Boundary Traceability Conditions in Food Supply Chains Using Block Chain Technology

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Abstract--- *Traceability of food supply chains products has become crucial in an environment in which economies are becoming competitive, heterogeneous and diverse and in which consumers expect high quality. The food supply chain is made up of many organizations with different interests, and is often reluctant to share information on traceability with each other. By establishing transparency, Block chain has been promoted to enhance traceability. Practice therefore appeared to be more persistent. The purpose of this paper is to define the boundary conditions for sharing information regarding assurance in order to improve traceability. Four cases were investigated using a template analysis of 16 interviews in the food supply chain. Eighteen boundary requirements were established, classified in the categories industry, policy, efficiency and traceability. Some boundary conditions were found in all supply chains while others were found to be specific to the supply chain. Standardization of traceability processes and interfaces, a joint platform and independent governance have been identified as key boundary conditions before the use of block chain. Our findings imply that supply chain systems need to be modified first and organizational measures need to be taken to meet the boundary conditions before the successful use of block chain can be achieved.*

Keywords--- *Business boundary conditions, Block chain technology, Food supply chain, Traceability***.**

I. INTRODUCTION

Block chain technology (BCT) is seen as one of the most critical business-influencing development developments. BCT has emerged as a potentially disruptive, general-purpose technology to increase trust by companies when interacting with each other. The potential benefits of the block chain vary from technological and social and economic advancements and are strong in hope. Yet Forrester's analysis estimated that 90 percent of the Distributed Ledger Technology (DLT)-based business project will be halted in the period 2015-2017. Adoption of block chains in the logistics and supply chain is country-specific and needs to take the context into account. So far, most literature has focused on the level of technology, addressing the technological challenges of using BCT for peer-to-peer (P2P) processes, whereas project stoppage suggests that the most difficulty can be found at the organizational level. BCT [1]has also recently been introduced as a technology to support enhancing the traceability of product data.

It is highly necessary to gain greater leverage over the heterogeneous, diverse and competitive food supply chain in order to meet the growing consumer demand for nutritional safety and quality, caused by several food controversies. The existing situation in the food supply chain is that individual quality standards are still used by participants to follow the

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specific nominator as specified by international regulations or national regulations. To significantly increase the traceability of food products, businesses need to exchange information regarding quality assurance at a detailed level with each other. It, though, also comes up against a lack of trust between supply chain stakeholders. BCT has been heralded as a confidence-building technology. BCT has focused on new programs to tackle the problems of the food supply chain. Such projects, though, are largely technology-driven and concentrate on areas of technical feasibility. A different starting point is used in this paper and the focus is on investigating the boundary conditions that need to be met in order to be able to use block chain and address the challenges of BCT's traceability information exchange within the dairy food supply chain.

The boundary conditions of this research are defined as "social technical constraints for the realization of a global food traceability system" Boundary conditions indicate whether the necessary constraints are met before use of block chain technology. For this analysis, the following two research questions were defined:

1. What are the restricting criteria in traceability information for actors in dairy food supply chain to exchange quality assurance information?

2. So, how does BCT fulfill these conditions?

A qualitative research approach is used to examine empirically the boundary conditions for exchanging quality assurance knowledge between participants in the dairy food supply chain, in order to address the first query. This section provides insight into the type of information already exchanged by participants, and the requirements for exchanging further details with the goal of increasing traceability. The second question relies on BCT's features to surmount the boundary conditions. This section is intended to decide how BCT in the dairy food supply chain will satisfy the requirements of a traceability information system.

The increasing need for traceability of food

Market globalization contributes to more goods, knowledge, and person movements between nations. Consumers benefit from this development by discovering food products in their local markets from other parts of the world. Therefore, purchasing fruit or vegetables regardless of the season is deemed' natural' nowadays. On the other hand, globalization in the food sector has also led to the challenge of ensuring food safety while food supply chains are becoming increasingly global and dependent on a growing number of players. The 2008 China Melamine Milk Powder Scandal was a very prominent example of a food scandal with disastrous consequences. In this scenario, it is reported that at least six babies have passed away due to infant milk powder tainted with Melamine. However, it has also contributed to the milk powder supplier's incarceration of business managers, industry collapse and recession that put the tainted baby milk powder onto the market.

Despite increasing attempts to implement the necessary food control measures more stringently, regulatory systems between countries and regions still diverge greatly and problems of food safety and crisis situations continue to occur regularly on a global level. For starters, a search on the New York Times website on the key words "food safety" results in the articles on this topic every month. Incidents of food safety and crisis situations have not only forced authorities into practice, but have also generated a stronger consumer awareness. Traceability of food is now seen as an important aspect in maintaining food safety and product quality, which improves consumer confidence and satisfaction.

