Towards a Governance Model Design for Traceability Systems

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Abstract. Lack of social fairness and increasing legal and regulatory obligations for traceability along the supply chain cause companies to face complex challenges. As a promising technology for supply chains, blockchain has the potential to address these challenges. This research focuses on governance for resilience in information systems for supply chain consortia. As instantiation, we aim to develop a governance model for blockchain-based traceability systems in supply chain consortia within an agricultural environment. To set a foundation and narrow down the research interests, within this article, we utilized a design science research approach to elicit seven tentative design principles (DP) for an agricultural supply chain consortia governance model using blockchain-based traceability systems. Drawing on existing literature and expert interviews requirements, we identified the design principle of data, legislation and regulation, roles and responsibilities, decisions, decisions rights, decision management, system as a service, social - environment and fairness, as well as an incentive system. The elaborated DP can be used as a foundation for researchers and practitioners to design a governance model, including roles, rules, incentives, structures, and processes with associated possible alternatives.

Keywords: Governance · Blockchain · Supply Chain · Traceability · Resilience · Design Principles.

1 Motivation and Problem Definition

Motivation. In today's globalized world, supply chains face various challenges impacting their efficiency, effectiveness, and sustainability that must be overcome [20]. Considered one of the most critical supply chain is the agricultural supply chain [14]. In particular, agricultural supply chains face challenges including the lack of transparency driven by difficult communication among stakeholders because of language barriers. In addition, especially in agricultural supply chains with large social imbalances between actors, greenwashing is widespread to create an environmentally friendly and responsible image for customers. Furthermore, social, cultural, and technological gaps between growing and consuming countries lead to exploitation and fraud [1]. To counteract this, increasing regulatory

changes are demanding accountability from companies to improve environmental, human, and child rights protections along global supply chains. In addition, companies lack guidelines on how to prepare for adopting recent legislation.
An information system in the form of a traceability system can provide assistance in uniquely identifying physical goods, documenting transactions, and storing states and environments in attributes while ensuring compliance [21]. However, existing systems using common databases neglect aspects such as fairness, trust, and intercultural boundaries [5]. To address these issues, traditional traceability systems are extended by new technologies. E.g., recent approaches integrate blockchain within these traceability systems from a technical view [21], which still provides a lack of organizational perspectives. Blockchain, a growing technology, has gained significant attention from companies and researchers. This technology provides the potential to increase efficiency, resilience, sovereignty, security, fairness, and above all, transparency [10]. Considering the challenges above, one possibility would be in implementing blockchain-based traceability systems [7]. The research in business models and technical implementations of this technology within supply chains is matured to the point that the organizational perspective for operating a blockchain should be included. Based on the blockchain operation categories, it now requires governance structures and processes to enable transparent and resilient control and regulation for traceability systems within the development, operation, and evolvement of blockchain-based consortia [12].
Research problem and objective. However, research and practice indicate a gap considering organizational governance issues within supply chain consortia in information systems. As instantiation, we focus on a specific environment, the agricultural supply chain. There is a missing understanding of the requirements for how to design a governance model for blockchain-based traceability systems in agricultural supply chain consortia. Furthermore, there is a lack of governance guidelines on developing, operating, and evolving blockchain-based consortia regarding incentives, decisions, decision rights, and accountabilities.
We approach the problem from two sides. On the one hand, we consider the research of trust and collaboration through blockchain-based traceability systems in the supply chain domain. On the other hand, we investigate the interorganizational governance perspective of consortia using the blockchain life cycle and strengthening resilience in supply chains.
To contribute to this research gap, our common interest lies in the governance of blockchain platforms within industrial application fields in supply chains to provide a foundation for further individual research. We identified missing design knowledge about governance providing resilience in a blockchain-based traceability system within supply chain consortia. Therefore, we want to identify design requirements, design principles, and design features for a governance model addressing resilience in blockchain-based traceability systems in interorganizational supply chain consortia. Our primary focus is the business value proposition for all participants, including customers and stakeholders.
This approach leads to the following overall research question: *"How to design*

a governance model for agricultural supply chain consortia using a blockchain-based traceability system?"
Guided by this research question, we want to investigate how design requirements, principles, and features can be mapped to a governance model for agricultural supply chain consortia using a blockchain-based traceability system.
Structure. The remainder of this paper is structured as follows: first, the foundations (Section 2) representing existing input knowledge and concepts used for our research are presented, followed by the applied research design (Section 3). Next, section 4 points out the expected results, including meta-design requirements, design principles, and a first suggestion of the governance model. Finally, this research-in-progress paper is concluded by discussing the contributions and future work (Section 5).

