretations, but also by their interaction with the technology. The last type of flexibility is that of structure, which covers the way we see a technology as separate from its use (Humphreys, 2005). In this research, the focus will be on the first to types of flexibility: language and use. The importance of flexibility of structure is not to be neglected, but not possible to research within the chosen scope of this case study research. The division between flexibility of language and of use will provide an helpful tool for analyzing the BCT development.

The flexibility does not only occur in the design phase of a technology, but remains when the technology has been put into use. Here, I follow the perspective of Orlikowski on technology in practice, which focuses on the interaction of people with properties of technologies (2000). A technology is developed as people engage and interact with it. This interaction can be further explored by using the article of Glover et al. (2017) on the mobility of technologies, in which they introduce the concepts of inscription and affordance. The inscription of a technology is that what is built in by its designers, so that the technology is used according to their expectations. However, to some extent, technologies have a potential for several options of actual use. This is the affordance: the opportunities for interaction of users with the technology. Affordances can be the materiality of a technology, but also the situational and relational aspect: the context and capabilities of its users (Glover et al., 2017, pp.17-18). Inscription and affordances can help with analyzing the flexibility of technologies.

The second main concept used in this study is that of technological frames. The flexibility in the development process can be analyzed through the technological frames of the different actors. How they see the technology influences interpretations and use of the blockchain applications. For analyzing the technological frames, I will take the distinction of Yousefikhah, who divides the technological frame into the elements *Nature of technology* and *Technological strategy* within her framework based on the work of Bartis (2007, cited in Yousefikhah 2017, p.37). The nature is about how users perceive technology: what they see as its capabilities and functions. The strategy is about motivations, goals and ideas that people have for using the technology (Yousefikhah, 2017). In other words, the flexibility of the development process is influenced through the technological frame, both by how the relevant actors understand the technology and what they want to achieve with it. Since this research takes place within an organizational context, the concept of social groups is not useful to describe these relevant actors. All actors are within the organization and can be categorized as Humphreys' group of producers (2005): they have an organizational and economic stake in the technology. The technological design is however subject to different interpretations within this group. The individual actors in their roles ensure the flexibility of the design process, there is no consensus yet. It is these individual actors that I take as the relevant actors or stakeholders (Oni and Papazafeiropoulou, 2014) to study the flexibility in the technological development. In the blockchain projects, other groups are present and of influence in the development. Users, advocates and bystanders (Humphreys, 2005) can be identified such as brands, consumers and farmers, advocates for transparency, sponsors, certifiers and governments. They are however not the subject of this particular study. Therefore there is less emphasis on the concept of social groups and the wider context that structures them.

In studying the application BCT in the projects, it is importance to analyze the flexibility of the technology development process. This flexibility is influenced by different technological frames of the relevant actors who shape the blockchain applications in their interpretations and use of the technology. It is this focus on flexibility, both of language and use, together with the concept of technological frames that I take as structure for analyzing the blockchain projects for transparency at the FairChain organization.

2.2 Technologies for transparency

As a technology for transparency, the development of BCT can not be seen as separate from its goal of transparency. Blockchain is an example of a technology that can be applied in food supply chains as an answer to the demand for transparency (Astill et al., 2019; Kamble et al., 2020). Transparency is increasing in importance in relation to the sustainability of value chains (Mol, 2015). Often believed to be a crucial step towards a more sustainable food system, transparency is linked to ideas of empowerment, accountability and effective governance (ibid). The theoretical framework based on the social construction of blockchain technology thus needs to be extended with the goal of transparency. In the following section I will theoretically explore the concept of transparency, starting with defining transparency and then going into categorizations of transparency.

2.2.1 Definitions of transparency

BCT has several features that are useful in the food sector and mostly its potential for transparency is often mentioned. For example Galvez et al. speak of transparency next to efficiency, food safety and security (2018), where Caro et al. emphasize auditability and immutability besides transparency (2018). Blockchain is put forward as a promising solution for more transparent food supply chains (Kamilaris et al., 2019; Yiannas, 2018). But how can we understand transparency in this context?

A concrete definition of transparency is hard to give, since the concept is associated with general terms such as openness, communication and information (Gupta and Mason, 2014). Perspectives differ on what transparency means and to what goals it is put to use in supply chains. For example a study on meat supply chains in relation to animal welfare describes transparency as 'consumer-oriented': a tool to make people aware about what they buy (Hoogland et al., 2005). Another example is a study on seafood supply chains and transparency, that emphasizes transparency as a way to hold the industry accountable (Iles, 2007). This link of transparency with accountability is also mentioned by Mol (2015) and Gupta and Mason (2014). Transparency is also closely linked to the actors who ask for transparency. As Trienekens et al. (2012) state, both consumers, governments and companies themselves can be seen as the 'claimants' of transparency.

Defining transparency while enhancing all these different aspects is challenging, if not impossible. For getting a better understanding of transparency specifically applied to supply chains, the definition of Wognum et al. provides some structure (2011). They see transparency as the availability of both relevant and accurate product-related data to both consumers and supply chain stakeholders in a manner that is accessible and readable to all (Wognum et al., 2011, p.65). This definition includes several elements that are useful for studying transparency in the blockchain projects: product-relatedness, relevance of data, inclusion of actors and access. These four elements emphasize not only what needs to be made visible, but also who need to be included and have access. I take this definition as a starting point for analyzing the role of transparency in the blockchain projects: what data (product related and relevant) is presented to which actors (inclusion) and in what way (access)? I combine this definition with the work of Mol (2015) on different types of transparency.

2.2.2 Types of transparency

Within studies on transparency in food supply chains, the relation between the target group and definitions of transparency is often present. There is a line of articles that argues for transparency with consumers as the main target, where transparency is for example linked to changing consumer behaviour (Hoogland et al., 2005), consumer trust (Beulens et al., 2005), or influencing consumer demand (Iles, 2007). In others, transparency is linked at several perspectives and all involved stakeholders are emphasized (Astill et al., 2019; Trienekens et al., 2012; Mol, 2015). Stakeholders can be food companies, producers, retailers, governments, certifiers. Following the definition of transparency by Wognum et al., transparency is about the elements *inclusion* of both consumers and supply chain *stakeholders* and their *access* to *relevant* data (2011). However, it is still a rather general definition of supply chain transparency. Is relevance the same for all stakeholders involved? And who needs access to what data?

For conceptualizing the idea of supply chain transparency, it is important to recognize that there exist different types of transparency. For this the categorization of Mol (2015) provides a useful structure. Where the definition of Wognum et al. (2011) speaks of supply chain data and actors in general, Mol (2015) recognizes that different data can be relevant for different actors. He speaks of four ideal types of transparency, recognizing that in practice they can mix. The first type is management transparency, which is about the disclosure of information of supply chain processes from and to economic actors, such as processors or producers. The second type is called regulatory transparency, which is data meant for inspections and regulations by authorities. The third type is consumer transparency, where information about the product is revealed from economic actors to consumers, for example through labels. The last type is public transparency, by which the disclosure of data of products and production processes to the wider public domain is meant. These different ideal types show that transparency is about what data is made visible to whom.

The two remaining elements of transparency as discussed above are the *product-relatedness* and the *accessibility* of the data (Wognum et al., 2011). The question of what data is made visible, is closely linked to the product information. The four ideal types of transparency show that product-related data can be about the product itself, its components or the production processes. In studies on blockchain applications for food supply chains, the focus is often on traceability (i.e. Behnke and Janssen (2020), Caro et al. (2018) or Galvez et al. (2018)) or provenance (i.e. Ehrenberg and King, 2020). Provenance is focused on the origin of a product, where traceability looks a bit further and includes the where and when of production. Traceability is seen as a part of transparency (Kashmanian, 2017). However, transparency exceeds traceability by adding data on production processes (Yiannas, 2018) or sustainability data (Astill et al., 2019). Traceability and provenance enabled by BCT are thus part of the product-related data. This enabling role of the technology is linked to the fourth and last element of transparency: access. If transparency is about making relevant data available for relevant stakeholders, the question remains on how this data is made accessible to all involved. The categorization of Trienekens et al., who speak of components of transparency, shows not only 'claimants' of transparency, but also enablers in the form of governance, standards and information systems (2012). These enabling components emphasize that transparency is also about how relevant data is communicated to stakeholders. Here the relation of BCT to transparency can be seen, as it is an enabling technology, or information system, for transparency.

In studying the concept of transparency in the innovation process of the blockchain projects, I use the definition of Wognum et al. (2011) as a starting point, combined with the four ideal types of transparency as a structure based on the work of Mol (2015). I complement this perspective on transparency with attention to the role that BCT can play as a technology for transparency, in determining what product data is made visible and enabling access to that data.

2.3 Building a conceptual framework

For studying the concept of transparency in the social construction of BCT, a framework is needed that combines the different theoretical concepts. This research examines how BCT combines with transparency and accordingly the conceptual framework integrates two bodies of literature on flexibility and transparency. This is visualized in the conceptual model that can be found in Figure 2.1, which provides a conceptual framework to study the innovation process of technologies for transparency.

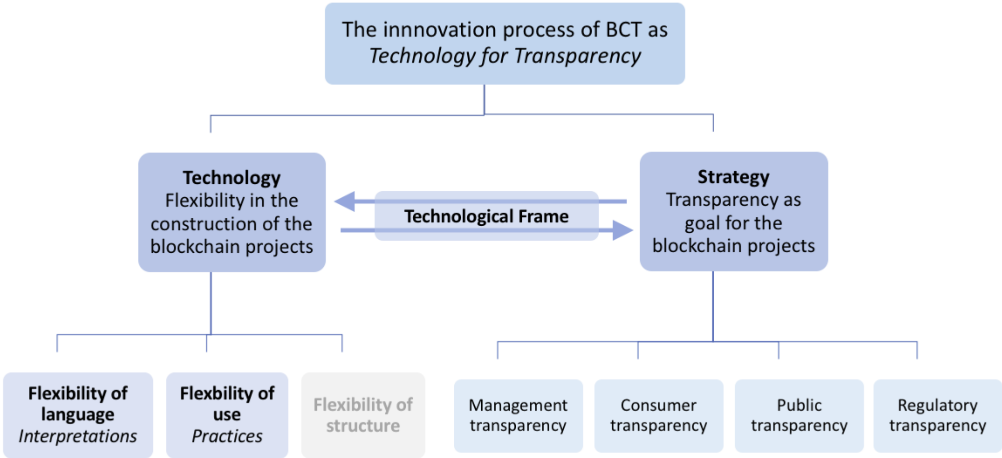

Figure 2.1: Conceptual framework on the innovation process of BCT applications for transparency

The construction of technology in this research is the innovation process of BCT as a technology for transparency in the food sector: how are blockchain applications in the food sector developed? Here, I take the flexibility in technological development of Pinch and Bijker (1984) as an entry point. Following Humphreys (2005), the flexibility in the development of technology can be analyzed at three different levels: language, use and structure. Within the scope of this research, I focus only on flexibility of language and use, or interpretations and practices in the interaction with BCT. The flexibility in the technological development is influenced by the different technological frames of the actors involved (Klein and Kleinman, 2002). It is the technological frame where I link the technology to the concept of transparency. Transparency is the part of the strategy or goal of the blockchain projects. I use the categorization of Mol (2015) in this conceptual framework to identify and analyze the different types of transparency that guide the innovation process of the blockchain projects. Transparency as a strategy relates to the development of the technology, as it is embedded in the technological frames around BCT in the food sector. For this, I use the distinction of technological frames of Yousefikhah (2017): the nature and strategy of the technology. Transparency is also part of the nature, since blockchain is seen as a technology for transparency. It is expected to offer transparency in food chains. The technological frames are used to analyse the connection between the goal of transparency and the technological development of the blockchain projects.

This research focuses on understanding this relation: how strategies of transparency of different actors influence and are influenced by the flexibility in the technological development of BCT applications in food supply chains.

Chapter 3

Methodology

This study is an ethnographic research of innovation processes through participatory observation. For this, a case study was selected at the FairChain organization, where the innovation process of blockchain projects is taking place. FairChain works on blockchain technology (BCT) applications in food supply chains for transparency and shared value chains (FairChain, nd). This case allows for studying the development of BCT as the technology is being applied for transparency in food supply chains. First, I will state the objective and research questions of the study. After this, I will go into the case selection of the innovation process at FairChain. I will conclude with the combination of methods used in this ethnography of an innovation process.

3.1 Research objectives

The main focus of this research is understanding the role of transparency in the construction of BCT in food supply chains. With a growing demand for more transparency in the food industry (Mol, 2015; Trienekens et al., 2012), there is a believe that technologies could bring transparent food supply chains (Astill et al., 2019; Kamble et al., 2020). BCT, as an example of technology for transparency, has been gaining interest in the food sector, but at the same time is still in its early phase of development (Kamilaris et al., 2019; Galvez et al., 2018). This research looks at the innovation process of BCT as it is being applied for transparency in food supply chains to ensure a sustainable food industry. This process is studied at FairChain, where they work on blockchain applications for transparency in food supply chains, with a specific focus on a sustainable food system through fair value distribution and the inclusion of the smallholder farmers. In the study, the set up and further development of blockchain projects in FairChain is followed and analysed.

Transparency is both part of the nature of blockchain technology and an end goal for the blockchain projects. As such, transparency plays an important role in the development of BCT applications of food supply chains. The blockchain projects in FairChain, and in other organizations, are still under construction and are therefore characterized by their flexibility. This research aims to study the flexibility in construction of blockchain projects and how this relates to the goal of transparency in the innovation process of the technology. This results in the overall aim to understand the role of transparency in the application of BCT in the food sector, in order to see how transparency through technology can enable sustainable and inclusive food chains in the further development of blockchain food applications.