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Concepts and characteristics of traceability and a food traceability system

The literature contains several different definitions of the term ' traceability.' These different definitions in the literature show that the term ' traceability' does not have a general understanding. Many traceability criteria rely on defining the ability of a substance to meet essential characteristics from origin (including ingredients) throughout the supply chain through to the final process stage. Analysis indicates that the different definitions of the word ' traceability ' include two or more of the following four concepts: accuracy and clarification in the language utilized (e.g. ' tracking ' vs. ' tracing '), backward item follow-up (tracing), forward component follow-up (tracking) and commodity background details during the supply chain.

Defining food traceability as part of logistics management highlights the fact that food safety and quality are quality assurance capabilities which are strongly dependent on logistics operations for efficiency and effectiveness. Take the case of food recalls which are often used in the literature as an illustration. While a detailed set of traceability information is an important prerequisite for this process, the effectiveness of the recall process also depends heavily on efficient logistics operations and the level of integration between the various supply chain actors.

Depending on the direction in which the information flows, traceability forward ("tracking") is distinct from traceability backward ("tracing"). In case of a product recall event the discrepancy can better be clarified. Tracking capability means that products are tracked from start to finish through the supply chain and can be identified based on the recall criteria. On the other side, the traceability ensures that the root of a commodity can be found, and with it the association between items that the product comprises. Chain traceability is "the ability to track a product batch and its history throughout the whole or part of a harvest chain through transportation, storage, processing, distribution and sales," while internal traceability is "the ability to trace... in one of the stages of the chain" In general, chain traceability is considered to be the traceability capability across the entire supply chain between all supply chain actors while internal traceability is the traceability capability of one supply chain actor's internal processes.

To also define the traceability within the supply chain between two entities, the Global Traceability System introduces the concept of external traceability (see also Fig. 1). Specific identifiers (or characteristics) must be identified for each commodity or product class in order to track goods and their ingredients, and grouped into a so-called traceable resource unit (TRU)[2].

Aung and Chang (2014) differentiate between the three traceable unit types:

- Batch unit Products undergoing the same process steps, e.g. milk powder canisters, have the same best before the data and the same batch number.
- Trading unit Goods sent from one participant to another supply chain actor, e.g. a box containing the same batch number of milk powder bottles.
- Logistic unit Goods organized into logistics items for shipment or storage, e.g. a pallet of milk powder containers, which contain different batch numbers Depending on these concepts, a batch unit may be the same as an industrial unit, and several logistics units could be one batch unit if the production process is the same and the goods had the same batch number.

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Based on these definitions, a batch unit could be the same as a trade unit, and if the production process was the same and the products had the same batch number, several logistic units could be one batch unit. Tractability can be stored on a batch, trade or logistics unit depending on the type of data.