2 Foundations and theoretical background

Service-dominant logic. As our focus for developing a governance model is on the business value proposition for all participating actors, service science, especially service-dominant (S-D) logic, is considered. This research aims to link S-D logic and governance of blockchain-based traceability systems within supply chain consortia through co-creation and emphasizing relationships and trust. In our context, blockchain technology facilitates collaboration through a traceability system by providing all parties with access to a shared, immutable record of transactions. In S-D logic and supply chains, trust is a key driver of value creation and building strong relationships with suppliers, producers, or customers. By using blockchain technology to improve transparency and security of transactions, companies can help build trust and enhance value creation throughout the supply chain [3]. Robert Lusch [16] describes that shifting dominant thinking of supply chain management toward the concepts of service, value co-creation, value propositions, operant resources, networks, and service ecosystems opens up many research opportunities and strategies for improved organizational performance.
Blockchain Governance. As further input knowledge and concepts, we investigate governance, especially the governance of blockchain networks, as the technology provides the basis for the consortium. Blockchain governance can be captured as the integration of norms and culture, the laws and the code, the people and the institutions that facilitate coordination and determine a given organization [8]. According to Weill [23], IT governance consists of three fundamental dimensions: incentives, decisions, and decision rights, as well as accountabilities. Considering blockchain governance, these dimensions have been retrieved, adapted, and extended by several researchers to capture the challenges, as well as research directions of this field [4, 25, 18, **?**].
Traceability systems. Furthermore, in fulfilling the current legislation and regulations, transparent supply chain processes are getting crucial for companies and organizations [11]. Therefore, we need a blockchain-based traceability system,an information system, within a consortium capturing objects and events

as information on the blockchain and analyzing data with forward and backward tracing [20, 21]. Forcing traceability in organizations, the lack of governance is an emerging topic [2].

3 Research Design

Overall research. Our overall research goal is to develop a governance model for agriculture supply chain consortia, ensuring resilience in traceability systems.

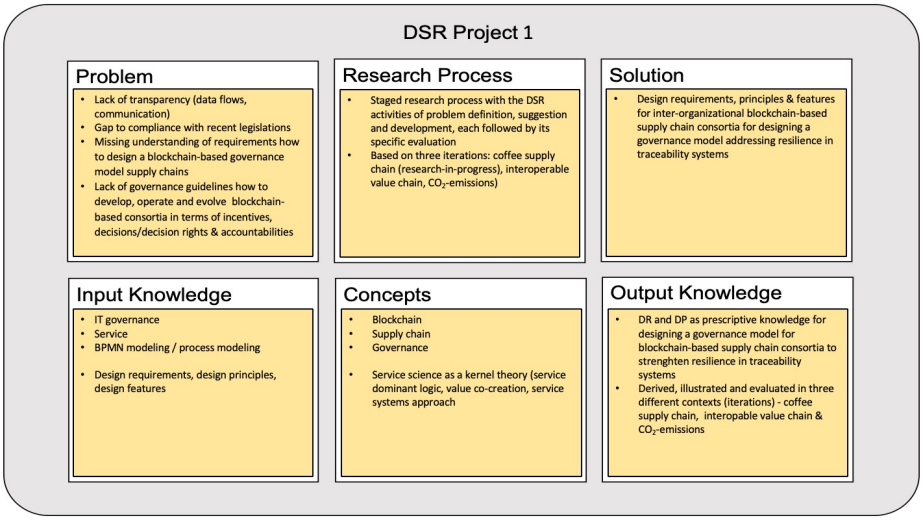

Fig. 1. DSR grid author 1 according to vom Brocke and Maedche [22]

This combines our previous outlined research interests of blockchain-based traceability systems and the inter-organizational governance perspective of consortia that are illustrated within two Design Science Research (DSR) grids according to vom Brocke and Maedche [22] (see Fig. 1, Fig. 2).