The main research question in this thesis is: *How is the development of blockchain technology for transparent food supply chains in the FairChain projects shaped by the interaction between flexibility in the technology construction and different types of transparency?* To understand the role of transparency in the innovation process of BCT, it is important to understand first how the concept of transparency is perceived and used, then how this is reflected in the construction of BCT as a technology for transparency and finally how the development of the technology interacts with the goal of transparency. This will be done by answering the following categories of sub research questions:

- **Defining the concept of transparency:** What types of transparency can be identified in the FairChain blockchain projects? How is transparency interpreted by the different actors?

- **Blockchain as enabler:** How can transparency be enabled by BCT in the FairChain projects? How is the development of BCT shaped through interpretations of the actors and interactions with the technology?

- **Technology for transparency:** What is the role of technological frames in the development of the FairChain blockchain applications? How can the interaction between BCT and transparency be understood in the innovation process of the projects?

These sub questions will be discussed in the empirical chapters on the interpretations of transparency by the different actors and the development process of the technology within the blockchain projects and then analysed in bringing transparency and the technological development together through technological frames.

3.2 The innovation process within FairChain

As this research studies transparency in the development of blockchain projects, it looks into the innovation process of BCT. Blockchain as it is applied in the food sector is still in an early stage and can be identified as a technology in the making. This implies that this is not a study after the potential or evaluation of transparency, but the aim is getting an understanding of it as it is taking shape within the flexibility of constructing the blockchain projects: a study of the innovation process. Following and analysing this open ended process can be done through an ethnography of the innovation process (Hoholm and Araujo, 2011). This allows for an understanding of processes and practices during the development of the blockchain applications. By following actors and resources throughout the different phases of innovation processes, it is possible to study an innovation-in-the-making.

For studying the innovation process of BCT in food supply chains, the development of blockchain projects was selected as a case study: the construction of BCT applications for transparency, in the context of an unfolding innovation process in the FairChain organization. Making use of a case study allows to follow the innovation process more closely and to get in depth and context-dependent knowledge (Flyvbjerg, 2006). FairChain develops BCT applications with the aim to build fair value chains through transparency. They see the technology for transparency as possibility to address sustainability issues in food supply chains, with a focus on social concerns related to smallholder farmers. FairChain can be characterized as a small organization [1] working on projects with different external partners. Within the time and scope of the research, I have chosen to mainly focus on the process and actors within the FairChain organization. Consequently, the FairChain team members are followed closely as key actors, as they design and commission how BCT is applied in the projects. Actors outside of FairChain, such as the technology developers, the food brands and other project partners were included in the research merely through interactions with the key actors. The time frame for this research was ten weeks of field work at the FairChain organization, in which the innovation process of the BCT applications was followed closely and analysed. During this time, FairChain worked on two projects: the supply chains of coffee and of cacao. For the coffee project, there already existed a blockchain application that was being further developed and improved. For the cacao project, the application was set up for the first time. Since the projects were constructed simultaneously and often intertwined, both are included in the study into the innovation process of

[1] Less than 20 employees

BCT for transparent food supply chains.

This study focuses on the innovation process of BCT, which is important to differentiate from invention. An invention is the introduction or idea of a new product or process for the first time, where innovation is about bringing these into practice (Ramella, 2015). In the case of the blockchain projects, the invention can be seen as the emergence of blockchain technology itself. The innovation studied here is the application of the technology in food supply chains within FairChain. Where the definition of Ramella (2015) emphasizes the first time of practice, I argue that innovation can be seen broader. While the first FairChain blockchain project has been launched two years ago already, the projects are still in the phase of pilots and experiments, and the BCT application in the food sector is still under development. This ongoing innovation process is the subject of this study.

This is not a study of the complete innovation process, but of a phase in the process, delimited by the time frame of ten weeks. An innovation process can be divided into different stages (Ramella, 2015) or sub-processes (Pavitt, 2006) for analytical purposes, but is not a linear process. I see a phase in the innovation process thus not as a specific stage of development, but as a period in which multiple sub-processes can be identified that overlap and take place simultaneously. In the phase of this study, even in a small organization as FairChain, it is not possible to include all that happens. The idea of an ethnography of innovations is that it allows to look for specific fragments of processes (Hoholm and Araujo, 2011). This is done by following key actors of the FairChain projects and mapping out the innovation sub-processes of the BCT applications for transparency in the coffee and cacao supply chains.

3.3 Data collection and analysis

Over a time period of two months at the FairChain organization, the projects were studied through participatory observation. During this time, I participated mostly in the team of FairChain responsible for the blockchain projects. The two months can be roughly divided into two periods: a first period of getting an understanding of the projects within FairChain and identifying actors involved and a second period of following some events in the innovation process more closely and carrying out interviews with key actors in the projects. The participatory observation consisted of being present at the FairChain office for three to four days a week. These days were filled with attending meetings and discussions and working on some administrative tasks for the blockchain team. These tasks allowed for not just observing, but gaining a more in depth understanding of the functioning of the organization and the projects. Reflective notes were taken on a daily basis, ranging from official meetings with project partners to conversations on the projects during lunch. In doing so, it was possible to follow not only the formal decision-making processes in the organization, but to also understand the informal discussions and challenges that lay behind this.

The participatory observation was complemented with interviews and literature research. For the interviews, key actors were selected with a direct link to FairChain and the blockchain projects. Since FairChain itself develops and designs the projects, this implied that the actors within the FairChain team were of relevance. Other actors that were spoken with informally, but not interviewed, were people who work commissioned by FairChain. These actors are more executing than shaping the projects and therefore not included in the interviews.[2] All interviews were semi-structured, using a list of topics and questions to discuss, and ranged from 20-80 minutes (see Appendix A for the structure). Next to this, a literature research was carried out to place the FairChain projects in the context of developments of the broader food sector. An innovation process as a case study, implies a situation in which the process takes place. Innovations can be characterised as relational: they take place in a specific time and context (Ramella, 2015). The context of the innovation studied in this research is mostly organizational: the context within FairChain. However, also a wider context has been studied in which the FairChain projects can be placed. For this, overviews of organizations that make use of BCT were consulted,[3] combined with scientific articles on blockchain applications in the food sector and online news articles on projects and organizations. This was complemented with documents of FairChain, both formal and informal, published and unpublished, to analyse the organizational context of the blockchain projects. Taken together, the literature study complemented the participatory observation and interviews for mapping and analysing the innovation process.

The data was analysed by combining the transcripts of the interviews with the daily notes from the participatory observations. For this a deductive coding process was used (see Appendix A for the coding scheme), where the theoretical concepts directed the collecting and analysis of the empirical

[2]In the representation of the interview data, the respondents are coded with TM1 to TM10 for Team Member, to ensure anonymity. The codes are complemented with the date when the interview took place. Not only the names, but also the functions are left out, as the organization is very small and identification of the respondent would be possible with the function. In the empirical data from the observations, external stakeholders are mentioned by the names of their organizations in general.

[3]These overviews exist of the reports of Galen et al. (2018) and Sylvester (2019), and the database https://positiveblockchain.io/, last checked on May 26, 2020).

data. As the research is about two theoretical themes, transparency and technology, both were used in the coding process. For transparency, sub-themes were identified based on respondents' perceptions in the interviews of what transparency makes visible and to whom. These sub-themes were placed within the categorization of the four ideal types of transparency introduced by Mol (2015). The theme of technology was analysed by combining the interviews with the data from the observations, to look into the construction of BCT. Here, the sub-themes were identified based on both the interpretations and the interactions of the respondents with BCT, following the division of Humphreys between flexibility of language and flexibility of use (2005). To structure the different stages of the innovation process, observed events are categorized using the sub-processes of Pavitt (2006): producing knowledge, transforming that knowledge into artifacts and matching it to market demand. For analysis, transparency and technology were brought together and studied through the concept of technological frames, using the division of nature and strategy (Yousefikhah, 2017). This analysis is focused on understanding the flexibility of BCT as a technology for transparency that is applied in the FairChain food supply chains.

In what follows, the innovation process of the blockchain projects for transparency in FairChain will be discussed, based on the collected data. Chapter five discusses the types of transparency that can be identified in the FairChain projects, using the interviews with the team members. In chapter six, the interview data is combined with observations to go into the flexibility of BCT through interpretations and interactions with the technology. Chapter seven combines the empirical chapters in an analysis of the relation between flexibility of technology, the goal of transparency and technological frames. Before zooming in on the FairChain case however, chapter four first provides the results of the literature review with an overview on the wider context of blockchain as a technology for transparency in food supply chains and how the FairChain projects can be placed into this.

Chapter 4

Blockchain applications for food

The development of the blockchain technology (BCT) applications in the FairChain projects for transparency, takes place in a context of increasing interest in the technology in the agrifood sector. Characterized as a transformative technology for food (World Economic Forum, 2019b), it is important to understand why and how the sector and FairChain are working with blockchain as a technology for transparency. I will first explain the principles of the technology, its background and application in food supply chain, before going into some current use cases in food value chains and the organizational context within FairChain.

4.1 Blockchain for food

4.1.1 Understanding blockchain technology

To see how BCT can be applied in the food sector and how it is used by the FairChain foundation, a basic understanding of the technology itself is important, as it is a complex concept. Here I will explain the basic principles and background of the technology, and it's link to agrifood. The purpose of this is not to give a complete explanation of the technology, but providing a basic understanding needed to understand the data of this research. [1]. Put most simply, a blockchain can be seen as a database that lets actors share information with each other in a manner the information is permanently saved and impossible to remove or change. The name itself explains the principle:

[1] As BCT has many complex features and applications, a complete explanation is not within the scope of this research. A more in depth exploration of the technological concept in relation to the agrifood sector could for example be found in Da Costa Guimaraes et al. (2019).

the blockchain consists of encrypted blocks with data that are linked together in a chain, forming the database. The database is not controlled by a central owner who determines what data comes into the database, but by a group of participants who decide what blocks are added to the database: it is a distributed database. This makes it promising for tracking and storing any data of value, including supply chain data and transactions.

BCT became known as the technology behind bitcoin, introduced as a peer-to-peer online payment system by Nakamoto et al. (2008). Bitcoin was introduced to provide digital transactions without the need of an intermediary.[2] The solution of bitcoin was to decentralise and distribute the verification of transactions to a network. After the verification, all transactions are stored in a ledger, keeping track of the transaction history. Bitcoin replaced what a middleman, e.g. a bank, does: making sure the money goes from one person to another. By using a distributed ledger technology that enables verification and storage of all transactions in a network of peers, the database is immutable. This technology, that started with bitcoin and other cryptocurrencies, gained the attention of other parties and industries and got named blockchain technology. Defined as a digital and distributed ledger of transactions, recorded and replicated in real time across a network (Deloitte, 2018). Real time, because as soon as data is added to the blockchain, this can be seen by the entire network. Agrifood is one of the industries that started making use of BCT, with projects in several directions such as agricultural risk management and financial inclusion and supply chains (Sylvester, 2019). Particularly the latter developed after the first introduction of BCT towards a promising potential for transparency in global food supply chains (Zhao et al., 2019; Antonucci et al., 2019). The idea behind using blockchain in the food supply chain is that every step in the value chain can be recorded, making food production completely traceable and transparent. The blockchain can capture and display the transactions in the entire food supply chain, showing the prices paid at each stage and trace the product back to the origin. This offers a solution for challenges in food supply chains through efficiency (World Economic Forum, 2019b) and trust (Galen et al., 2018), by transforming the supply chains into decentralized, neutral and transparent systems.

Building transparent food supply chains is only one possible application of BCT. The technology can be used in different functions and moreover, different forms of BCT are possible. There are variations in the technology, in degrees of decentralization, how access to the blockchain is controlled

[2]The technology was proposed as a solution to the double-spending-problem in digital transactions.

and how data is accepted to the blockchain (Da Costa Guimaraes et al., 2019). Different BCT applications can thus have different forms of BCT, depending on preferences and available resources. This implies that how immutable and decentralized the blockchain in reality is, depends on how the application is constructed. For food supply chains applications, a challenge lies in combining the digital world with the non-digital: where the blockchain is a digital database, the supply chain itself is about physical products. How to make sure that a farmer indeed sold ten kilograms of coffee to a processor and not nine? This issue relates to the last feature of BCT that I will discuss here: smart contracts and the use of other technologies. Smart contracts are sets of rules, captured and performed through the blockchain to automate the input of data on the blockchain. As soon as the rules of the smart contract are met, the data is added to the chain. This can increase efficiency and avoid manual errors and misunderstandings (World Economic Forum, 2019a). In the situation of the coffee farmer this could mean that the transaction is carried out and saved on the blockchain when the farmer and the processor both confirm the ten kilogram of coffee beans. This could however also be confirmed combining BCT with other technologies, like the Internet of Things (IoT) and Artificial Intelligence (AI), strengthening the link between the physical and digital world. Sensors in a scale could automatically pass the information on and trigger the blockchain-enabled transaction through the rules of the smart contract. A camera could complement this with a quality check of the beans . Developing such combinations together with BCT in practice is still challenging, but has the potential to make food production completely transparent (Astill et al., 2019). The characteristics and features of BCT applications make it a promising technology for transparency in food supply chains.

4.1.2 Developing blockchain for food

With the potential for food supply chain transparency, several possible BCT applications are under development. Two areas that the technology is analysed to develop towards are provenance and chain-of-custody (Ehrenberg and King, 2020); both can be applied broadly in the food industry. BCT is characterized as transformative for supply chains, because it can not only track, but also collect and share data in an efficient manner (World Economic Forum, 2019b), causing an increasing interest in the technology for food supply chains.

