Experience on Using ArchiMate Models for Modelling Blockchain-Enhanced Value Chains

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ABSTRACT

Blockchain is an emerging disruptive technology with a great potential to impact business value creation. Yet it is challenging to understand how blockchain can be utilised to improve enterprises' performance and value creation. A formalised conceptual and enterprise modelling may help bridge the communication gap between domain experts and blockchain system designers. The goal of this study is to explore how can modelling facilitate blockchain-enhanced value chain design from a motivation viewpoint. We report our experience from modelling a blockchain-enhanced seafood supply chain using ArchiMate motivation and strategy models, where stakeholders have diverse concerns and goals. Preliminary results have indicated that such a modelling approach facilitates the common understanding, and the decision and prioritisation of the business strategies, as well as the identification of the blockchain benefits for the enterprises. It may help stakeholders along the value chain to align their business strategies and priorities, and can be an effective tool for value co-creation and enhancing the collaboration and communication among stakeholders and with blockchain application developers.

CCS CONCEPTS

• **Software and its engineering** → **Software notations and tools**; **Requirements analysis**; • **Applied computing** → **Enterprise modeling**;

KEYWORDS

Blockchain, Enterprise modelling, ArchiMate, Motivation, Goal, Strategy

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1 INTRODUCTION

Blockchain is a disruptive distributed ledger technology (DLT) that has the potential to bring huge benefits based on its tamper-proof data, transparency and traceability [4]. Blockchain has been applied in various domains and contexts, such as supply chains and smart cities [9][21][24]. For a global food supply chain, blockchain can enable more granular traceability and more efficient and targeted recall than traditional traceability systems, and facilitate automated regulatory compliance [4][21]. Blockchain can also solve current challenges related to information sharing barriers, e.g., regarding the fragmented traceability-related information [1], and the privacy and reliability of the traceability-related information [4].

Although blockchain has a great potential to change the way enterprises create value, it is also a complex technology and may not be applicable in all contexts. The business managers and domain experts usually do not know what blockchain can provide and how blockchain can be applied to help achieve their business goals and needs. To utilise blockchain technology without introducing too much additional work or need for system adaptation, it is important to have a clear understanding of why blockchain technology should be applied and how. This requires a clear and integrated vision on the relation between business and information technology (IT) [14]. The communication for IT-enabled value co-creation in a multi-stakeholder value chain can be extremely complex as proclaimed by [3], and a good common and easy-to-understand language is needed to facilitate the communication between business domain experts and system designers to explore the potential of blockchain technology.

In enterprise modelling, modelling languages and tools provide formal structures and notations to visualise the design of a technical system. They facilitate the communication with system users and can bridge the gap in the dialogue with the users. ArchiMate is a modelling language for formalising the technical systems from business perspectives [7]. The technical requirements are often strongly linked to enterprise strategies and should support their business goals [22]. ArchiMate modelling approach supports this linkage, in particular, through the motivation and strategy models.

For a complex value chain, such as a global supply chain, the stakeholders collaborate to co-create values. The stakeholders may have diverse or even conflicting interests and strategies, and they may not understand each other's key values or motivations in the value chain. A formal and structured overview of the holistic value chain may help align business strategies and goals, and identify the potential application of blockchain across and along the value chain. The goal of this research is thus to investigate *"how will a shared understanding of individual organisations' motivation influence overall value chain design and focus through adoption of* *blockchain technology?"* Specifically, we want to explore *"how can modelling facilitate blockchain-enhanced value chain design from a motivation viewpoint?"*

Under a research collaboration, several key stakeholders in a global seafood supply chain are involved and aim at exploring the possibility of applying blockchain in real business settings to enhance their value (co-)creation capabilities. The seafood supply chain is about exporting Norwegian fish to different countries, such as UK and China. Figure 1 shows the main stakeholders with primary roles (nodes in the main chain) and secondary roles (side nodes) in this supply chain. A great number of stakeholders are involved, and none of them have existing blockchain systems. This supply chain represents a value chain where various stakeholders collaborate for value co-creation: the stakeholders need to collaborate well to ensure an unbroken cold chain, as the fish and fish products have to be processed, stored and transported properly to meet food safety and quality requirements. In this paper, we demonstrate how ArchiMate and its methodology can be used in conceptual and enterprise modelling of the value chain of this blockchain-enhanced seafood supply chain. The focus is on modelling the high-level business motivations, needs and strategies, instead of technical details of the designed system. The purpose is to create a better understanding of the shared values in the value chain and identify how blockchain can be utilised to realise the prioritised business goals. The findings are that blockchain-enhanced end-to-end traceability with transparent and tamper-proof data is an appropriate mechanism to meet stakeholder concerns and goals for value co-creation, and that modelling motivations with ArchiMate helps the communication with non-technical stakeholders, and eases understanding of the role of blockchain in this co-creation, contributing to convincing stakeholders to adopt this new technology.