For this purpose, we use the DSR approach according to Kuechler and Vaishnavi [15] to design our governance model. We include different stakeholder perspectives and combine different knowledge bases by using S-D logic as a kernel theory. S-D logic should thereby ensure aiming for customer and stakeholder needs as well as wants. We adopt our research approach with a method [17] for systematically generating design principles in an iterative supportive, or reflective way. This approach focuses on the design of an artifact and the theory associated with highlighting the importance of the iterative learning cycle of design science research considering the DSR design decision taxonomy [19].

In our overall research agenda, we systematically elaborate design requirements (DR), design principles (DP), and additionally design features (DF) for

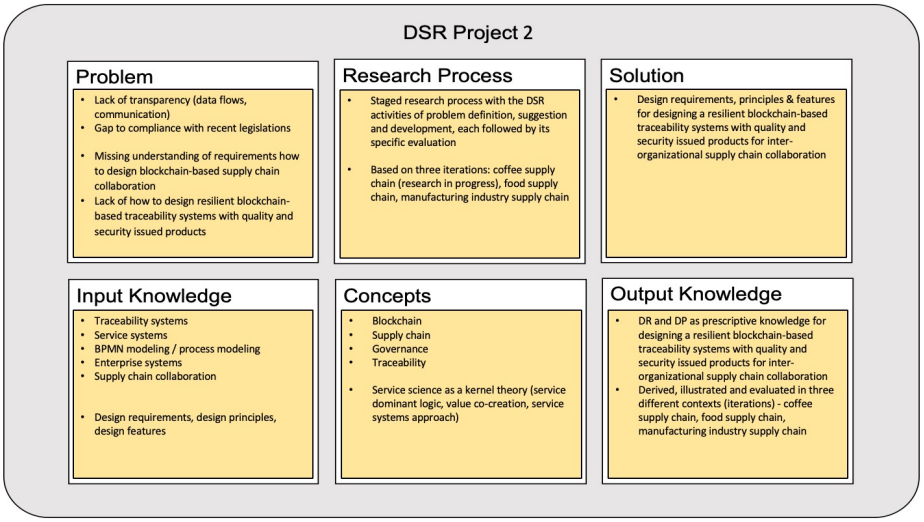

Fig. 2. DSR grid author 2 according to vom Brocke and Maedche [22]

our governance model. This governance model includes roles, rules, incentives, as well as structures and processes with associated possible alternatives to provide guidance for companies in participating or developing a supply chain consortium using blockchain-based traceability systems.

Research-in-progress. In this research-in-progress paper, we present the exploration of our DR and DP in terms of the first two steps including problem definition and suggestion of the DSR process model [15]. For generating DP, we use an iterative method (see Fig. 3) [17]. We choose secondary sources (scientific literature) in the first iteration as a knowledge base. Next, we conduct a structured literature review according to vom Brocke et al. [6] on blockchain governance including databases *Web of Science, IEEE, EBSCO and ACM*. From this, we extract the first set of DR. Furthermore, we derive DP as general guidance. Afterwards, we evaluate our DP based on internal reviews by blockchain and supply chain experts. We use expert interviews as a new knowledge base in a second iteration. Therefore, we use semi-structured interviews [9] with five managing directors within the coffee supply chain. To analyse the results we used case study research following Yin [24]. We refine our DR and DP with this method. In the final evaluation, we compare our DR and DP. Additionally, we demonstrate a prototypical suggestion for the governance model. Subsequently, we intend to extend the evaluation of Iteration 2 in future research by conducting a survey with blockchain and supply chain experts.