In recent years, several studies explored how blockchain can be applied in the food sector (Antonucci et al., 2019), and there is a rising number of initiatives, projects and case studies that work with BCT in food supply chains (Kamilaris et al., 2019). As the technology is still in an early stage of development, studies often focus on the potential of using the technology in food supply chains (see e.g. Galvez et al. (2018), citeKumar et al. (2020), Zhao et al. (2019)). However, some studies go a step further, by focusing on building practical implementations (Caro et al., 2018), or on already existing projects (Kamilaris et al., 2019). In the latter, Kamilaris et al. showed that for a diverse range of products - such as beef, chicken and pork, but also mangoes, grapes, grains and soybeans - initiatives have been started using BCT.[3] They distinguish six categories of initiatives that give an indication on how broad the use of the technology is now: food security, food safety, food integrity, support of small farmers, waste reduction and environmental concerns, supply chain management and supervision. The technology is related to tackling issues such as food fraud and contamination, trust issues, inefficiencies and addressing environmental and social concerns (Galvez et al., 2018; Caro et al., 2018; Galen et al., 2018; Kumar et al., 2020; Zhao et al., 2019).

There is a trend noticeable, but at the same time few projects are operational (Kamilaris et al., 2019), and often still in a pilot stage (Galen et al., 2018; Galvez et al., 2018). BCT is a complex technology that is still immature and complicated to apply (Antonucci et al., 2019). In both the design and implementation of the technology challenges still exist (see e.g. Kumar et al. (2020), Kamilaris et al. (2019) or Galvez et al. (2018)). Despite the potential for social issues such as helping smallholder farmers, the use of blockchain is not necessarily inclusive and can deepen inequalities (Manski, 2017). Moreover, Zhao et al. identify six challenges based on a literature review that still need to be tackled (2019): scalability, privacy, costs, regulation, capacity and skills. At the same time, solutions to these challenges are already being explored (ibid.), showing that the technology is still in the development process. By exposing the challenges it is possible to gain a realistic understanding of the technology and further develop the applications (Kumar et al., 2020). In the literature on BCT applications for food supply chains, the emphasis is on the potential of the technology. Characteristics as immutability, auditability, authenticity and traceability are believed to make a difference (Caro et al., 2018; Saberi et al., 2019; Zhao et al., 2019). Related to these characteristics, and often mentioned, is the transparency BCT provides in food supply chains. Despite the challenges the application of the technology in the food sector still faces, the growing attention seems to

[3]Other studies suggest similar product ranges (Galvez et al., 2018) or contain also other products (Antonucci et al., 2019). These studies do not provide a complete overview of all food products that work with BCT yet, but give an idea on how the technology is applied over different product supply chains.

indicate a serious interest in using BCT for food supply chain transparency.

4.2 Blockchain and Transparency

4.2.1 Transparency projects

The interest in the technology is related to the increasing demand for transparency in the food industry. Food systems are characterised by increasingly complex global supply chains (Saberi et al., 2019; Wognum et al., 2011). Transparency is believed to open up supply chains, allowing actors to work on challenges on the ground and making visible where and how progress is being made (Gardner et al., 2019). As different perspectives exist on the concept of transparency and it's different elements (see paragraph 2.2), different perspectives exist on the need for transparency. Through traceability, transparency can provide better safety and quality of food, avoid fraud and detect contamination sources (Beulens et al., 2005; Galvez et al., 2018). Another objective is to increase efficiency through transparent supply chain management (Caro et al., 2018), as traceability is part of logistics management (Behnke and Janssen, 2020). These two objectives focus on saving costs for supply chain actors. A third objective is related to consumers, who increasingly want to be informed about food products, beyond certificates, for their buying decisions (Wognum et al., 2011). In addition to these objectives, there is a believe that transparency should improve social and environmental sustainability through revealing data on food production (Astill et al., 2019). To achieve sustainable food supply chains, transparency is needed first to expose the social and environmental risks and opportunities (Gardner et al., 2019). BCT can be applied for all these transparency objectives and is thus an interesting technology for organizations working on transparent food supply chains.

Different projects have started in the food sector, that strive for transparency through BCT applications. These projects show a range of different transparency objectives and different food products, but all work on transparent supply chains.[4] One of the first organizations working on BCT applications was large retailer Walmart, that started two pilot projects in 2016 (Yiannas, 2018). The pilots focused on traceable mangoes for improving safety and efficiency, and authenticity in pork supply chains to regain people's trust in food (Kamath, 2018; Yiannas, 2018). Other retailers that also started with blockchain projects are Carrefour and Albert Heijn. Car-

[4]This is a small selection to give an idea of the type of organizations that work on transparent food supply chains using BCT applications.

refour introduced a transparent chicken supply chain through BCT, to gain consumer trust (Carrefour, nd). Albert Heijn started with an orange juice project (Albert Heijn , 2018) and now also have eggs on the blockchain (Albert Heijn, nd), to show consumers what they do in the supply chains of these products. These retailers all focus on transparency for the consumer: gaining their trust by ensuring food safety and showing provenance of the products. Organizations that address sustainability issues more explicitly through BCT applications are NGOs. The WWF works with partners as Nestle to address environmental concerns (e.g. biodiversity loss) with their open supply chain platform that runs on BCT (OpenSC, nd; Nestle, 2019; WWF, nd). Oxfam Novib launched BlocRice, a blockchain project in Cambodia for social sustainability, by using the technology to improve livelihoods through correct payments and empowering farmers (Oxfam, nd). An example close to FairChain is the Fairfood organization, a foundation that focuses on the living income and empowerment of smallholder farmers and making supply chains inclusive by giving access to consumers and farmers (Van Gils, 2017). They have built transparent supply chains of coconuts and coffee through BCT and are now working with the company Verstegen on nutmeg and other spices (Fairfood, nd). The projects of WWF, Oxfam Novib and Fairfood are examples of using BCT to improve conditions in food supply chains. Similar to Fairfood and Oxfam Novib, FairChain builds BCT applications for farmer inclusion, using it for fair value distribution and improving farmer livelihoods. BCT is applied as a technology for transparency to enhance sustainable supply chains.

4.2.2 FairChain as organizational context

The innovation process of constructing BCT applications for transparent food supply chains takes place within FairChain. This implies that the blockchain projects are developed from their viewpoint and ideas. FairChain is a foundation that works on fair value distribution in supply chains.[5] They started with tackling inequality in coffee supply chains, where a very small percentage of the value stays with the farmers in the countries of origin. Redistribution of value is made possible here, through rearranging the supply chain: moving value-adding activities, such as roasting the beans, to the countries of origin and sharing the created value with the farmers by paying more for their products. Together with coffee brand Moyee, they developed this inclusive business model for fair coffee supply chains.

[5]See https://fairchain.org/ for the mission and current projects (Last checked on May 26, 2020). The information in this paragraph is based on internal observation data. Part of this can also be found on the FairChain website.

In 2017, FairChain started a blockchain project to communicate these new fair value chains, with the idea to show how they redistribute the value in coffee production. For FairChain, BCT is an enabler of radical transparency, that helps with story proving: it makes the production processes and transactions visible. It allows them to give quantifiable and verifiable proof of the social impact they make in the supply chains. Blockchain allows them to drive more value to the farmers, give them access to credit and work on living incomes. Additionally, by working completely transparently, FairChain wants to demonstrate to other food companies that their inclusive business model works and can be adopted. The BCT applications are developed for this purpose: setting an example in fair value chains and assisting companies in transforming their supply chains. FairChain works on the blockchain projects through partnerships. The organization does not develop the technology, but designs the conceptual applications for their supply chains and gives order to the external technological developers.[6] Since the first introduction of BCT in their projects, FairChain has worked on developing the coffee blockchain and started with a second product, chocolate. Coffee and cacao beans are both products characterised by complex supply chains, with production in low-income countries by large amounts of smallholder farmers (Rijn et al., 2016). Both coffee and cacao supply chains can profit from transparency and fair value distribution. In the case of the FairChain projects, the supply chains are relatively simple and short. Moyee owns and controls their complete coffee supply chain and has contact with all coffee farmers and processors in Ethiopia. The cacao project is set up together with the UNDP and a local chocolate producer in Ecuador, where they work with 15 farmers in a small scale pilot. In both countries there are field officers on the ground that work for FairChain and are connected with all supply chain stakeholders. In the developing the BCT application however, the starting point is that it can be applied to other products than coffee and cacao, and for other food companies. The application thus needs to be scalable and deployable for more complex projects.

During the time of this research, FairChain worked on the further development of the coffee blockchain and setting up the cacao blockchain. For the coffee project, there already existed a preliminary, general version of the blockchain. Through their website, people could access the complete batch of coffee beans of that season, see who worked on that batch and what the workers got paid. The further development was making this more individid-

[6] At the time of this research, the BCT was developed by external partner KrypC. The Hyperledger platform (private) was used to build the blockchain, with the intention to keep the possibility to switch to the Ethereum platform (public) in the future.

ual and show a consumer of a specific bag of beans or cup of coffee what happened in the supply chain of those beans. At the same time they were expanding the group of farmers in Ethiopia connected to the blockchain. The cacao project was still in an early stage of development, but with the idea to use the base of the coffee project and to let the projects develop and improve simultaneously. With this project, a chocolate bar was made to test if consumers see the added value in a product with blockchain enabled transparency.[7] For both the coffee project and the cacao project, FairChain was working on getting the products through BCT applications on the market. Since the projects ran simultaneously and interchangeably, both are included in this research. The emphasis of the data displayed in this work is however on a small, representative, part of the innovation process in the coffee project, as it allows for a more in-depth exploration of the process. This will be further explained in chapter six, on the blockchain development process. First however, I will go into the goal of transparency in the FairChain blockchain projects.

[7]This product is now on the market under the name The Other Bar (TOB).

Chapter 5

Transparency as a strategy

Transparency is at the core of blockchain projects and an important goal for FairChain. The development of the technology in the projects is influenced by the concept of transparency, as transparency is part of the technological frame of the blockchain technology (BCT). The two sides of technological frames, nature and strategy (Yousefikhah, 2017), both incorporate transparency: transparency is a goal and an expected capability of BCT. In this chapter, I will focus on transparency as a strategy within the technological frames of the FairChain team members. While transparency is an important goal of the blockchain projects, the concept is not unambiguous. As a commonly agreed definitions lack, transparency is an idea that actors can give their own interpretation to. This allows for an organization as FairChain to fill in its own definition. It also allows for the the actors within the organization to interpret transparency their way: how they think about the role of transparency, what it entails, to whom it is targeted, how it is related to BCT, and so on.

This chapter goes into the different perspectives on the transparency of the key actors based on the conducted interviews and is structured by the categorization of ideal types of transparency by Mol (2015): management transparency, consumer transparency, public transparency and regulatory transparency. How is transparency interpreted by the different actors within FairChain and what ideal types of transparency can be identified in these interpretations? I will go into the different types of transparency in the blockchain projects, first by looking at the object of transparency: the information or data that is part of transparency according to the FairChain team members, and the relevance of context. I will then analyse the subject of transparency, the target groups identified by the actors and conclude with linking the objects and subjects of transparency together.

5.1 Perspectives on transparency

Within FairChain there exist multiple perspectives on what transparency could entail, revealing the different aspects of transparency that can occur in supply chains. When asked for a definition of transparency, a team member stated: "Transparency in the value chain is provenance, so where was the product on what time, what place and in whose hands, and what process was involved."[1] A second team member described it as: "The transparency is mainly showing what is going on in the chain. However not only how it is done, but also the value that reaches a farmer. And next to that, the things that are done for making impact. [...] And to make all that traceable."[2] In both definitions there is a clear focus on the different aspects related to the production of food. The second quote however reveals some more elements, mentioning farmer income and impact. It is this broad perspective that is the base for analysing the different interpretations of transparency within the FairChain blockchain projects.

5.1.1 Traceability of products and transactions

In the two definitions mentioned above, the team members speak of 'provenance' and 'traceable'. Transparency within the blockchain projects should be about the origin of the products and making both the products and the production processes traceable. The first ideal type of transparency, *management transparency*, can be seen in the emphasis on product traceability. Management transparency is about the sharing of product and production information between economic actors in a supply chain (Mol, 2015). It is about the what, when and where of products. A team member described it as follows: "How I see it, [transparency is] knowing where the product is coming from, from who, how was it processed and who processed it."[3] This focus on production processes is more often mentioned. "How the product is made, by who, where and what is added to it. That kind of processes."[4] Within FairChain, most respondents agree that traceability is part of what should be made visible with transparency. The quotes above describe the traceability of a product and production processes, or what I define as *product traceability.* This object of transparency I distinguish from another component that can be identified in the projects: *transaction traceability.* As FairChain works on fair value chains, the distribution of value is often mentioned as

[1] TM 2, 24-06-2019
[2] TM 8, 26-06-2019
[3] TM 6, 20-06-2019
[4] TM 8, 26-06-2019

object of transparency: “Very important is the way of checking the manner in which value is spent.”[5] Tracing transactions is about “showing transaction history”[6], “the ability to following the money”[7] or “what did it cost [on every location]”[8]. As reaching a living income for the farmers is an important goal of FairChain, the transaction data of farmers is mentioned specifically in some cases. Management transparency in the form of traceability is a way to make the supply chain more efficient for FairChain. Traceability becomes possible with connecting all economic actors: “Supply chain actors who all act independently, now become linked together.”[9] Through this traceability, it shows that some actors become redundant, often described within FairChain as the middlemen. This was explained as: “Traceability all the way to the first mile, makes that some links in the chain are omitted. Buyers, commodity traders, the middlemen so to say.”[10] Efficiency through transparency means that more value can go to farmers and empowerment of the farmers: “You give [farmers] transparent information about the chain that leads to more decision making power for them. [...] More financial access for them, sharing the value with them.”[11] This is an important goal of the management transparency in the projects: value redistribution by cutting out the middlemen and paying a higher farmer income.