In the following, Section 2 introduces the theoretical framing of this work. Section 3 describes our approach of applying ArchiMate for the modelling and the initial validation. Preliminary results and lessons learned from this process are presented in Section 4. Section 5 discusses related work and Section 6 concludes the paper.

2 THEORETICAL FRAMING

2.1 Enterprise Modelling and ArchiMate

Value co-creation in a network of organisations enabled by IT technologies requires "tools and techniques for discovering new valuable and necessary artefacts to support inter-organisational and network-centric business activities" [3]. The starting point for value co-creation is good communication with the stakeholders and appropriate methods and tools for the common understanding of the system-of-interest and the requirement elicitation.

In enterprise modelling, enterprise models are created using modelling languages and visually represented in diagrams with well-defined notations. Enterprise models therefore provide "a medium to foster communication between stakeholders with different professional background" [6]. Enterprise modelling can thus contribute to the understanding of the business practices and processes for operating blockchains, and to the Enterprise IT and business alignment. Furthermore, the models allow for user involvement in the system analysis and design process.

ArchiMate is a standard architecture description and a modelling language for enterprise architectures [7][14]. Designed to enable impact and change analysis embracing all aspects related to the enterprises [6], ArchiMate is typically used for modelling high-level processes in the broader enterprise context, while other modelling languages have narrower scope, e.g., UML for software modelling and BPMN for detailed workflow modelling. ArchiMate provides multi-level and multi-perspective modelling techniques with concepts representing various perspectives (called views) of enterprise architectures. The ArchiMate Core Framework consists of three layers (Business, Application and Technology) and three aspects (Active structure, Passive structure and Behavior), while the ArchiMate Full Framework adds Strategy layer and Motivation aspect to the Core Framework [7].

Feltus et al. [3] proposed an extension to ArchiMate as a common language for supporting value co-creation. We adopt a similar approach but focus on the ArchiMate motivational perspective (using motivation and strategy views) as the common language, as we limit the scope of this paper to applying ArchiMate for the early-stage requirement analysis and system design. The models from the ArchiMate motivation and strategy views capture the high-level abstraction of business aspects and are suitable for our purpose. They were used to document, organise, and analyse stakeholder concerns and goals, assisting in the understanding of stakeholder motivations and needs, as well as overall requirements.

The ArchiMate *motivation view* defines the rationale and motivation for the enterprise architecture. It consists of the key concepts of *stakeholder*, *driver*, *assessment* and *goal* for specifying the motivation models. A stakeholder represents a role in the value chain. A stakeholder has several concerns represented as drivers, which can be external or internal to the enterprise. Drivers motivate a stakeholder to define its goals and implement the necessary changes. An assessment represents an analysis of the current situation with regard to a driver. Goals represent high-level directions or desired end states for stakeholders. Assessments help in defining goals. For example, assessments from a SWOT-analysis (Strength, Weakness, Opportunities and Threats) can indicate barriers to overcome or opportunities to seize for the enterprise and can be translated into goals. Both drivers and goals can be decomposed. Functional and non-functional system *requirements* can then be derived for achieving the goals. *Constraints* for the realisation of the goals may be defined as well. The *strategy view* implements the business goals with the concepts of *resource*, *capability*, *course of action* and *outcome*. Outcomes are high-level, tangible, business-oriented results. Resources represent tangible, intangible, or human assets of an enterprise. Capabilities represent the abilities of an enterprise realised by its people, processes, and systems. Courses of action are strategies representing plans or approaches to configuring capabilities and resources of the enterprise in order to realise concrete outcomes that can achieve the desired goals. Figure 2 lists the key concepts and their notations in motivation and strategy views which we use in the following description of the models.