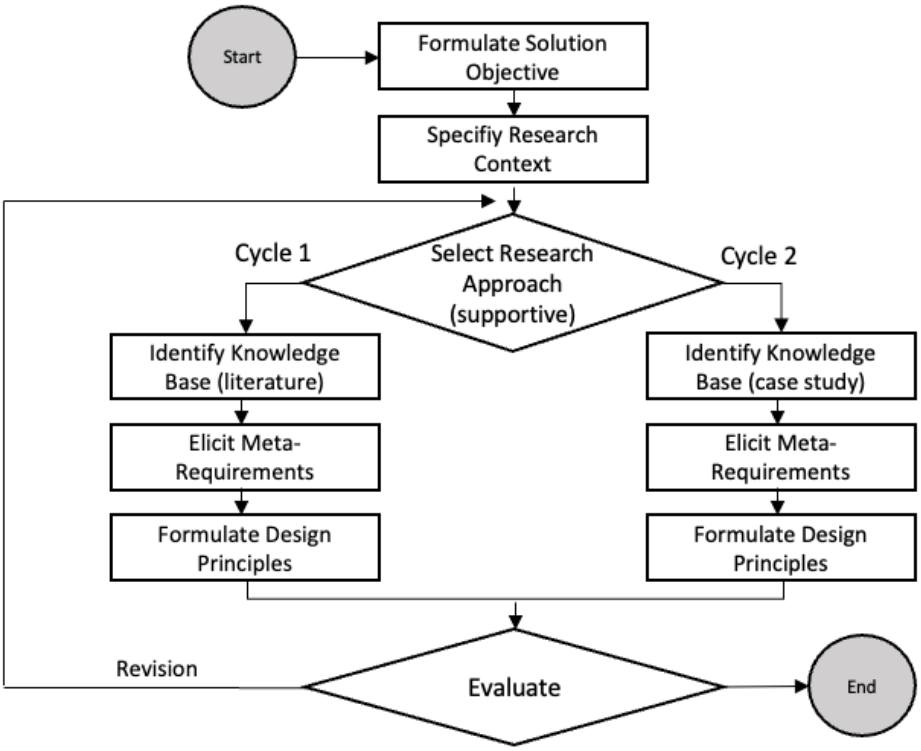

Fig. 3. Design science research model according to Möller[17]

4 Designing a governance model for blockchain-based traceability systems in agricultural supply chains

Identification of meta-design requirements (MDR) in iteration one. We start our first iteration with a literature review on blockchain governance as a knowledge base. After analyzing the results, 29 design requirements can be identified and aggregated into MDRs. **MDR1** Stakeholder trust addresses the need to understand how the blockchain economy can achieve trust between agricultural stakeholders [4, 25] or how transparent decision processes can establish trust in an global environment. **MDR2** Compliance and laws include ensuring the integration of current and future cross-national compliance and legislative requirements towards the traceability system [25, 13]. **MDR3** Transparent information flows represent the requirement of stakeholders to receive the data for decisions in the blockchain-based traceability system according to previously agreed upon policies and rights [4, 25, 18]. In the next step, DPs were derived from the MDRs. At the end of the iteration, an internal evaluation based on blockchain and supply chain experts showed that especially the user perspective and industry-specific insights were not captured by the previously extracted

DPs.

Identification of MDRs in iteration two. In the second iteration, a new knowledge base will be implemented as a foundation through interviews with agriculture supply chain experts. The interview analysis results in 18 design requirements, which are generalized into four meta-design requirements. **MDR4** Coordination & control covers the need for external deployment and maintenance of the blockchain-based traceability system considering the technological imbalances of the growing countries. **MDR5** Social & ethical awareness describes the responsibility of the individual participants of the value chain towards the social situation and environment of the farmers or producers. **MDR6** Inter-organizational collaboration gathers the requirements of experts in terms of data exchange, collaboration, and communication, as well as support and consulting activities for growing countries. **MDR7** Resilience refers to the adoption of changing circumstances, such as fluctuations in demand, disruptions in the availability of materials or components, or transportation delays caused by the global agricultural supply chain. We evaluate our DPs at the end of iteration 2