Traceability of products origin and value distribution is, however, also about the second type of transparency, *consumer transparency*, when it is related to specific products a consumer buys. In an interpretation of their current traceability through BCT, a team member states that “[it] is now in general about all coffee beans in total, added together.”[12] This general traceability he distinguished from individual traceability per package of coffee: “Seeing where is my own specific coffee coming from, which farmer.”[13] Here, the perspective of the consumer is taken into account, who buys an individual product. The traceability of that specific product can be seen as the object of consumer transparency. Consumer transparency is the information about products that is disclosed by economic actors to consumers, for example on packaging (Mol, 2015). This type of transparency can be seen in how some team members emphasize the goal of traceability to the consumer: “We have

[5]TM 2, 24-06-2019
[6]TM 6, 20-06-2019
[7]TM 9, 25-06-2019
[8]TM 2, 24-06-2019
[9]TM 2, 24-06-2019
[10]TM 7, 25-06-2019
[11]TM 10, 01-07-2019
[12]TM 2, 24-06-2019
[13]TM 2, 24-06-2019

the idea that a lot of consumers want to see where there product is coming from."[14] Another states: "For the consumer it is interesting to know a lot about the supply chain. How is a product made, by whom, where and what is added."[15] Traceability of production and transactions in this perspective are then linked to a consumer that buys an individual product. Traceability as part of transparency shows that two types of transparency can be identified, depending on what perspective is taken by the FairChain team members. Where in some perspectives one type of transparency is emphasized over the other, management and consumer can also overlap: the categories of Mol (2015) are ideal types, meaning that in reality the distinction is not as clear.

5.1.2 The impact story

In the interviews conducted within the FairChain team, another object of transparency came forward. A recurring idea of transparency is that it exceeds traceability, as it is also about the story. "I think the transparency is important: telling the story in the right manner and be able to actually show it."[16] This story as an object of transparency is about the impact made in supply chains. It is often related to consumers, as it brings the farmer and consumer together according to FairChain: "[The] technology ensures that farming is more linked to the consumers [...]. There is a story that is told, of what is happening now".[17] The story fits within consumer transparency, as information about the production and other processes on the farmer level is shared with the consumer. Where some team members focus on storytelling, others emphasize that transparency is more about "story proving"[18] As one team member stated: "I think that transparency is meant to prove the thing that you preach."[19] This story is about proving the impact that FairChain is working on, by making visible what is done within the supply chain through value distribution, but also with data that is not chain related. The story is not only shared with the consumers that buy a product, but with a broader audience. This can be seen in statements like "we can communicate that to the world"[20]. Here the third form of transparency can be identified, *public transparency*. This is when information about products and processes is shared with the wider public domain (Mol, 2015). Telling or proving the

[14]TM 7, 25-06-2019
[15]TM 8, 26-06-2019
[16]TM 1, 18-06-2019
[17]TM 1, 18-06-2019
[18]TM 4, 08-07-2019 and TM 5, 21-06-2019
[19]TM 7, 25-06-2019
[20]TM 2, 24-06-2019

impact story, is part of the strategy of transparency that has to reach the public. As TM8 stated: "Transparency just for the transparency is nothing. [...] it has to have a use."[21] For some, the story was focused on sharing the impact made, but another perspective was on the degrees or "the steps you take towards a goal"[22]. Perspectives on what the story and impact entail can differ as it is an object of both consumer and public transparency.

These two types of transparency, with the impact story as an object, expose the flexibility of transparency as strategy within FairChain. Making the 'story' visible is complex, as it should be placed into a context, both for consumers and the wider public. This became clear in different views within FairChain about when something is transparent and when it is not. A team member described that transparency can be "fake transparency"[23]. For transparency to be real, the whole story should be told. "Being transparent opens a conversation. [...] We show what is going well, and what is not going well."[24] Or: "When you fail, you can show that you have failed and adjust it for this reason."[25] In this meaning, transparency is not only showing what you do, but also what you do not do or do wrong. The story can be about the completeness of information and showing all there is: "For me it is important [...] that you can dig, reach a deep layer of information."[26] In that sense, transparency is about being able to look for everything. However, complete can also be interpreted as relevant, or placed into the context. In that case, fake transparency takes place when the data shown is misleading, because: "It is not capturing all the relevant information and not summarizing in an honest way."[27] The context makes people understand what the data tells, makes it readable. This shows the complexity of the transparency definition of Wognum et al. (2011): what information is relevant, accurate and readable can differ from the perspectives of actors. Following the perspective public transparency, it could make sense to present all history of the data, so that people can dig through the complete information as described above. For a consumer transparency perspective, it could make sense to present only part of the information, to ensure that it is still understandable and relatable to the product bought.

The perspectives of the team members show that within FairChain there

[21] TM 8, 26-06-2019
[22] TM 4, 08-07-2019
[23] TM 10, 01-07-2019
[24] TM 4, 08-07-2019
[25] TM 8, 26-06-2019
[26] TM 9, 25-06-2019
[27] TM 10, 01-07-2019

is agreement on transparency as making supply chain information visible, but what this information should include is subject to flexibility, as it is open to interests, perspectives and objectives. In the interpretations of what the object of transparency entails, three different ideal types can be identified. The fourth and final type is that of regulatory transparency, which is disclosing information for inspections and regulations by authorities(Mol, 2015). While this type of transparency certainly plays a role in the FairChain products, as they are subject to rules and regulations, this was not related to BCT or the goals of transparency by the FairChain team members in the interviews. It is therefore not identified as part of transparency within the context of the projects in this research. The remaining three types can all be found in the perspectives on transparency as strategy for the blockchain projects. Various objects of transparency are identified within FairChain and there exist different understandings of what data is relevant and should be made visible.

5.2 Objectives of transparency

As the three ideal types show, what is made visible is linked to the subject of transparency: economic actors, consumers or the wider public domain, as targets determine what is relevant to show. Mol (2015) puts a strong emphasis on the subject of transparency, as his categorization is based on what actors are involved in the disclosure of information. Also, the definition of Wognum et al. (2011) mentions a subject of transparency in the form of consumers and supply chain stakeholders gaining access to data. The concept of transparency within the blockchain projects of FairChain is strategically used: it is a desired goal of using BCT. The subject, or target, of transparency is also part of that strategy: it is about who has access to the data disclosed through the technology. Within this strategic use of transparency, I will analyse here who is targeted by FairChain as subject of transparency and how these target groups relate to the objects of different types of transparency.

5.2.1 Target groups of transparency

An important part of the blockchain project goals of FairChain that was often mentioned during my time at the organization is connecting the first mile, the farmer, with the last mile, the consumer. Resulting from this, the farmer and consumer would be the logical main target groups of transparency within the blockchain projects. In reality however, the FairChain team members identified more groups to whom they state the transparency is or should be addressing.

The first ideal type, management transparency, can be seen in defining the supply chain stakeholders as a target group: “The target for me is the whole supply chain in itself. [...] it is about saving costs within businesses.”[28] This interpretation of transparency is focused on the efficiency it can bring, which relates to eliminating unnecessary actors as discussed in the paragraph above. The target group is also described as the brand or company that controls the supply chain, such as Moyee in the case of FairChain. “The target is [...] Moyee, a good overview of the supply chain of who makes what. And then it is their choice what to use that transparency for.”[29] Here, transparency in the projects is seen as a facilitator that brands can use. Besides the supply chain as a whole, one specific actor is mentioned by some team members as a target group: the farmer. An important aim of FairChain is the inclusion of farmers in the value chain and for that, access to supply chain data is of importance. A team member explains about farmers as specific target of transparency: “[The farmers] should get more insights, [...] I think that information is key, and that it is especially important for farmers.”[30] Another describes the farmers as ’co-owners’ of the supply chain, and as such need access to data. Here, the transparency is not only facilitating the stakeholders, but related to empowering them.

Consumer transparency, the second form, is seen in the emphasis on consumers of the FairChain products as a target. The consumer is often mentioned as a main target in the interviews within the organization. “Involving consumers with the activities that take place in the first mile, the countries of origin.”[31] For this involvement, the story should be told to consumers: “That the consumer knows what we do and how we do it.”[32] Perspectives differ however, in how consumers are described as target group. Consumers can be the end goal of transparency projects, but some team members stress that they get too much attention as objective: “I sometimes think that the focus is too much on the consumer.”[33] This attention is partly explained by the role FairChain ascribed to consumers, that could be seen as a way to reach other target groups through transparency. “They are the means, but to be the means you have to serve them [transparency]. FairChain is demand-driven. If we cannot sell, then we cannot help the farmers. It is the

[28]TM 3, 18-06-2019
[29]TM 10, 01-07-2019
[30]TM 8, 26-06-2019
[31]TM 2, 24-06-2019
[32]TM 1, 18-06-2019
[33]TM 5, 21-06-2019

consumer that needs to be convinced [...] they have to act."[34] In this sense, transparency is put to use as a way to activate consumers: they are a target of transparency not as and end goal, but as a means.

Finally, the third type of transparency is related to the wider public that FairChain targets. In this category, different target groups can be placed. FairChain wants to inspire: "To set an example of organizing supply chains differently."[35] As an organization they work on gaining more value of origin without making the prices higher for consumers. Transparency on their own supply chains, how it is organized, is thus meant to inspire. Here the target groups of other food companies are mentioned. Inspiring through transparency however, is also aimed at other target groups. The media are for example mentioned by a team member, as a tool to spread the FairChain story.[36] NGOs[37] and donors[38] are targeted to fund their projects to continue their work as example organization. Transparency within FairChain can have several goals: facilitating supply chain stakeholders, empowering farmers, activating consumers or inspiring the public. This shows three types of transparency, and within the types more target groups, different perspectives on the main target and different strategies of transparency

5.2.2 Strategies of internal and external transparency

Depending on their perspective, the FairChain team members discussed different target groups that were the main focus of transparency for them. Why a group was described as the main target, can be based on personal ideas on what transparency should achieve: often team members emphasized that it was their own opinion. Another reason for selecting a main target group was related to who they thought would profit from transparency. TM1 described consumers as the main target: "It is the group that feels the most [of transparency]. Who sees the most results."[39] Statements such as "I think farmers, consumers and brands can profit the most"[40] or "I hope that it can help farmers"[41] were expressed in relation to transparency targets. The team members have different visions on the main targets of transparency. This flexibility in transparency as a strategy for the blockchain projects reveals the complexity

[34] TM 2, 24-06-2019
[35] TM 4, 08-07-2019
[36] TM 4, 08-07-2019
[37] Mentioned by TM 8, 26-06-2019
[38] Mentioned by TM 4, 08-07-2019, TM 7, 25-06-2019 and TM 9, 25-06-2019
[39] TM 1, 18-06-2019
[40] TM 2, 24-06-2019
[41] TM 5, 21-06-2019

and ambiguity of transparency. The broad focus of FairChain indicates a broad range of data that should be disclosed to a range of stakeholders.

The different objects and subjects of transparency identified in the perspectives within FairChain are presented in Table 5.1. Here, the target groups are linked to the data that FairChain wants to make visible with transparency, and placed within the categorization of ideal types: management, consumer and public transparency.

Relating what is made visible with to whom it is made visible, shows that overlap exists between the ideal types of transparency in the objects of transparency. What data is relevant to disclose depends on the stakeholder that is targeted. It also shows different target groups that exist within a specific type of transparency. For FairChain, there is not one clear type of transparency, as the team members emphasize varied goals and target groups. In connecting the objects and subjects of transparency, an extra underlying categorization can be presented: internal transparency and external transparency. Under internal transparency falls the management transparency, since this is about making data accessible within the supply chains. External transparency includes both consumer transparency and public transparency, as it makes data visible outside the supply chain. While it excludes the farmer, an important target group, the overall emphasis within FairChain is more on external transparency. By aiming the transparency towards consumers and the public, they can be respectively activated and inspired: when a consumer buys the product or another brand makes the supply chain more efficient, more value can be moved towards farmers. The farmer profits of this type of transparency, without being the target of transparency itself.

Even with an emphasis on external transparency, there is no consensus on the type of transparency as a strategy of the BCT projects. Internal transparency, or management transparency, is still part of the technological frames, and also within external transparency several forms of both consumer and public transparency exist. There is no agreement yet within FairChain on what data should be made visible to whom. The concept of transparency is under development and subject to different perspectives, interpretations and emphasis of all team members. Transparency is part of the the technological frame, as it is perceived as strategy for the blockchain project. This strategy influences the flexibility of the technological innovation process, but in itself it is also subject to flexibility.

Transparency type	Object of transparency	Subject of transparency	Transparency strategy
Management transparency Internal transparency, where product and production data is shared between economic supply chain actors	- *Product traceability* When, where and how of all products - *Transaction traceability* Transaction history of all products	Economic supply chain actors of the product (general)	Facilitating supply chain efficiency by sharing data on products and transactions within the supply chain.
		Supply chain owner of the product	Facilitating the food company by providing a supply chain overview, exposing risks and opportunities to act on.
		Small farmers / producers	Empowering farmers with insights in the supply chain, through access to information on products and prices.
Consumer transparency External transparency, where product and production data is disclosed to consumers	- *Product traceability* When, where and how of a specific product - *Transaction traceability* Value distribution of a specific product - *Impact story* Connecting consumers with the farmer behind the product	Consumers of the product	Activating consumers by showing product data on the production, value distribution and impact in the supply chain, that is relevant readable and placed into context.
Public transparency External transparency, where product and production data is disclosed to the wider public domain	- *Impact story* Goal setting and progress reporting, telling the complete story including - *Product and transaction traceability* of all products	Food companies	Inspiring other companies through showing different redistributed value chains as a business model.
		Media	Means to spread the complete impact story in the wider public domain.
		NGOs and donors	Proving progress on impact in the supply chain, by making production processes and value redistribution visible.

Table 5.1: An overview of the three transparency types of (Mol, 2015) that where identified in the FairChain organization, linking the objects and subjects of transparency mentioned by the team members. For each subject there is a specific transparency strategy, describing what transparency should achieve for the target group.