2.2 Blockchain and Supply Chain Management

Blockchain is a decentralised shared ledger technology which stores data, such as transactions between different stakeholders, in blocks

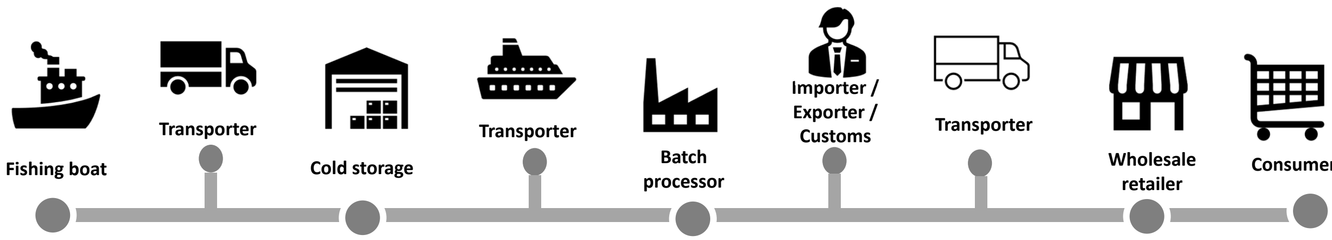

Figure 1: Main stakeholders in a global seafood supply chain.

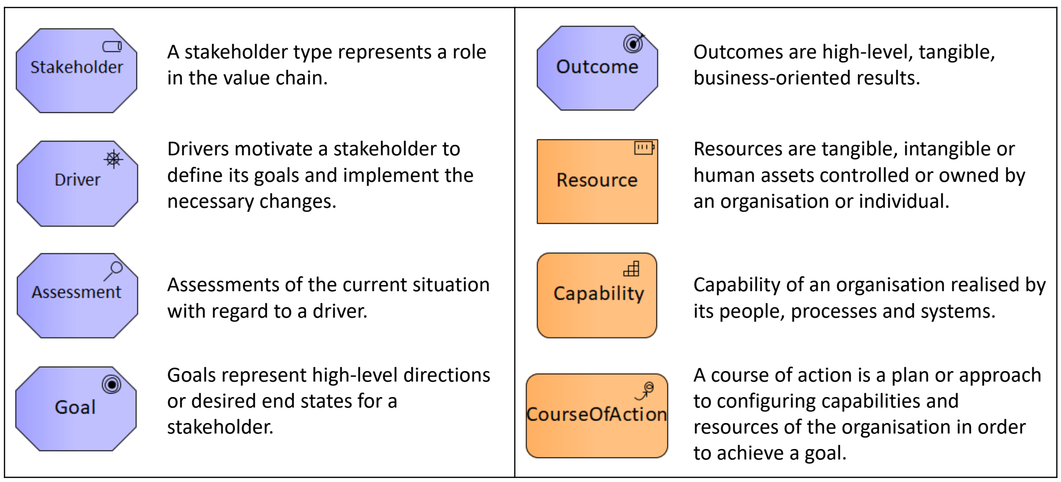

Figure 2: Key concepts and their notations in ArchiMate motivation and strategy views [7] used in this paper .

linked together chronologically via cryptography. Distributed consensus mechanisms are used to generate, verify and authenticate data stored in the blockchain. These ensure that every member in the blockchain can have access to the same copy of information in the blockchain (transparency and information symmetry), and at the same time, no single party can alter existing information (data integrity, immutability and accountability). In addition, blockchain offers mechanisms to ensure data security and user privacy, and can facilitate secure and trustworthy information sharing [1][12]. The blockchain characteristics have a potential to build trust and facilitate collaborations among stakeholders who may not know each other well in complex global supply chains [18].

Global food supply chains involve a great number of stakeholders and cover wide geographical regions, posing challenges for maintaining food quality and performing efficient food recall when necessary. Food traceability systems can be used to identify food product origin (provenance), ensure product authenticity, guarantee product in transit, and reduce the cost and time of food recalls [20], thus adding value to food products [2]. Integrating blockchain in food supply chains is expected to improve food traceability and enhance sustainable food supply chain management [2], contribute to a more transparent, secure, reliable and authentic supply chain [18], and boost consumer trust [2]. Blockchain technology has been applied in food supply chains to facilitate tracking and authentication of the information throughout the whole supply chain [13]. The transparency and accountability offered by blockchain can contribute to fraud prevention in the supply chain, e.g., uncover Illegal, Unreported and Unregulated (IUU) fishing [13][18], mislabelling of food or beverage products [13]. Blockchain combined with Internet of Things (IoT) can provide real time data transparency and more granular traceability, improving recall efficiency [2]. For example, end-to-end information about each fish can be traced instead of traditionally tracking only at the batch level. The improved traceability with smart contract can also ensure automated compliance to regulatory requirements [4][12][21], and provide reliable, verifiable data for sustainability monitoring and reporting, facilitating sustainability assessment and evaluation [13].