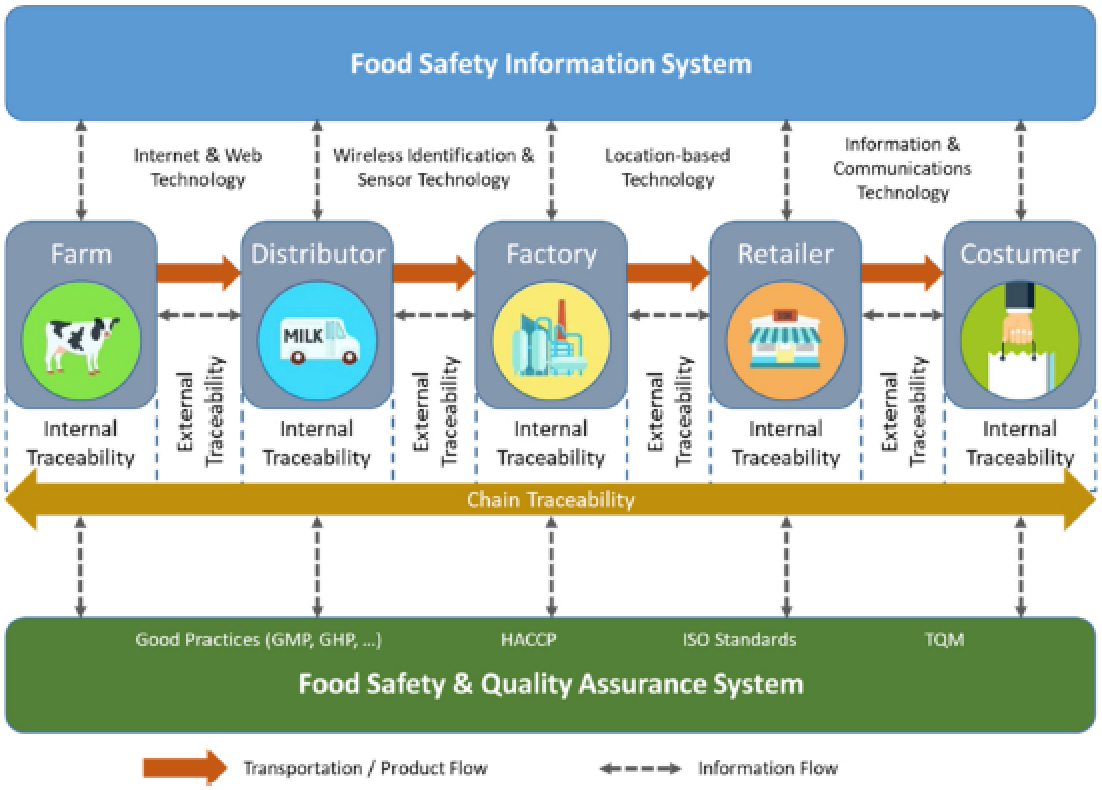

Fig. 1. Conceptual framework of a food traceability system

Block chain technology for traceability

BCT is the underlying technology which was originally used for digital currencies like Bitcoin. Since the discovery by several large financial companies of its potential for other financial services in 2015, it has gained widespread attention and resulted in a growing number of usage cases in several industries, including insurance, logistics, and healthcare and supply chain management. A major promise of BCT for supply chain management is its potential to increase product transparency and traceability by allowing transactional data to be exchanged between two or more supply chain partners, the immutability of stored transactional data, and the maintenance of a single version of the transactional database without an intermediate third party accountant.

The general statement is that BCT would revolutionize industry and provide a solution to the current shortage of technical convergence in economic and legal processes. The enormous opportunity is especially seen in the automation of operations that still involve a confidence broker like a judge, notary or banker nowadays. BCT "has the ability in this context to create new structures for our economic and social systems". The "killer application" for BCT has yet to be found, however. Startups have developed several BCT-based solutions but no application has yet reached a scale that extends concept proof or pilot stage. This is also attributed to the still economic advantage of current and well-established

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systems. Further investigation of pervasive use cases is therefore needed to encourage the adoption of BCT and to reveal benefits for its users.

II. LITERATURE REVIEW

This paper support why ontologies can contribute to the design of block chain. To support this case, as per analysis of an ontology of traceability and translate some of its representations into smart contracts that trace provenance and enforce traceability restrictions on the Ethereum block chain platform[3]. Food safety has become an outstanding issue in the last few years. Since conventional agri-food logistics practices can no longer meet market demands, it is becoming increasingly imperative to develop an agri-food supply chain traceability network. In this paper, study on the utilization and development situation of RFID (Radio-Frequency Identification) and block chain technology is firstly performed, and then analysis of the advantages and disadvantages of using RFID and block chain technology in the construction of the traceability system for the agro-food supply chain is performed; finally, this paper demonstrates the construction process of this system[4]. This study examines the promise of block chain technology in the food supply chain for maintaining traceability and authenticity. To ensure the quality of the third step of the analytical processes: data acquisition and management, it may be considered a true advancement and valid strategy[5]. This paper explains why ontologies can contribute to the analysis of traceability ontology by block chain design and translate some of its representations into smart contracts that execute trace provenance and enforce traceability restrictions on the Ethereum block chain platform[6]. The aim of this paper is to identify the boundary conditions for sharing information about assurance in order to improve traceability. Four cases were investigated using a template analysis of 16 interviews in the food supply chain. Eighteen boundary requirements were established, classified in the categories industry, policy, efficiency and traceability. Some boundary conditions were found in all supply chains while others were found to be specific to the supply chain[7]. The purpose of this paper is to investigate meat traceability by outlining the different perspectives and opinions of stakeholders in the meat supply chain (SCS); it also assesses the potential for accepting block chain technology (BCT) as a viable system of transparency and traceability (TTS)[8]. In order to ensure food safety, this paper aims to increase our understanding of food traceability perspectives in four approaches to the supply chain risk management (SCRM). The occurrence of food safety failures has led to increased attention being paid to food traceability as a means of identifying the causes of supply chains deficiencies[9]. A case study illustrates the complexities of integrating block chain technology within the food supply chain, as well as the potential to incorporate block chain applications across the global food industry to increase safety and reduce waste[10].

CONCLUSION

The findings demonstrate that BCT can be used to trace goods in supply chains and can be used to create transparency in the supply of goods. Block chain is an acceptable tool, as this can result in more data sharing between supply chain participants collaborating with each other. Nevertheless, boundary conditions should be met before using BCT. This is the first paper exploring BCT boundary conditions and was established for a food traceability under a total of eighteen

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boundary conditions from which 5 explicitly relate to BCT. A significant number of these apply to regulatory requirements, internal supply chain and production processes which require substantial operational improvements to support the full benefits of traceability. That includes both tracing and tracking functionality. Which type of data is shared and who has access to which key questions are the data. The absence of master data and protocols standardization restricts the level of automation. The uncertainty resides in the coordination of the various actors in the supply chain regarding protocols and norms. The findings suggest that the supply chain has to be structured first before it can be used for block chain.

The variety of boundary conditions shows the need for systemic improvements before BCT can be widely used in the supply chain. This discovery can clarify why many pilot-level block chain ventures remain. Before BCT can be used, a well-organized and standardized supply chain between all (interior / external) actors is needed.

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