Chapter 6

Using blockchain technology

During the ten weeks I participated in the FairChain organization, the projects were in the process of developing and working on new features. The blockchain technology (BCT) applied to the coffee supply chain was working with live traceability through the website. The FairChain team was working on applying the same principle on a cacao supply chain and adding the possibility in both supply chains for consumers to give something back to the farmer through BCT. The technology for transparency thus existed, but was applied to both a new product, the cacao, and to a new feature in linking the consumer to the farmer. This stage of development shows how the actors interact with the technology to shape and enable transparency: it allows to observe the flexibility of the development process and the conditions that influence this process (Pinch and Bijker, 1984). The focus of this chapter will be on the technology itself: how can transparency be enabled by BCT? The innovation process of blockchain as technology for transparency is subject to two types of flexibility, following Humphreys' analytical division (2005). The first is flexibility of language, which describes the interpretations, perception and meanings people associate with a technology. This is distinguished from the second form, flexibility of use, that is about how people use and interact with the technology. Both interpretation and interaction have the ability to shape the technology as the stakeholders are working on transparency. In this chapter I will first analyse the flexibility of language by going into the different perspectives within FairChain on blockchain as a technology for transparency. This is based on the individual interviews with the FairChain team members. I then will analyse the flexibility of use, based on my observations, by zooming in on a specific series of events, where the team worked on achieving transparency in practice within the blockchain projects.

6.1 Interpretations of technology

Blockchain is understood as a technology that leads to transparency: by implementing BCT in the projects, it is expected that transparency is achieved. This is part of the technological frame as discussed in the previous chapter, that focused on transparency as part of the strategic technological frame, transparency as a goal. It is also related to the nature of a technology as part of a technological frame as described by Yousefikhah (2017). What do people see as the capabilities and functions of a technology? In this paragraph I will go into the perceptions of transparency as part of the capabilities of BCT, following the flexibility of language of the FairChain team members.

Within FairChain, there is a common perception that blockchain is a means to reach their goal of transparency. When asked to describe BCT, a team member explained: "Blockchain is the notebook in which you can write everything, and that notebook is managed by everyone".[1] As such BCT enables transparency as a system that collects information and provides access. During the interviews, it was often emphasized that BCT has a supporting role. TM4: "FairChain is not a blockchain organization [...], we only use tech."[2] When asked about the relation of BCT with transparency, it is described as a tool. "It is just a tool, not the end goal [...], a tool that prevents cheating and that all is verified and checked."[3] Or: "Blockchain is purely a means, a tool so to say."[4] The view of BCT as 'just' a tool for transparency, is strengthened by the idea that it could be "any other technology, as long as there is a good governance structure possible"[5]. The majority within FairChain sees it as a technology, a means, to use that does not make a difference in the transparency goals. However, some see a bigger role for the technology: "I think [FairChain] underestimated, that if you implement it, it is not just a technology, but it completely changes your business model."[6] Blockchain creates an "infrastructure"[7] or the "need for an ecosystem"[8]. This need for an ecosystem was explained as follows: "A blockchain is, by definition, meant for more parties, stakeholders, that work together on a common interest."[9] In this perspective, BCT is not a means

[1] TM 7, 25-06-2019
[2] TM 4, 08-07-2019
[3] TM 9, 25-06-2019
[4] TM 5, 21-06-2019
[5] TM 2, 24-06-2019
[6] TM 2, 24-06-2019
[7] TM 2, 24-06-2019
[8] TM 8, 26-06-2019
[9] TM 8, 26-06-2019

for transparency through a technology, but it provides infrastructure or the basis on which they can build and shape transparency in supply chains. While both views underline BCT as an enabling component, there is a difference in how much weight is attached to it. As a means, the BCT applications are shaped by the goal of transparent supply chains. As an infrastructure however, BCT has the ability to influence how the concept of transparency is shaped in practice.

In the perceptions of the FairChain team, BCT is believed to induce transparency. TM2 states: "For transparency, [blockchain] is enough [...], as it just shows that what happens. That is what blockchain can do."[10] In this perspective, transparency is seen as a capability of BCT and an important part of the technological frame in terms of nature. It was however also stated in the interviews, that the technology alone is not enough for transparency, and that "a lot more is needed"[11]. In the discussions with the FairChain employees about the functioning of BCT for transparency, two issues emerged: the issue of trust and that of (missing) other technologies. Trust is an issue, because the supply chain actors feed the information to the blockchain themselves: "You can use the system, but if someone at a hulling station[12] gives the wrong information, that person can say this is what it states [on the blockchain] [...]. That data needs to be honest [...] and for that you need to trust your fellow actors."[13] Blockchain can overcome some of the trust issues, because of the immutability it offers, is agreed on by several team members.[14] Once the data is on the blockchain, it can not be changed. However, this does not solve it completely: "You always need a certain amount of trust [...] 100% trust because of the technology is not yet possible."[15] The input is controlled by people, who you need to trust: "It remains a bit like this: you have to believe it."[16] A recurring idea is that as long as people are the ones feeding data to the blockchain, trust is needed. This relates to the second issue: other technologies might be able to overcome the trust problem. New technologies could complement BCT, as is described by one of the team members: "Devices that automatically give information

[10] TM 2, 24-06-2019

[11] TM 5, 21-06-2019

[12] The hulling station is a processing stage in the coffee supply chain, where the coffee beans are separated from the cherry pulp. This stage was often used as an example by the FairChain team members, because in this stage the coffee batches of individual farmers are put together in bigger batches: it brings together multiple actors and flows of beans.

[13] TM 1, 18-06-2019

[14] TM 3, 18-06-2019, TM 6, 20-06-2019 and TM 7, 25-06-2019

[15] TM 6, 20-06-2019

[16] TM 7, 25-06-2019

to the blockchain [...] to overcome human or intended mistakes."[17] Different examples of technologies came up during the interviews: quality and quantity sensors,[18] IoT devices,[19] remote sensing[20]. This means that you do not need a human to tell the blockchain a kilo coffee beans has been processed, but that you use a machine to do this. As TM2 explained, to ensure trust, a human connection to the blockchain should be minimalized.[21] Within FairChain there is no agreement on if people can or should be excluded from entering data to the blockchain to achieve transparency. Interpretations differ on whether transparency can include a level of trust and if the addition of other technologies stands for more transparent supply chains.

Taken these views on BCT within FairChain together, the technology can be described as only a part of transparency. It is a means in achieving transparency, but in itself it is not enough. Here an interpretation of transparency becomes clear, that divides the concept in components that either claim or enable transparency (Trienekens et al., 2012). As a technology that stores data and manages access, BCT can be seen as an enabling component of transparency. However, the concept of transparency is about more than the enabler, but also about "what kind of data is being showed"[22]. As TM10 explained: "It is about having the [blockchain] technology, but also about having the intentions, [...] if you do not have a plan to create impact for using it, you miss the intention and you can throw blockchain away."[23] This quote shows that what respondents expect from the capabilities of the technology, the nature of a technology, is closely linked to the intentions, or the strategic part of the technology. The interpretative flexibility of the FairChain team members that shapes the technology, is not only about what the technology can do, but also about what it should do in terms of goals of transparency. Together these perceptions and expectations of the technology related to transparency influence how the BCT applications are developed for transparent food supply chains.

[17]TM 2, 24-06-2019
[18]TM 5, 21-06-2019
[19]TM 5, 21-06-2019 and TM 6, 20-06-2019
[20]TM 7, 25-06-2019
[21]TM 2, 24-06-2019
[22]TM 2, 24-06-2019
[23]TM 10, 01-07-2019

6.2 Technology in practice

To analyse the shaping of BCT as enabler of transparency, it is not only important to analyse how the technology is seen, but also how it is used by the different team members of FairChain. Here the technology in practice perspective is taken, that focuses on the interaction of people with properties of technologies (Orlikowski, 2000). The BCT and it's application for transparency is developed as the actors within FairChain engage with it: the technology is subject to flexibility of use (Humphreys, 2005). For analysing this form of flexibility in the development process, this paragraph zooms in on a on a specific series of events around a small part of the projects: the tree planting pilot in Ethiopia. This pilot is part of the new features that FairChain was working on during my time there. In the ten weeks I followed the development of the pilot, through observing relevant meetings and discussions. Zooming in on this specific event allows for a more detailed description and analysis of the blockchain innovations. The tree planting project shows different phases and challenges in the technological designs and is illustrative for the bigger blockchain projects for transparency. In order to structure and analyse the tree planting design process, I identified three analytical stages, based on the sub-processes of Pavitt (2006), i.e. production of knowledge, transforming knowledge into artifacts and matching it to market demand. In the case of the FairChain tree planting project, this is the initial idea of adding trees to the BCT, linking the BCT to the practices on the ground and using this project as a template product for different use cases. I will go into the flexibility of use by describing the challenges and possibilities that came up in interactions with the technology in the development process.

6.2.1 Knowledge production

The first stage is that of coming up with the initial idea, or the knowledge production, following Pavitt (2006). For FairChain it started with the idea to add impact to the supply chain: the 'impact chain' as they describe this part of the potential technological application. In this project the impact goal was to plant a tree for every cup of coffee sold. In my second week I was explained that the idea was to use the blockchain for ensuring verification of the impact goal. Until this project, FairChain had worked on the traceability of the coffee beans, and the value distribution linked to this: where are the beans coming from and what price is paid for them, to all actors in every stage. With the tree planting, they wanted to build a new link from customer to farmer, by enabling the consumer to give something directly to the farmer (see Figure 6.1). This concept was piloted at a theatre festival during the summer of 2019, where the Moyee coffee was sold to the visitors. With each cup a consumer bought, a token was given with a value of 0,25 euro. With this token, a digital coin accessible by scanning a QR-code, the consumer could buy a tree for a farmer through BCT.

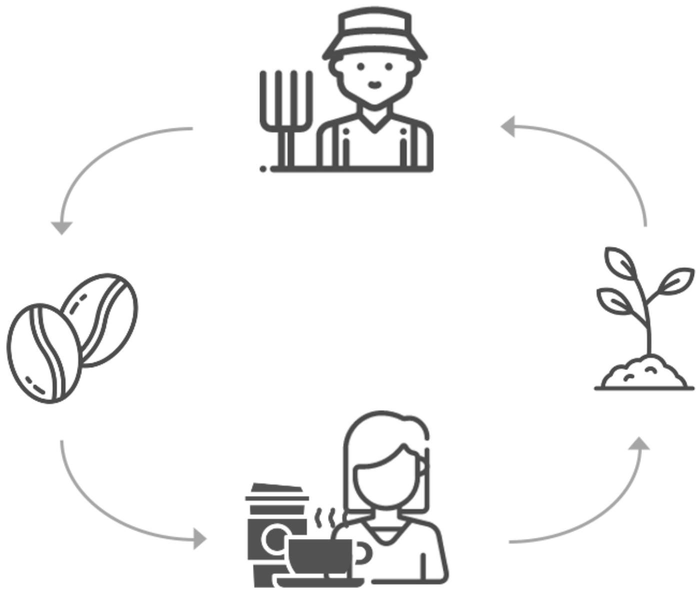

Figure 6.1: A simplified illustration of the tree planting pilot. The consumer of a cup of coffee can trace the coffee beans back to a specific farmer. Next to this, the consumer can decide to give a tree to a farmer, establishing a second connection between the farmer and the consumer. *(Source: own drawing based on FairChain's conceptual designs.)*

In developing this tree planting concept, several discussions were held during the time of my research that showed the challenges to use BCT here for transparency about the coffee beans and trees. A first issue that was discussed during various meetings, was the traceability from bean to cup. This was an agenda item in two of the internal weekly meetings in week five and six with part of the team, and also talked over with Moyee. The data on the coffee bean supply chain existed, but only for a complete batch, not for a specific cup of coffee. During the meetings, it became clear that a problem existed: they tracked all the coffee beans from individual farmers, but when these were processed at the hulling station all farmer batches were thrown together. This made it impossible to trace a cup of coffee back to one of the hundred farmers the beans where coming from. To trace coffee to individual farmers, a change in the ground process would be needed, through working with smaller batches in all the processing stages. Changing this process on the ground was difficult on the short term, as working with small batches throughout the supply chain is very inefficient. Therefore, the team decided for the tree pilot to work with a randomizer that showed the consumer one of the farmers at random. A second question that was raised in external meetings, was on the choice for trees. In meetings, often with potential new partners, FairChain was asked why the money is not directly transferred to the farmer and why they selected coffee trees. This was answered in different ways. It was either explained that with money no measurable and verifiable impact could be made, or that trees were an investment to make more money. However, in internal discussions with the team members that visited the coffee farms in Ethiopia, pragmatic reasons appeared as well. In the fields there was no internet connection, so the farmers could not access the blockchain directly, making it impossible to get their money from the token this way. The token was thus transferred to an NGO that could buy tree seedlings to distribute among the farmers. To hand out coffee trees made sense, not only as an investment, but also because most farmers had a lot of space for trees and coffee seedlings were available. Furthermore, the value of a token and the costs of tree planting were comparable, which allowed consumers to give a tree for each cup of coffee.

In the final concept of the tree pilot, introduced at the festival in week eight, the consumer received two transparency features enabled through BCT. They could see where the coffee was coming from, with all different steps of the supply chain back to the farmer, selected by a randomizer. And they could give a tree by transferring the token to an NGO that would buy and distribute the trees among the farmers. This process could be followed by the consumer, as every step was recorded on the blockchain. The final concept was an outcome of different meetings, discussions and design sessions, with mostly pragmatic reasons shaping the concept.

6.2.2 From knowledge to product

The second stage, is described by Pavitt as the sub-process of transforming the produced knowledge into the product (2006). In the case of the tree planting, this was about matching the designed concept for the technology, to what happens on the ground in the coffee supply chain. A feature of BCT that makes it interesting for FairChain is the promise of real time transparency: making impact visible to the consumer through showing that the tree is bought, distributed and planted at the farm at the same time it is happening. For this they designed different points of proof that could be captured and stored on the blockchain. During my ten weeks at FairChain, different possibilities and timelines were discussed and conceptualised to identify moments when proof could be captured, ranging from transactions, collecting trees, planting trees and growing trees.