On the other hand, there are barriers to blockchain adoption, for instance, technical challenges regarding blockchain performance (response time, data storage, scalability, etc), high implementation cost (infrastructure, skills, training, etc), infrastructure requirements (may not work in the open sea or rural areas with poor Internet connections) [2][12][18]. Furthermore, improved and more granular traceability is based on the collection of information on each input factor of the end product throughout the supply chain, which may be difficult due to the diverse priorities and interests of the involved stakeholders [18].

Therefore, enterprises need to assess blockchain's applicability based on their business contexts and needs. One of the goals of this study is to analyse the suitability of blockchain for the shared value creation in the seafood supply chain and identify where and how blockchain can and should be utilised.

3 APPLYING ARCHIMATE FOR MODELLING A SHARED VALUE CHAIN

The design science methodology as proposed by [8][19] is followed in this study. The value co-creation in a global seafood supply chain is the context and motivation for the modelling and design of the blockchain system. The purpose of modelling this real-life use-case is to identify the core values of individual stakeholders and investigate how the application of blockchain can boost these values and enhance stakeholder collaboration along the value chain.

To help design a joint blockchain-based system, we used ArchiMate diagrams in motivation view as a tool to identify and align the individual goals for defining the common requirements for an enhanced value chain. The system design is based on a top-down approach starting from the needs, goals and strategies of the stakeholders, where the key stakeholders were involved in the modelling process. The overall approach for modelling and designing a blockchain-enhanced value chain is as follows. We started with stakeholder and requirement analysis to determine the scope of the system and to identify potential use-case scenarios. As a result, motivation diagrams were created with requirements for a blockchain-based solution. Then a strategy model was created to map business goals to the blockchain-based technology implementation at a high level before detailed technical design and implementation. Further design, which is not addressed in this paper, includes business process analysis identifying information and data flows as well as on-chain and off-chain data design.

In this paper, we focus on motivation and strategy models. We collected initial requirements from several primary and secondary sources. At the project start, a kickoff workshop with key stakeholders was organised and gathered an initial set of needs and requirements. Afterwards, 4 semi-structured interviews and over 15 unstructured conversations with key stakeholders were performed. The participants involved have various roles in the companies: CEO, CTO / Technical director, CFO, Head of sustainability, Compliance officer, Procurement director, Head of Quality, Head of Marketing, Captain on boat. The semi-structured interviews covered open questions regarding business practices (e.g., the current business process of the company in the supply chain, the roles and responsibilities of the stakeholders the company interact with in the supply chain as well as how they interact, disputes in business operations), expectations to the planned system (e.g., the data to be recorded in the planned system, the data to be used in the business operations), and barriers to the adoption of blockchain. Unstructured conversations were used to clarify unclear issues after interviews and provide supplementary information from various perspectives. Based on the current state of practices and expectations from the stakeholders gathered from the above workshop, interviews and conversations, we extracted their concerns and goals using ArchiMate motivation models. The authors had performed a systematic literature review in parallel [10][11] and gained familiarity with the literature about the blockchain use cases and applications, benefits and impacts that blockchain can contribute to supply chains, as well as the drivers and barriers to blockchain adoption. A short summary from the literature review is provided in Section 2.2. This familiarity helped construct the drivers and assessments in the motivation modelling.

The first models contained different individual drivers and goals, but also some common aspects. In addition, the first models were made to cover the diverse set of stakeholder interests mentioned in interviews. To refine, prioritise and merge goals, we performed initial validation with key stakeholders: We showed stakeholders their individual motivation diagrams and asked them to prioritise goals and give feedback, e.g., regarding changes needed for drivers or goals. We then showed them the motivation diagrams from other stakeholders and checked whether there will be changes to the goals or of the priority of the goals. At the end, we asked them their opinion on using the diagrams: "Will the diagrams help understand the system to be developed? Will the diagrams help the communication with system developers?" The diagrams and requirements were thus improved leading to refined system design.

4 PRELIMINARY RESULTS WITH INITIAL VALIDATION

This section presents the preliminary results and lessons learned from the modelling process as described in Section 3.