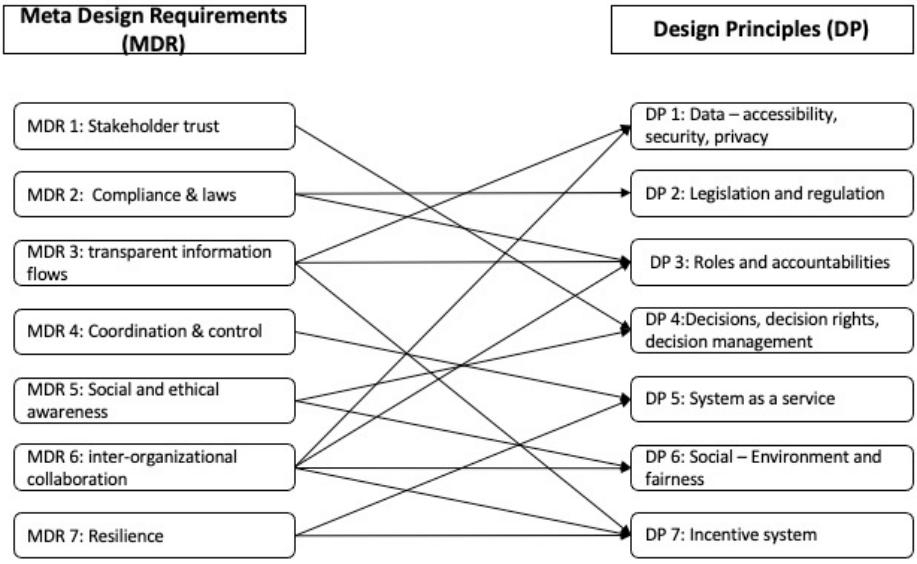

Fig. 4. Meta-design requirements and design principle - mapping diagram (own illustration)

with a final comparison of all MDRs and DPs. In the next step we conclude our evaluation with a survey of external supply chain and blockchain experts, but this is not part of this article.

Design principle deviation. We present our DP in a mapping diagram (see Fig. 4). This highlights the links between the DP and MDR. **DP1** Data covers

data management of accessibility, security, and privacy in a cross-organizational consortium. **DP2** Legislation and regulation describe a mechanism to implement current and future regulations and laws in the structures and processes of the traceability system. **DP3** Roles and accountabilities address a transparent rights system that can be derived from existing organizational structures. **DP4** Decisions and decision rights cover the management of trust and social factors in decision processes involving actors of producer countries. **DP5** System as a Service describes the provision of the traceability system as a service ensuring the inclusion of S-D logic by value creation for all participants and customers. **DP6** Social - Environment & fairness addresses the disbalances between consumer and producer countries and should enable improvements in working and environmental conditions. **DP7** Incentive System should provide incentives for stakeholders and customers to capture tensions for continuous participation within the consortium.

We understand our artifact, the elaborated DPs, as a starting point to provide resilience. The DPs can be used by traceability system providers or agricultural supply chain consortia to drive the building of their own governance model and implement it later into their blockchain-based traceability system. Our research also expands the knowledge base of the underlying domains. In the future, other researchers may incorporate our results, the DPs, into their own research.

Governance model approach. As already pointed out, the development of DRs and DPs should lead to the identification of design features. These features will be the foundations for the design of concrete roles, rules, incentives, as well as structures and processes, including associated alternatives, which in turn should be the basis for our overall artifact, the governance model (see Fig 5). This includes the description, explanation, and design of our information

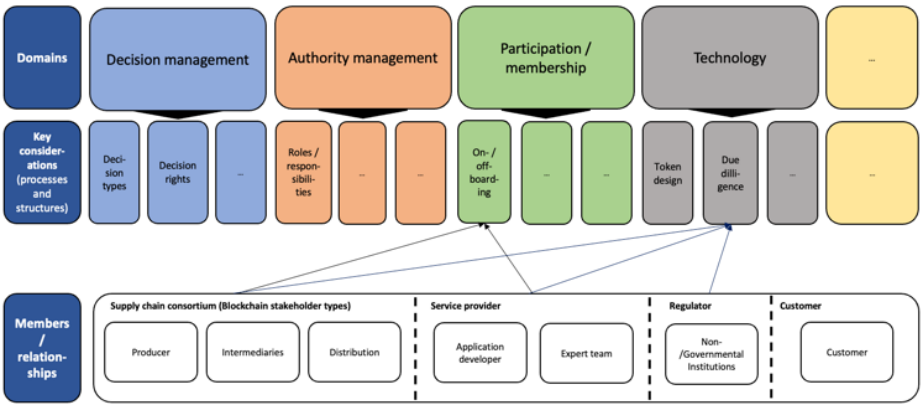

Fig. 5. Governance model for blockchain-based supply chain consortia version 1 (own illustration)