The starting point was to show the consumer per tree they gave to a farmer, what happened with that tree. In an internal meeting with team members that designed the concepts and those that were in contact with the Ethiopian field office, a challenge of matching the ground process to the technology became clear: giving proof per individual tree was not feasible. The tree seedlings bought in Ethiopia had to be transported, distributed and planted in batches, to minimize costs and workload. A range of formal meetings and informal discussions, including consultation with contacts in Ethiopia and the external technological developers, followed to determine the size of such a batch. The team members struggled to make a decision on this, as there were different trade offs affecting the tree planting and the traceability of the process. I will explain here shortly the arguments and issues that emerged in the different discussions held to determine the amount of trees per batch. It did not make sense for the farmers to pick up and plant one tree at the time, so there was a need to work with larger batches. Transportation could then go in larger amounts with minimal costs. Not all the farmers had the space for a same amount of trees, a point of discussion was the fairness of the (un)equal distribution. Also, getting larger batches of trees at once, meant that the soil needed to be prepared. This extra manpower was not available to all farmers, but waiting was not an option because the seedlings need to be planted in a specific time of year. Together these issues influenced the technological development of determining proof points. If the trees are to be distributed in larger batches, there is no moment of a farmer picking up a tree that can be captured on the blockchain. Capturing the data on the blockchain real time caused another problem, because the seedlings needed to be distributed and planted in time, even if the cups of coffee were not yet sold.

These discussions and issues show there is a complex question: do you start from the technology perspective to set up the process, or do you base it on what is possible on the ground? From the technological perspective small batches are preferable, that are planted real time, as consumers buy the coffee and give away a tree. This is however complicated by the environmental conditions and practical constraints of the situation on the ground, that favours larger batches, planted and distributed all at the same time. For the tree pilot a decision was made internally by FairChain in week six and presented to Moyee a week later: the pilot would work with batches of 2500 seedlings, meaning that the consumer had to wait until 2499 other coffee cup tokens were shared, before the tree seedlings were bought. The seedlings were distributed in batches of 30 trees and proof, through pictures of the planting and coordinates of the location, was also captured per 30 trees. This decision on the amount of trees per batch and the number of discussions to get there, illustrate the complexity of combining the development of the BCT application with the ground process in the coffee supply chains.

6.2.3 Matching to market demand

The tree pilot at FairChain was designed to see if the blockchain project worked and if consumers would be interested. The moment of introducing this pilot at the festival, can thus be seen as part of the sub-process of matching the product to market demand Pavitt (2006). This was a particular moment, when in week eight the project was going live, but matching the product to market demand was also a sub-process visible in all the weeks I spend at FairChain. It was explained to me in my first week at the organization that two products, coffee and chocolate, were developed simultaneously in blockchain projects. The chocolate project in Ecuador could use learned lessons from the coffee project, that had had some market introduction already, and the other way around. In matching the product to market demand, an important condition was the usefulness of the BCT application for other products. The usefulness for chocolate as the second product FairChain worked with, but ultimately for any product with a supply chain that could use transparency. This intention was clearly stated by the FairChain team when I started my research, but became more concrete later, when they were contacted by new potential brands during my weeks there and when they started with a new product in the tenth week, while the coffee and chocolate pilots were still under development.

In the meetings on the tree project I attended during the first weeks, there was the assumption that the conceptual design of the tree pilot for coffee in Ethiopia could be used in the chocolate project as well. There the concept would be that for every bought chocolate bar, the consumer could plant a tree with a token received through the packaging of the bar to help reforestation in the Amazon area. The focus of the project development was thus completely on how transparency through BCT could be applied on planting trees, both in Ethiopia and Ecuador. A problem appeared however after a phone call with the project partners in Ecuador in week five: planting seedlings in Ecuador was becoming more of a challenge than it was in Ethiopia. The visit that some of the team members made to Ecuador in week three, had already made clear that the trees could not be planted on the cacao farms themselves, like in Ethiopia, as the farmers did not have the space for more trees. During the phone call it became clear that planting them in the Amazon area as a reforestation project was challenging in the time frame of the project. To plant trees in the Amazon, permits are required that would delay the planting by at least a year. This would not work with the current BCT design for transparency. After an internal brainstorm session and a meeting with the external partners in Ecuador, the idea of planting trees was replaced by buying farming tools. This required a new conceptual design of capturing proof on the blockchain, as one token on a chocolate bar was not enough for one tool, so a number of tokens had to be collected before a tool could be bought. Next to this, the idea was not to give each farmer a tool, as this was a big investment, but to let farmers share the tools. The data that could be captured on the blockchain would then not be the distribution of the tools among farmers, but the use of the product by different farmers. A new concept of proof mechanisms was thus needed for the blockchain pilot project in the chocolate supply chain. Applying the BTC concept to a new product requires a new design, which can be done in two ways: FairChain can either adjust the existing concept slightly with every new product, or develop a more abstract concept that is applicable to all and that can be filled in with product specifics.

This relates to another point of discussion that came up during the coffee and cacao projects about the focus of the technological development: should this be on the specific use of BCT in these pilots or on a concept with a broader application already? The formal meetings held with the FairChain team often prioritized the pilot designs, as they had strict deadlines. During informal discussions and brainstorm sessions however, it became clear that different opinions on this priority existed. During these conversations, the question was raised several times by different team members, if the priority should not be on designing a template. This was the ultimate goal with the blockchain projects for transparency: to fit any product supply chain and impact goal. In consultation with the technological developers it was decided to prioritize the pilot design and only after this focus on a template design in which learned lessons could be included. A template design was still important for FairChain as they saw this as a way to scale up their projects. During the ten weeks of this research, the views on scalability were ambiguous. It was often emphasized in discussions that scaling was about expanding to other supply chains, which became concrete in meetings with potential new product brands. However, other directions of scaling also existed in the perceptions of the team members, as was clear from the individual interviews. In these conversations scaling was related not only to other products[24], but also other countries [25], other impact goals[26] next to trees and tools, involving more external partners[27] and expanding the coffee and cacao projects by engaging more farmers.[28] The sub-process of matching the product to market demand demonstrates not only the complexity of working in different contexts, but also shows the different perspectives on priorities on pilots and scalability.

The examples of discussions and challenges in the sub processes of designing the tree planting project, reveals that the development of blockchain applications for transparency is linked to the pragmatic boundaries of the context. The decisions for trees and later on tools, the size of batches, the ways of distribution are guided by both what the technology asks in terms of data input and what is feasible or preferable in the situation on the ground. As BCT needs a specific form of data input to ensure transparency, the technology shapes to some extend how data in the tree planting project is collected. The application of the technology is however shaped by the context: what data can actually be collected, how the process can be organized and in what time frame. The process of the tree planting pilot shows that through interactions with the technology, the application of BCT is subject to the flexibility of use. As with the interpretations of the technology, there is flexibility in how BCT can be applied for transparency to some extent. However, this flexibility is limited by the pragmatic constraints of the contexts in the coffee supply chain. The BCT application as an enabler of transparency, is both shaping and shaped by the concept of transparency through interpretations of and interactions with the technology.

[24]Mentioned by TM 5, 21-06-2019, TM 6, 20-06-2019, TM 7, 25-06-2019 and TM 10, 01-07-2019

[25]TM 4, 08-07-2019 and TM 5, 21-06-2019

[26]TM 1, 18-06-2019 and TM 8, 26-06-2019

[27]TM 10, 01-07-2019

[28]TM 1, 18-06-2019, TM 3, 18-06-2019, TM 5, 21-06-2019 and TM 8, 26-06-2019

Chapter 7

Blockchain for transparency

In FairChain, the blockchain projects are about radical transparency. In the search for a way of communicating their story about what happens in the supply chain with the products and value, they came across blockchain technology (BCT). It is a "method for story doing", says TM4, which is more than telling the story, as it is making visible what actually happens.[1] BCT is used as technology for transparency in food supply chains. In the last two chapters, perspectives on the concept of transparency in food supply chains and flexibility in the construction of the technology were discussed, based on interpretations and interactions. Here, the two are linked together: how can the interaction between the flexibility and transparency be understood in the development of the projects? This relation can be analysed through the concept of technological frames, as presented in the conceptual framework (see Figure 7.1). These cognitive frames structure the way of thinking of actors, their perspectives and interpretations (Klein and Kleinman, 2002). In the previous chapters, two sides of the technological frames of BCT were discussed: the strategy and nature of a technology (Yousefikhah, 2017). This showed the role of transparency in the intentions of the technological application, but also as an expected capability of the technology. The development of the technology is influenced by ideas on transparency in the cognitive frames of the people working in the projects. However, this relation is also formed in practices: through interactions with the technology, the limitations in using BCT in the coffee supply chains influence the transparency strategy. This means there are degrees of flexibility in both the concept of transparency and the technology construction, interacting through the technological frames. In this chapter, these different types of flexibility are brought together and analysed, to understand the interaction between

[1] TM 4, 08-07-2019

flexibility in the technology construction and transparency that drives the innovation process of the projects.

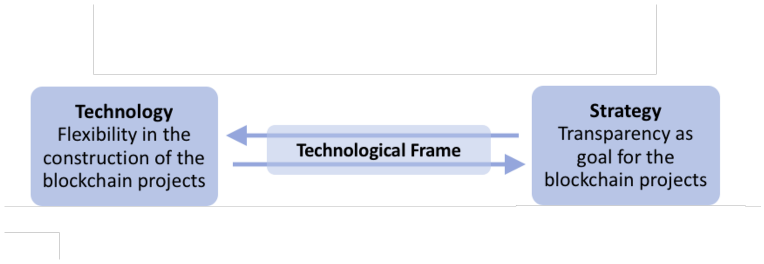

Figure 7.1: This is the middle part of the conceptual framework (see paragraph 2.3), showing the interaction between the flexibility in the technology construction and the strategy of transparency through the technological frames. The top arrow illustrates the role of transparency as strategy for and capability of BCT in the flexibility of the technology construction. The bottom arrow illustrates the influence of using the technology on the flexibility of transparency strategies.

7.1 Degrees of flexibility

This study into the development of BCT applications for transparent supply chains shows that there is a certain degree of flexibility in the innovation process. The different perspectives of the FairChain team members expose the interpretive flexibility as introduced by Pinch and Bijker (1984): the design of the BCT application in the projects for transparency is open, as interpretations differ. There is no consensus yet in the process towards stabilization for blockchain application in the FairChain food projects. The technological frames of the different FairChain team members provide different meanings, perceptions and ideas on the strategy of transparency and the capabilities of BCT. Flexibility exists in different forms and to various degrees in the development process of the blockchain projects.

The first form of flexibility relates to the strategic part of the technological frame: the goal of transparency. Here, flexibility is relatively high, as the team members focus on various types of transparency and differ in opinion on what type of transparency has priority. There is agreement of transparency as goal of the blockchain projects, but there is no shared strategic technological frame among the team members, as transparency as goal shows flexibility in interpretations. The interview data present a range of objects and subjects, which show that transparency as a strategy in food supply chains can still be ambiguous. Facilitating supply chain stakeholders, empowering farmers, activating consumers and inspiring others can all be transparency strategies (see Table5.1). Which objects or subjects are focused on, depends on which strategy is given priority. In the interviews with the team members, three ideal types of transparency of Mol (2015) were identified: management transparency, consumer transparency and public transparency. While there is overlap between these ideal types, a transparency strategy does not include all. Transparency in supply chains is about relevant and readable data, made accessible for supply chain stakeholders, according to the definition by Wognum et al. (2011). However, there is a relation between the relevance of product data and the stakeholder it is made visible to: the subject of transparency determines what object is relevant and readable. There is no agreement within FairChain on one target of transparency as a goal, with a specific set of relevant product data. The three ideal types show different perspectives on the target and product data, and there is no clear selection of a type of transparency that FairChain is aiming for, as was described in chapter five (see Table 5.1). Understandings of *who* should be provided with access to *what* data, is still subject to flexibility in the projects.

A second form of flexibility can be seen in the expectations of BCT as a technology for transparency: the nature of the technology as described by Yousefikhah (2017). This part of the technological frame is related to how the access to product data is established or enabled. The concept of transparency in the categorization of Mol (2015) is an ideal, and the three discussed ideal types describe transparency as a goal. However, transparency as an expected function of BCT is also about how the data is made visible. In practice, the concept is dependent on the enabling technology that ensures the subjects' access to the objects. Technology as enabler follows the transparency perspective of Trienekens et al. (2012), who divide the concept in claimants and enabling components. Where the claimants are similar to the targets in the categorization of Mol (2015), the focus on enablers shows that transparency is also defined by its implementation through BCT. In FairChain, the technology is emphasized as a tool for transparency, but perspectives differ on the capability of the technology. There is flexibility visible in the perceptions on whether BCT equals transparency and what the technology *should* do for transparency. Following the perspective of Trienekens et al. (2012), enablers are part of the concept of transparency. This implies that not only the technological development is shaped by the different expectations of the team members for transparency, the concept of transparency is shaped by the technology that enables it as well. The interpretations on BCT capabilities influence what types of transparency in objects and subjects are seen as possible.

The two discussed forms of flexibility, flexibility in strategy and in expected capabilities, are about interpretations, expectations and meanings the team members ascribe to transparency and the technology. They fall into the type *flexibility of language*, as introduced by Humphreys (2005). The second category, the *flexibility of use*, is visible to varying degrees in interactions with the technology within FairChain. Flexibility seems to occur in the use of technology, as different types of transparency appear in the development process. This can be seen in the work on improving and increasing access for farmers as a form of management transparency, but at the same time focusing on the external transparency towards consumers and the public in the design of the tree planting pilot. The three ideal types of transparency, and even more strategies within them, came forward in the interviews. At this stage of the innovation process, there appears to be a high degree of flexibility in the technological frames of the team members. There is little closure in the construction of the blockchain projects related to intentions of transparency. However, by zooming in on the tree planting pilot, also limits in the flexibility became clear. In the context of the coffee supply chain, a more set development process of BCT applications for transparency is uncovered. The interactions with the technology imply that some transparency strategies within management transparency are excluded from the projects. Interpretations and intentions on both the concept of transparency and blockchain technology reveal flexibility in through the technological frames, and suggest an open innovation process. Interactions with the technology however give a more complex picture and less flexibility in the technological frames.