4.1 Modelling shared values for stakeholders

A global seafood supply chain involves many actors and stakeholders, like fishing companies, batch processors and factories, wholesalers and retailers, transporters, cold storages, and consumers as shown in Figure 1. Importers, Exporters, and Customs are secondary stakeholders in the supply chain, but their roles cannot be ignored as the regulations and rules in different countries may vary and have substantial impact on the supply chain management. The stakeholders collaborate to ensure an unbroken cold chain, i.e., the fish and fish products are always stored with appropriate temperature for quality assurance and food safety along the supply chain. To illustrate the modelling and validation process, two representative stakeholders in a real-life global seafood supply chain and their business concerns and goals are described below based on the data collection we presented in Section 3.

From the initial interviews and dialogue with the key stakeholders, we modelled the concerns (i.e., drivers), assessments and goals of each individual stakeholders. Then we combined the individual motivation models into a common motivation model for the supply chain, where similar motivation elements were merged. This was an iterative process during which the model elements and their relationship had been refined. The validated overall motivation diagram for key stakeholders is given in Figure 3. To avoid cluttering the diagram, only the drivers, assessments and goals for the two key stakeholders are shown (requirements are omitted). Moreover, abbreviations are used for model element types: Stakeholder (S), Driver (D), Assessment (A), Goal (G).

A fishing company in Norway works with wild fishing. It has one trawler with processing capacity on board. A fishing trip can take up to several weeks in the cold Arctic seas. The fish caught are slaughtered and filleted, then packaged in bags and stored in the freezer on board, before the trawler returns to land. Norwegian fish is a high-value product in the global market. The fishermen are proud of the wild fish they caught (e.g., white fish like Atlantic cod) in the clean, cold Arctic seas. They assume that by telling the story of their fishery and documenting the provenance of their fish, customers' trust in the authenticity of their fish will increase, therefore, their reputation can be enhanced and value can be added to their products. The company is also quite advanced in technology adoption and possesses a huge amount of operational and business-related data, and so is keen on the potential of big data analysis.

For the fishing company, two main drivers are defined: *D1 Big data analysis* and *D2 Storytelling*. Storytelling means to utilise traceability (D4), provenance (D7), transparency and accountability (D5) to guarantee an unbroken cold chain (D6). In addition, arguments for the value added are needed (A5). For example, proof of provenance (G7) is a mechanism for authentication and ensuring the high product price. Moreover, there is concern about the correctness of data (A2), e.g., the interviewee mentioned that non-Norwegian fish is mislabelled as Norwegian fish. Mechanisms are needed to prevent fraud and provide tamper-free data (G2). Furthermore, there is a lack of information about the events along the supply chain (A4), and it is difficult to identify whose responsibility and where the problem occurs in case of dispute (A3). This situation can be improved by adding sensors to collect more data (G4) and record all relevant events along the supply chain (G5).

A seafood batch processing company buys fish from several suppliers (e.g., different fishing companies) and mixes them into batches for further processing in its factories. The system requirements come from processes related to quality control, procurement and sustainability. The company's primary goal is to reduce risks (D3) through a good insight into its supply chain. The risks are associated with unpredictable quality and quantity of the fish from various suppliers (D10, D11), product authenticity (G10) and the compliance to regulations (D8). Currently, their risk rating is based on the long-term predictability of the raw materials. At the same time, they are enthusiastic about data-driven sustainability (D9). Sustainability is all about getting data - to track and measure things. They need all available information for sustainability reporting. However, it is both labour-intensive and difficult (i.e., accessibility) to collect the data needed for sustainability assessment and reporting (A7). They struggled with getting data and claimed that a barrier to the adoption of blockchain is to convince suppliers to share information. Furthermore, the company has an existing traceability system, which is mainly manual. Traceability is considered as a tool for risk assessment (e.g., in case a recall should happen, how big is the risk of a recall, how much should be recalled). Mixing fish from different suppliers into one batch is a challenge for traceability, as it is not possible to differentiate the sources upstream (i.e., traceability only possible at the batch level instead of individual fish level after the mix). The more the company mixes the batch, the higher risk in case of a recall. There is also concerns about the robustness of the system, e.g., if the source data can be trusted as the data quality may vary depending on the data provider (A2).