system, the blockchain-based traceability system, the associated processes, and

process models.
The governance model for blockchain-based traceability systems in agricultural supply chain consortia is divided into three stages. The first stage represents the members and relationships, including the supply chain consortium, i.e., stakeholders of the supply chain, the service providers, the regulator, and the customer. The second stage is given by key considerations, developed of the design features identified by our proposed DPs, representing the processes and structures included in our governance domains (third stage). Finally, the model links the stakeholder to the respective processes and structures.

5 Discussion, Research-in-Progress and Outlook

Summary. This research-in-progress paper addresses the lack of research on how to design a governance model for blockchain-based traceability systems in agricultural supply chain consortia considering the business value proposition for all participants, including customers and stakeholders. To this end, we derive seven tentative design principles from seven meta-design requirements based on 47 DRs (29 theoretical and 18 practical DRs). Due to our instantiation, we provide cumulative prescriptive knowledge and thus contribute to the knowledge base of blockchain governance and blockchain-based traceability systems. Furthermore, our proposed artifact (DPs) can be generalized to expand the understanding of governance for resilience in information systems wihtin supply chain consortia.
Further research. In subsequent research, a survey addressing external blockchain and supply chain experts to validate the identified design principles is planned which are the basis for our governance domains (see Fig. 2). Afterwards, we want to implement the design principles into a governance model by developing design features. The latter should support the governance model with concrete incentives, rules, processes, structures and alternatives that are demonstrated within the key consideration stage. For the evaluation of our governance model, we plan to use focus groups, surveys as well as evaluation of the fulfillment of the requirements to conclude the first iteration.
After this, the research interests will split. On the one hand, the research towards blockchain governance for resilience and digital sovereignty plans to carry out three iterations. This contributional research focused on setting the foundation, the coffee supply chain (iteration 1). In the future, a second and third iteration will include greenhouse gas emissions and interoperable product and information flow of agricultural supply chains to derive further implications for governance and subsequent processes, structures, and alternatives. Therefore, further input knowledge in supply chain resilience, coordination, and digital sovereignty will be included. Within the final governance model, these processes and structures are intended to enable guidance for specific situations in developing, operating, or evolving a blockchain-based consortium to strengthen resilience and digital sovereignty. On the other hand, future research on traceability systems will focus on mapping organization structures on rights and accountabilities of the

governance model, securing backward and forward traceability with governance guidelines, performance measures, and inter-organizational collaboration of the supply chain on the enterprise level.
Limitations. The preliminary nature and high abstraction of our DPs also represent a limitation emphasizing the lack of completeness at this stage. Furthermore, our DPs are based on literature reviews as well as five experts interviews validated by an internal evaluation. Before developing our design features, a comprehensive second evaluation, which is already in the development phase, needs to take place. Since our paper exclusively addresses a blockchain-based traceability system, a detailed investigation of alternatives, such as distributed or federated databases, should be included in the future.
Conclusion. Nevertheless, our research provides an initial foundation for further research on governance within blockchain-based consortia focusing on resilience as well as digital sovereignty.

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Contributions can be attributed to the coauthors as described below:

- Maximilian Greiner conducted the interview study and executed the data analysis (Sect. 4). Furthermore, he contributed the input knowledge in service science and blockchain governance within Section 2.
- Christian Zeiß designed the research approach (Sect.3) and executed the data analysis (Sect.4). In addition, he contributed the input knowledge for traceability systems and supply chain(Sect.2).
- The authors jointly wrote the introduction (Sect. 1), methodology (Sect. 2), and conclusion (Sect. 5).
- Ulrike Lechner contributed to the interpretation and revisions of the article.
- Axel Winkelmann contributed to the interpretation and revisions of the article.

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