7.2 Inscription and affordances

The strategy of transparency and BCT as an enabler are subject to not only interpretations of the technology, but also to the use in practice. A technology is developed as people engage and interact with it (Orlikowski, 2000): the use of the technology is linked with working on transparency in practice. In the interactions of the FairChain team members with BCT, the different challenges emphasized how the technology as enabling component influences the transparency strategy. To understand this enabling role, I use the work of Glover et al. (2017) on the concepts inscription and affordances in analysing the use of technology. These concepts help to interpret the challenges and opportunities in the interactions with the technology and analyse the flexibility of BCT as enabler for transparency in the FairChain tree planting pilot.

The first concept, inscription, is that what is build in a technology, so that the expectations and intentions of the developers govern the use of the technology (Glover et al., 2017). The application of BCT in the food sector, and specifically how it is applied in linking the consumption of a cup of coffee to a farmer and a tree seedling, makes visible what is inscribed in the technology. A first example that became clear in the tree planting pilot, is the challenge of using internet. In the design of the pilot, the missing internet connection for farmers resulted in needing an intermediary to access the blockchain. A tree was given, because transferring money directly through BCT was not possible in the Ethiopian coffee fields. The design of BCT technology is such that all actors involved need to be in the same network where data is added, stored and accessed: internet provides this network. This inscription of the technology makes that FairChain uses an NGO to distribute trees and capture proof of this on the blockchain, as the farmers can not be reached directly with BCT. Another example of inscription can be seen in working on making the coffee traceable. With BCT, it is possible to follow a unit of coffee, as the information is added and stored on the blockchain per added unit. This unit could be a coffee bean, a bag of beans that a farmer produces, or a batch of coffee from all farmers in a certain region. To ensure full traceability, the unit needs to stay the same, which is where it becomes challenging. Tracing the beans used for the cup of coffee back to the farmer who grew them, is not possible as beans have been added together in the processing. This caused the discussions in FairChain on what units could or should be traced in the pilot, a decision that is also related to the second concept: affordances.

With affordances, Glover et al. describe how technologies have potential options for users to interact with what is built in the technology (2017). Affordances can be the materiality that enables or constrains potential use of the technology, but the context and capabilities of the users also influence affordances. The selection of the unit shows an example of the situational aspects of affordance: FairChain can trace the batches of coffee per group of farmers as unit. The discussions held on changing the ground process or working with a randomizer expose how the context relates to what degree of transparency in the form of traceability is possible. The affordance of BCT allows for several opportunities of traceability and the context of the FairChain coffee pilot determines what is possible. Another moment that demonstrated the importance of affordance, was in the selection of trees as an impact goal. The motivation for giving a tree was explained as an investment, facilitating impact measurement, but also pragmatic: farmers had enough space, so trees could easily be distributed and the price of planting one seedling could be related to one cup of coffee. BCT allows for any object or money to be given, but in the context of the Ethiopian coffee production, trees worked well for the pilot. A last example exposes how the capabilities of the users relates to affordance. With BCT, any moment of proof can be recorded on the blockchain. The donation, distribution and planting could be added of one coffee seedling at the time, or of a thousand trees together. In the pilot however, FairChain had to work with feasible batches of trees in alignment with transport efficiency, soil preparation by the farmers, taking pictures for proof and planting seasons. A farmer would not come to pick up one single seedling, but also was not capable to prepare his fields for to many seedlings in one time. The affordances show that the potential use of BCT in the tree planting pilot is constrained by the context of the coffee supply chain.

Blockchain is seen as a technology for transparency and this transparency is also inscribed in the technology through access, immutability and verifiability. However, in the design of BCT, inscription enables transparency only to some extent, and the affordances expose that the type of transparency is related to where the technology is applied. Here, a higher degree of closure and less flexibility becomes visible in the innovation process. Through the technological frames, where the technological construction and the goal of transparency come together, certain strategies are excluded. In the series of events studied in this research, the tree planting pilot, there was a focus on transparency towards activating consumers and inspiring other brands: consumer and public transparency. The working process on BCT as enabler of transparency did not show the third type of management transparency. Allowing farmers, or other supply chain actors, to access data, was not worked on, as this was complicated by the context of the pilot projects trough inscription and affordances. The further the innovation process will stabilize towards more closure, the sharper inscription and affordances become in interactions with the technology. When changes in the process take place in objectives, technological development or the context, the innovation process of the blockchain projects can have a different transparency strategy as a result. However, in the current line of development, the FairChain BCT applications will enable consumer and public transparency strategies, and not management transparency. BCT as an enabling component of the concept of transparency thus limits the types of transparency in the studied projects.

Flexibility, in use and language, influences the development process of a technology. In this research, the focus was not solely on BCT, but on BCT as a technology for transparency. The technological frames of the involved actors on the technology are characterised by the concept of transparency, as capability and goal of using the technology, and influence the construction of BCT applications. This innovation process is still open and characterised by the flexibility of language. At the same time, through analysing interactions with the technology, limitations are found in the flexibility of use, suggesting a more closed innovation process. In the context of coffee supply chains, there is a limited flexibility of use in the development of BCT applications for transparency and as such, the technological development shapes the concept of transparency. Transparency is not only an ideal type that is used as strategy, but is shaped by its enabler, BCT. Limited flexibility through interactions with the technology thus shape limited flexibility of the concept of transparency as well. Technological frames are cognitive frames, linking technological development with interpretations on transparency. The cognitive frames however are not only related to the flexibility of language, shaping the technology with intentions and expectations, but are also influenced by the flexibility of use: interactions with the technology that shape the concept of transparency in the innovation process of BCT applications for food supply chains.

Chapter 8

Conclusion and discussion

In the food industry, expectations on blockchain technology (BCT) are high and there is a believe that the technology has the potential to provide sustainable food supply chains through transparency. The innovation process of the technology for transparency is moving from conceptual designs and first pilots to the further development and wider application for transparent supply chains. In this research, BCT was selected as an example of a technology for achieving transparency in food supply chains, to analyse the concept of transparency and its relations to technological innovations in sustainable food systems. The main research question was how the development of BCT for transparent food supply chains in the FairChain projects is shaped by the interaction between flexibility in the technology construction and different types of transparency. This was studied through interpretations and interactions of the team members with the concept of transparency and the technology in the innovation process of blockchain applications. The results show that the development of BCT in the projects is influenced by the different goals and expectations of transparency. What do you want to achieve with transparency, but also what are you able to achieve? The flexibility in interpretations on the transparency strategy and nature of BCT presents a still open innovation process. The sub research questions of this study were about defining the concept of transparency, the enabling role of BCT and the role of technological frames in the development of the BCT applications. The results show that three ideal types of transparency can be identified in the projects - management, consumer and public transparency - and that each type had several strategies within it for transparency in food supply chains. The types consumer and public transparency received more attention, especially in interactions with BCT during working on the projects. Meanwhile, it is clear that the concept of transparency is not only an ideal type, but also shaped by the implementation in practice. The technology itself is important in this implementation in practice. BCT, as it is part of the concept of transparency, shapes transparency in its enabling role through the technological frames. Inscriptions in the technology make consumer and public transparency possible in the tree planting pilot and affordances show how the potential use of BCT for transparency can be constrained in the context of coffee supply chains. In addition, there is the consideration whether within a certain transparency strategy, a technology perspective is taken to set up the process or that it is based on what is possible on the ground. Together, these findings show that the development of BCT is not only shaped by the goal of transparency, but the technology also influences that goal in the innovation process. There is flexibility in technological construction and in different types of transparency in the FairChain projects. Through the technological frames, where the technological construction and the goal of transparency come together, the flexibility decreases and certain transparency strategies are excluded.

In the case of FairChain, the innovation process is still open. Understandings of who should be provided with what transparency objectives and how this can be enabled through BCT are still subject to flexibility in the projects. At the same time, interactions with the technology suggest a more limited flexibility of use in the context of the projects. This is linked to the specific context of the FairChain projects. In this study, the innovation process was analysed within the organization and focused on two specific supply chains: coffee in Ethiopia and cacao in Ecuador. In addition, FairChain is an organization that works on transparency for sustainable food systems through fair value distribution and the inclusion of smallholder farmers. In theory, management transparency is part of their strategy, but in practice this has less focus. In a broader context, this type of transparency can be pursued as main focus, just like the other types, in blockchain projects of other organizations, as discussed in chapter 4. Sustainable food systems through blockchain-enabled transparency can thus include different transparency strategies. It depends on the intentions and the specific supply chains the BCT applications are developed for what strategy is preferable and possible.

Stabilization and external contexts

This study looked into the relation between the two theoretical concepts technology and transparency, through technological frames characterised by flexibility in language and use. In the organization context of the FairChain projects, the innovation process of BCT applications was analysed based on the SCOT framework of Pinch and Bijker (1984), with a focus on flexibility and the concept of technological frames that was added later. This study contributes to existing literature by reflecting on technological frames and linking the social construction of technological development to the goal of transparency. Here, I will discuss how these two elements relate to the broader SCOT framework, to understand the limitations of the study and the possibilities for further research.

The focus on different types of flexibility in this research suggests that the innovation process is open. The process of stabilization has not reached closure. The negotiation process between the different actors in the design of a technology reaches closure when flexibility fades (Klein and Kleinman, 2002). For the BCT applications, characterised as *in the making*, there is no agreed closure within FairChain, caused by the flexibility of language in the technological frames of the team members. From a practice perspective, however, a technology is never fully stabilized as it continuously redefined and reinterpret through using the technology (Orlikowski, 2000; Clayton, 2002). Stabilization could be presented as an agreed moment where a certain degree of closure is reached. This perspective on *degrees of closure* can be seen through the inscription and affordances of the BCT applications, that limit the flexibility of use in the FairChain projects. The flexibility of language shows no agreements on transparency as strategy or capability. However, the flexibility of use shows some degree of closure, as the context poses certain limitations that drive the projects towards consumer and public transparency. Technological frames can also be seen as open to new interpretations (Khoo, 2005). The degree of closure applies both to the technology itself and to the technological frames of the actors that shape the technology.

The degree of closure could also be an interesting element of analysis as the technological application evolves, in particular in relation to scalability. The analysed data show the importance of scalability for the FairChain team members, as this is a next step in the development process of the BCT applications. For scaling, a degree of closure is needed, as is argued by Seelos and Mair (2014), who relate degrees of organizational closure to scaling and differentiate different types of scaling potential of social enterprises such as FairChain: scaling as increasing in productive or size, replication and knowledge transfers. It would be interesting for further research to analyse the BCT development for transparency towards a scalable format and see how this is linked to degrees of closure in the innovation process.

The technological frames were studied within the boundaries of the FairChain organization and focused on a limited time scope as the innovation process was taking place. The external context and its relation to flexibility has been minimally included in this study. Flexibility of both use and language were analysed to understand the current process of the technological innovation. There is a third type of flexibility introduced by Humphreys, flexibility of structure, that provides a way to understand long-term evolution of a technology and relations between technologies (2005). Humphreys conceptualizes this type of flexibility through categories that people use for technologies. How the technology is seen in its design, separate from its use. Structural flexibility is opposed here to stabilization of a technology as category. By looking at the level of structural flexibility, it becomes possible to place technologies in a broader context and see how they evolve and influence innovations, according to Humphreys (2005, p.248). This structural flexibility is part of the social construction of technologies, together with flexibility of use and language. Within the scope of this study, it was not possible to go into the structural flexibility of BCT in food supply chains: BCT is still in its innovation process, as it is shaped as an application for food supply chains. It is not yet stabilized in that form, and therefore it is not possible to study how it will evolve. For future research, it could be interesting to see how structural flexibility is linked to the goals and expectations of transparency. How the meaning of transparency develops, as linked to the further evolving BCT applications. To analyse this structural flexibility in the future, studies would need a longer timeline and should include attention to the economic, political and social context of the development, next to the organizational context of FairChain.

Another limitation of the research related to the external context and scope of the study, is the focus on the innovation process within one internal group: the FairChain team members. This development process of a technology is, however, also influenced by external actors, in the form of social groups (Pinch and Bijker, 1984), or stakeholders (Oni and Papazafeiropoulou, 2014). In the empirical data of this study, some examples of stakeholders can be identified that have a strong relation to the technological development in the projects. There is a role of NGOs and donor organizations as facilitators of the projects, whose influence can be seen in the focus on impact measurement in the FairChain projects, stirring towards public transparency. In addition, consumers and farmers as stakeholders could provide interesting perspectives on technologies for transparency. What in the transparency enabled by BCT activates consumers? What type of data do farmers want or need to access through the blockchain? While there is a wish to include farmers in the blockchain, it is not clear what demand for transparency there is from the farmers. These stakeholders all have their own technological frames shaped by their capabilities, that influence the social construction of BCT for transparency. These perspectives, external contexts and longer time frames could bring new insights when included in further research on blockchain-enabled transparency and sustainable food supply chains.

Transparency for sustainability and inclusion

FairChain is an example of an organization that uses BCT because it wants to include farmers and works towards a fair value distribution. The strategy to use technologies for transparency does not only aim at transparency as an end goal, but also aims to change the value chain. They are not alone in this strategy, show the different blockchain projects discussed in chapter four that address environmental and social sustainability through transparency. This research focused on technologies for transparency as a first step towards sustainable and inclusive food systems. The emphasis was on understanding the role of transparency in the construction of the technological applications. When using BCT applications for sustainable and inclusive food supply chains in practice, it is important to understand the implications of connecting technologies for transparency to goals of sustainability and inclusion in the food sector.