As seen from the motivation models, a shared driver for all involved stakeholders is *D4 Traceability* as the guarantee of a sustainable unbroken cold chain and the basis for quality control and food safety. In addition, several drivers, assessments and goals can be addressed by the benefits of blockchain as described in Section 2.2, e.g., D4 (Traceability), D5(Transparency and accountability), D3 (Risk reduction), D8 (Compliance to regulations), D7 (Provenance), G2 (Prevent fraud and provide tamper-free data), G8 (Improve targeted recall), G10 (Ensure product authenticity). A blockchain-based traceability system is thus identified as the target system that facilitates secure information sharing and tracking of assets. Easy access to any necessary information and documentation along the supply chain (G3) is a main goal for this system, and can be decomposed to detailed goals and requirements. In addition, a constraint of the target system is to not disrupt the current core business operations. A derived requirement is thus to design the blockchain application as a separate system covering the supply chain, integrating with existing enterprise systems to extract needed data. Furthermore, assessments of the current situation and challenges can act as bridges between drivers and goals. For instance, for traceability (D4), provenance (D7) is of the utmost importance, as it is a crucial basis for both establishing legal compliance of the catch (D8) and being able to perform targeted recalls (G8).

Figure 4 shows the strategy diagram illustrating how business goals are realised by the technical system through mapping to blockchain and other related technology (e.g., IoT, big data analysis). Abbreviations are used for model element types: Goal (G), Outcome (O), Resource (R), Capability (C), CourseOfAction (CA). For performance and scalability consideration, not all data will be stored on the blockchain. Only essential data and their hash will be stored on-chain, while detailed information for traceability will be stored on off-chain database. Therefore, the end-to-end traceability system consists of Blockchain network (R5), Off-chain database (R4) and Visualisation system (R6). Such a system is expected to provide trustworthy and more granular traceability (C5) and improve targeted recall (G8). In addition, the storytelling web visualisation integrated with more granular traceability is intended as a mechanism to enhance company reputation (O3). The strategy to achieve the main goals is implemented by the main actions of collecting and securely storing data (C4) for tracking the assets and associated important events in the supply chain. The traceability system will keep track of the asset status and events related to asset registration, transition (e.g., in transportation and storage) and handover (R1, R2, R3). Various types of sensor data are used as indicators for the product quality. The data also acts as the basis for big data analysis and prediction (G1), including sustainability analysis and for planning efficient and low carbon logistics. The Blockchain network facilitates secured data sharing across value chain (C6, O4), ensuring fraud prevention and tamper-proof data (G2), and easy access to all information along the supply chain (G3).

This modelling process facilitates necessary decision making. For example, various types of sensors will be used to document the cold chain, including temperature logs (C3) along the supply chain and tilt sensors (C2) to detect physical tampering during transportation. This affects the enterprise architectures and information systems as new sensors are deployed to collect data along the whole chain, e.g., along with pallets under transport, inside containers, at cold storages on the boat or in storage warehouses. An Internet of Things (IoT) network needs to be set up accordingly. In addition, statistical methods are applied to ensure trustworthy traceability, like Bayesian uncertainty quantification methods (C1).