In this research, there is an assumption that transparency is a first step towards sustainable food systems. With increasingly complex global food supply chains (Trienekens et al., 2012), transparency can reveal where problems take place and how progress is made. As data on food production is exposed, transparency is believed to lead to environmental and social improvements in the supply chains (Astill et al., 2019). By transferring and distributing knowledge and through opportunities for collaborations, transparency can minimize sustainability risks (Garcia-Torres et al., 2019). To achieve a sustainable and inclusive food production, transparency is needed, but transparency does not necessarily cause these improvements. The concept of transparency in itself is neutral and does nothing. The impact of transparency for sustainability depends on the intentions and how they are translated in the transparency strategy. This perspective can be defined as *transformative transparency*, as introduced by Gardner et al. (2019): transparency designed and implemented to act for transformative change. In their research they present propositions about the purpose of the data, the type of data and the process of collecting the data that is exposed through transparency. Together, these propositions should ensure that transparency actually leads to sustainability. In the further development of technologies for transparency in supply chains, this perspective on transparency could provide interesting insights to secure a sustainable food production.

For FairChain, working on a sustainable food system means including smallholder farmers in the development process of technologies. Again, transparency in itself is neutral and not necessarily inclusive. It can lead to both empowerment and disempowerment, related to who has access to information (Gardner et al., 2019). This research has shown that empowerment through technologies for transparency is not automatically ensured and needs active commitment. In the FairChain projects, the coffee and cacao farmers are important stakeholders, but actually including them as a subjects of transparency turned out to be more complicated in the context of the supply chains. With technologies for transparency, inclusion is about access. The definition of Wognum et al. approaches supply chain transparency as the availability of information, in a manner that is accessible to all stakeholders (2011). The construction of the BCT applications indicates that this is not necessarily the case. To use BCT as technology for transparency, stakeholders need the capability to have access (Behnke and Janssen, 2020). For inclusion in food supply chains, attention to these capabilities of actors is needed and not only to transparency on its own. The importance of inclusion, especially of smallholder farmers, in the further development of BCT applications in the food sector is recognized (World Economic Forum, 2019a,b), but clear strategies are missing. When using blockchain as technology for transparency with the intention of inclusion, a further exploration of inclusive innovations would be needed to see how accessibility can or should be ensured. The farmers in the FairChain projects can profit from several transparency strategies, even if no access through transparency is possible. For actual inclusion in the technological development, however, it is not only important to see what type of inclusion is possible, but also what is desirable in BCT development in food value chains as technology for transparency. In this research, the focus was on understanding the role of transparency in the application of BCT in food supply chains. The next step is to understand how blockchain-enabled transparency can be transformative in the further development of the technology applications, in working towards sustainable and inclusive food supply chains.

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Appendix A

Data collection and analysis

1. Interview structure

Interviews were held with ten FairChain team members. All interviews were semi-structured, using a list of themes of the different interview topics. Each theme consists of a number of questions. Which actual questions were asked and in what order varied a bit in each interview, taking into account that all themes and topics were discussed in all interviews.

Introduction

Introduction of the research
This research project is about blockchain projects in the food sector, specifically focused on transparency and social impact, for my master thesis in International Development Studies at Wageningen University and Research. The study zooms in on the development of the blockchain projects at FairChain as a case.

Introduction of the respondent
About the role the respondent has within the FairChain team.
- How long have you been working at FairChain?
- What are (and have been) your responsibilities and tasks?
- What is your role in relation to the blockchain projects?

FairChain mission and blockchain

How respondent sees the overall FairChain mission and how this relates to the current blockchain projects.
- How would you describe the mission of FairChain?

- What is the most important goal for FairChain?
- What is the role of blockchain technology in this mission/goal?
- What is the most important reason for FairChain to use blockchain?
- Why did FairChain decide to start using blockchain technology?

Transparency

Perceptions of respondent on transparency and blockchain as a technology for transparency.
- In what ways does FairChain provide transparency?
- For whom or to whom is this transparency intended?
- Why is transparency part of the FairChain strategy?
- In what ways does blockchain technology provide transparency?
- Is the technology enough for transparency (if no, what more is needed)?
- What is the role of transparency in the current blockchain projects (coffee and cacao)?

4 Inclusion and targets

How respondents see the inclusion of different actors in the projects and who is targeted by the blockchain projects.
- What actors are involved in the blockchain projects?
- What actors are targeted by blockchain technology in the projects?
- What actors are targeted by transparency in the projects?
- How are the projects influenced by the different actors?
- How are the blockchain projects related to the Farming program of FairChain?
- How are the projects related to the strategy of "inclusive business models" of FairChain?

5 Development process

How is the current development process of the blockchain applications in the projects seen by the respondent. In this part, images were shown of the current blockchain live feed (see below). Next to this, respondent was asked to reflect on the tree planting pilot.
- Could you describe what you see on the images?
- What would you say has happened since this was put online?
- What is the origin of the tree planting pilot? Why and how was it decided to work with tree seedlings?
- What are the challenges of this project? What are the opportunities of this

project?
- How is the development process of the tree planting pilot related to other projects within FairChain? And to future projects?

6 Future projects

Asking the respondent to speculate on the future of the blockchain projects and FairChain, related to scaling possibilities and expanding to new (food) products.
- What is scaling for FairChain in your opinion?
- What is scaling for the blockchain projects specifically in your opinion?
- How do the current projects (coffee and cacao) relate to potential new sectors for blockchain applications?
- How do you envision the development of the blockchain projects in the near future (coming months)?
- How do you envision FairChain in five years from now?

Figure A.1: Screenshot FairChain blockchain circle on June 10, 2019 (*Source: https://fairchain.org/circle/*)

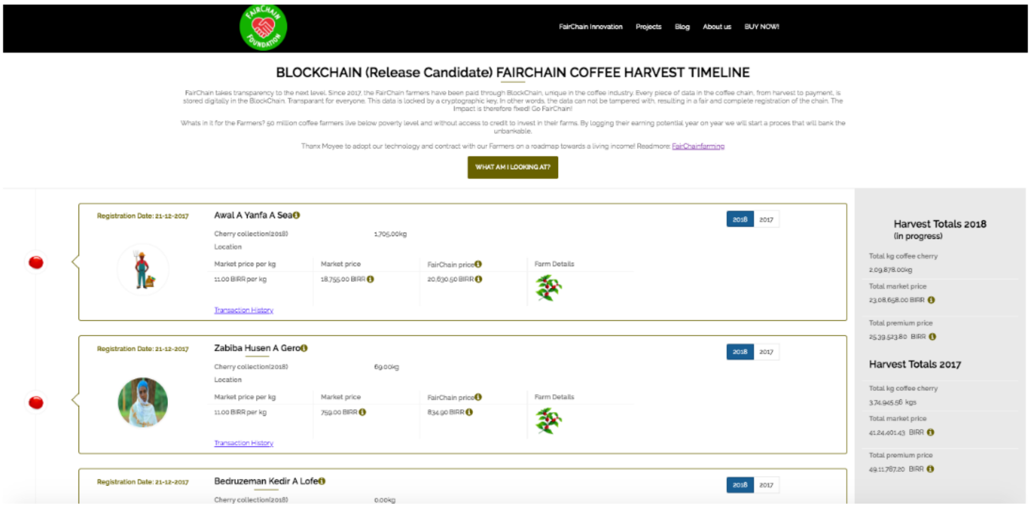


Figure A.2: Screenshot FairChain blockchain livefeed on June 10, 2019 (*Source: https://fairchain.org/livefeed/*)

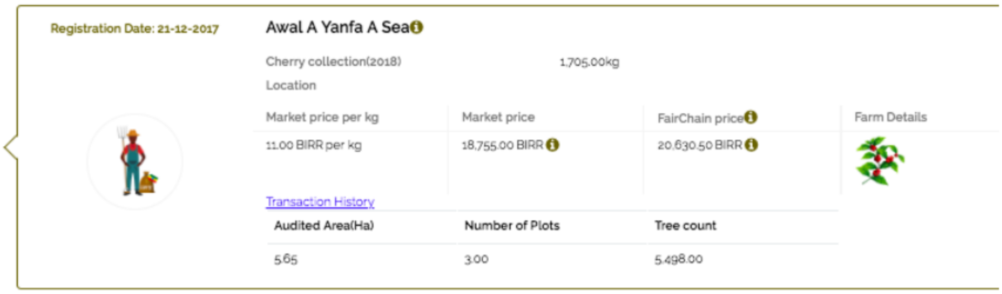
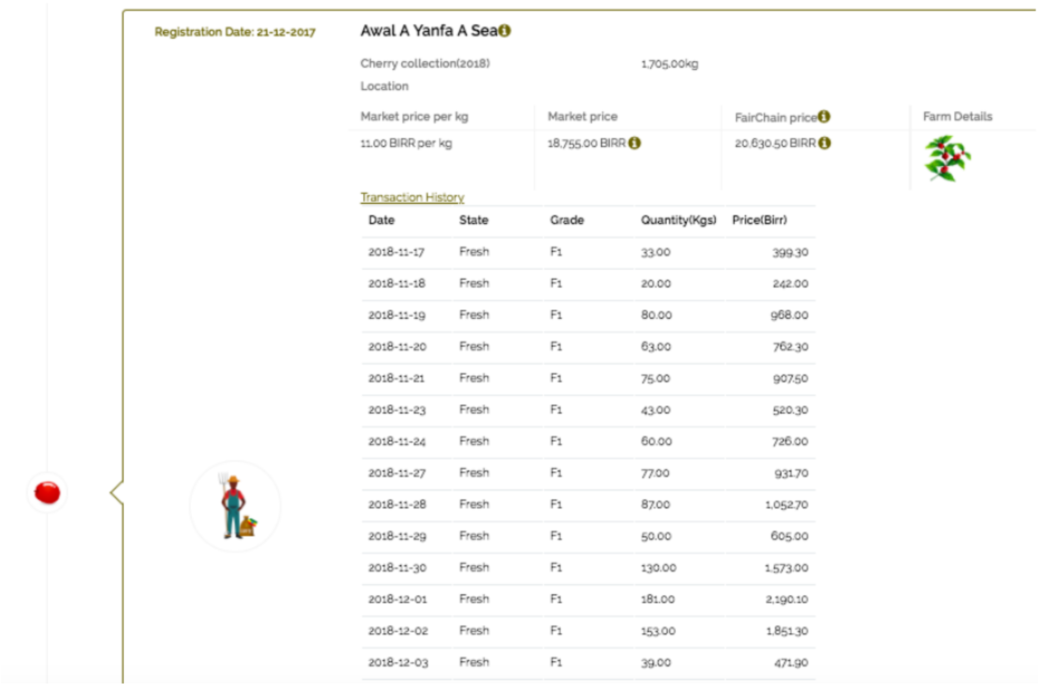


Figure A.3: Zoomed in section of screenshot FairChain blockchain livefeed on June 10, 2019 (*Source: https://fairchain.org/livefeed/*)



Registration Date: 21-12-2017

Awal A Yanfa A Sea

Cherry collection(2018) 1,705.00kg

Location

Market price per kg	Market price	FairChain price	Farm Details
11.00 BIRR per kg	18,755.00 BIRR	20,630.50 BIRR	

Transaction History

Date	State	Grade	Quantity(Kgs)	Price(Birr)
2018-11-17	Fresh	F1	33.00	399.30
2018-11-18	Fresh	F1	20.00	242.00
2018-11-19	Fresh	F1	80.00	968.00
2018-11-20	Fresh	F1	63.00	762.30
2018-11-21	Fresh	F1	75.00	907.50
2018-11-23	Fresh	F1	43.00	520.30
2018-11-24	Fresh	F1	60.00	726.00
2018-11-27	Fresh	F1	77.00	931.70
2018-11-28	Fresh	F1	87.00	1,052.70
2018-11-29	Fresh	F1	50.00	605.00
2018-11-30	Fresh	F1	130.00	1,573.00
2018-12-01	Fresh	F1	181.00	2,190.10
2018-12-02	Fresh	F1	153.00	1,851.30
2018-12-03	Fresh	F1	39.00	471.90

Figure A.4: Unfolded section of screenshot FairChain blockchain livefeed on June 10, 2019 (*Source: https://fairchain.org/livefeed/*)

2. Coding scheme

A deductive coding process was used in this research, based on the theoretical concepts of transparency and technology.

Transparency

Subjects of transparency: *Target group of transparency*
- Management transparency, *Supply chain stakeholders*: SCS
    - Processors: SCS-P
    - Transport: SCS-T
    - Farmers: SCS-F
    - Owner: SCS-O
- Consumer transparency - *Consumers*: CON
- Regulatory transparency - *Supply chain regulators*: SCR
- Public transparency - *The broader public*: PUB
    - Brands: PUB-B

NGOs: PUB-N
Donors: PUB-D
Media: PUB-M
Others: PUB-O

Objects of transparency: *What is made visible in the projects?*
- Product data: P-DATA
- Transaction data: T-DATA
- Impact data: I-DATA
- Complete / incomplete data: COM-DATA
- Relevance of data: REL-DATA
- Accuracy of data: ACC-DATA

Technology

Language *on blockchain technology for transparency (interviews)*
- Blockchain technology as enabler: BCT-ENA
  Blockchain as a tool: BCT-ENA-TOOL
  Blockchain as infrastructure: BCT-ENA-INFRA
- Blockchain technology adequacy: BCT-ADE
  Technological additions: BCT-ADE-TECH
  Non-technological additions: BCT-ADE-NONTECH

Use *of blockchain technology for transparency (observations)*
- Subprocess 1, knowledge production: SUB1
  Conceptual design: SUB1-DES
  Discussions on concept: SUB1-DIS
  Decisions on concept: SUB1-DEC
- Subprocess 2, from knowledge to product: SUB2
  Product design: SUB2-DES
  Discussions on product: SUB2-DIS
  Decisions on product: SUB2-DEC
- Subprocess 3, market demand: SUB3
  Market introduction: SUB3-INTRO
  Learned lessons applicability: SUB3-LES
  Scalability focus: SUB3-SCALE