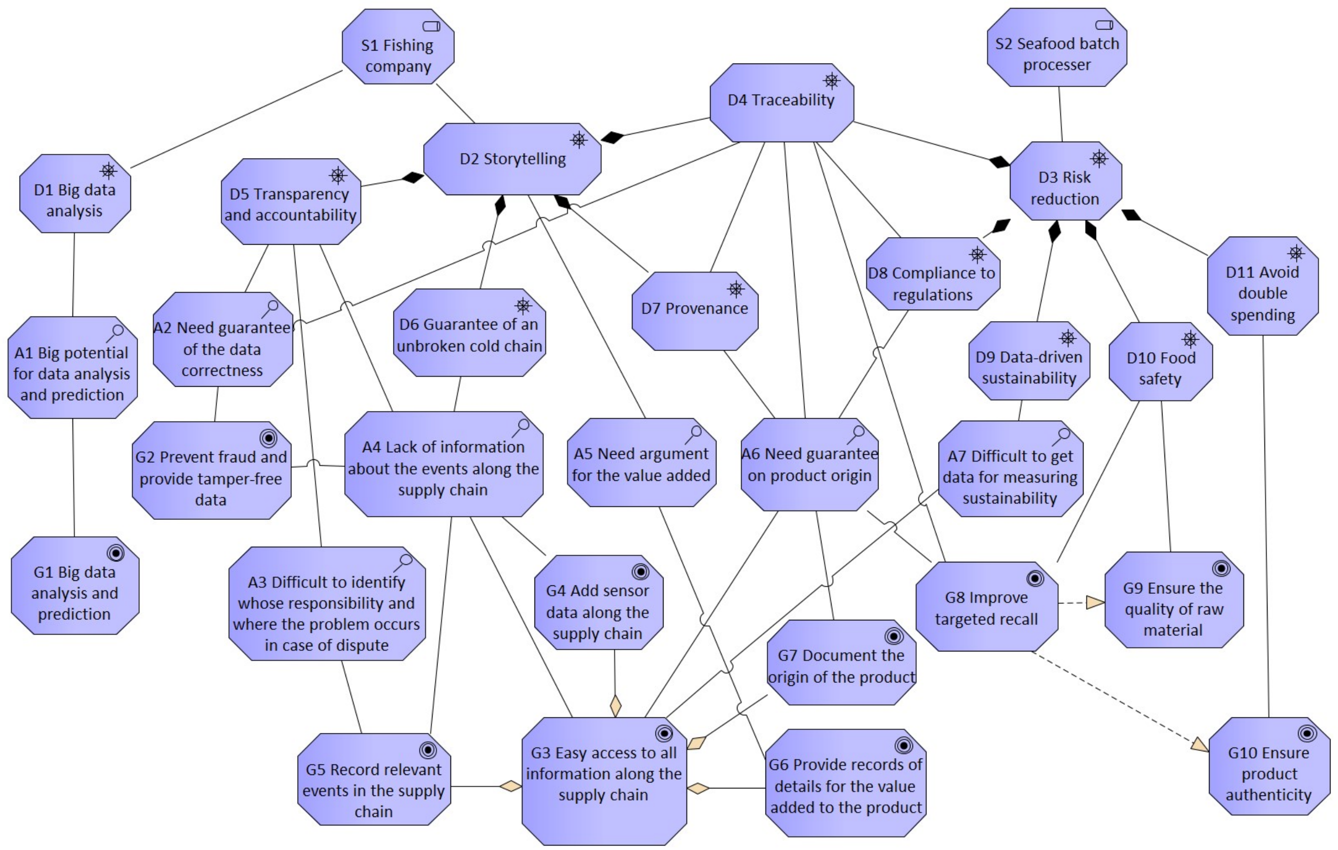

Figure 3: The overall motivation diagram for key stakeholders in the value chain.

4.2 Initial validations and lessons learned

Analysis of interviews and literature review led to first versions of motivation diagrams. We observed diverse business goals, illustrated in Section 4.1. The motivation models uncovered similarities and core values that blockchain technology can boost, like the need for transparency and traceability. In the refinement and validation steps, we prioritised properties of the system based on the feedback from stakeholders. The end-to-end traceability system for the supply chain was found to be essential for supporting the unbroken cold chain. Use cases for individual stakeholders with high value creation potential were also included, like communicating to the entire world through a storytelling website for the fishing company.

The validation process with stakeholders indicated that the initial diagrams facilitated communication between domain experts and technology developers, as well as the refinement of the goals, drivers and models. Using the diagrams, it was easy to discuss issues regarding what is missing, what should be changed, whether new aspects should be added and where new aspects can best fit. For example, feedback from the batch processing company consolidated some of their drivers under the umbrella term of "risk reduction," as well as adding the vision of "data-driven sustainability" as a new driver. Moreover, they were able to articulate concrete data to include into the system's dashboard.

Our experience is that it can be challenging to extract concerns, goals and outcomes from interviews. Especially constraints are difficult, because it possibly depends on both domain and technical knowledge to know what is and is not possible in a given setting for a given system. However, using knowledge obtained from literature review [10][11] alleviated some of these troubles.

Moreover, modelling and visualising the drivers, assessments and goals makes it easier to link business concerns and goals with the benefits provided by adoption of blockchain, thus helps identifying why and how blockchain can and should be utilised.

Finally, using motivation models to share the goals and concerns aids understanding requirements of the system and enhances the collaboration among stakeholders with diverse goals and priorities, e.g., to easily adjust their priorities and align their goals when they have the holistic view of the supply chain. The modelling also revealed that stakeholders share goals and drivers for applying blockchain for value co-creation.

5 RELATED WORK AND DISCUSSION

ArchiMate motivation models are used as a tool in the initial steps in model-driven development, e.g., in the big data applications context [22][25], and in understanding the emerging eMobility domain and its corresponding system requirements [17]. Based on experience from earlier work [17], we applied this approach to a new context:

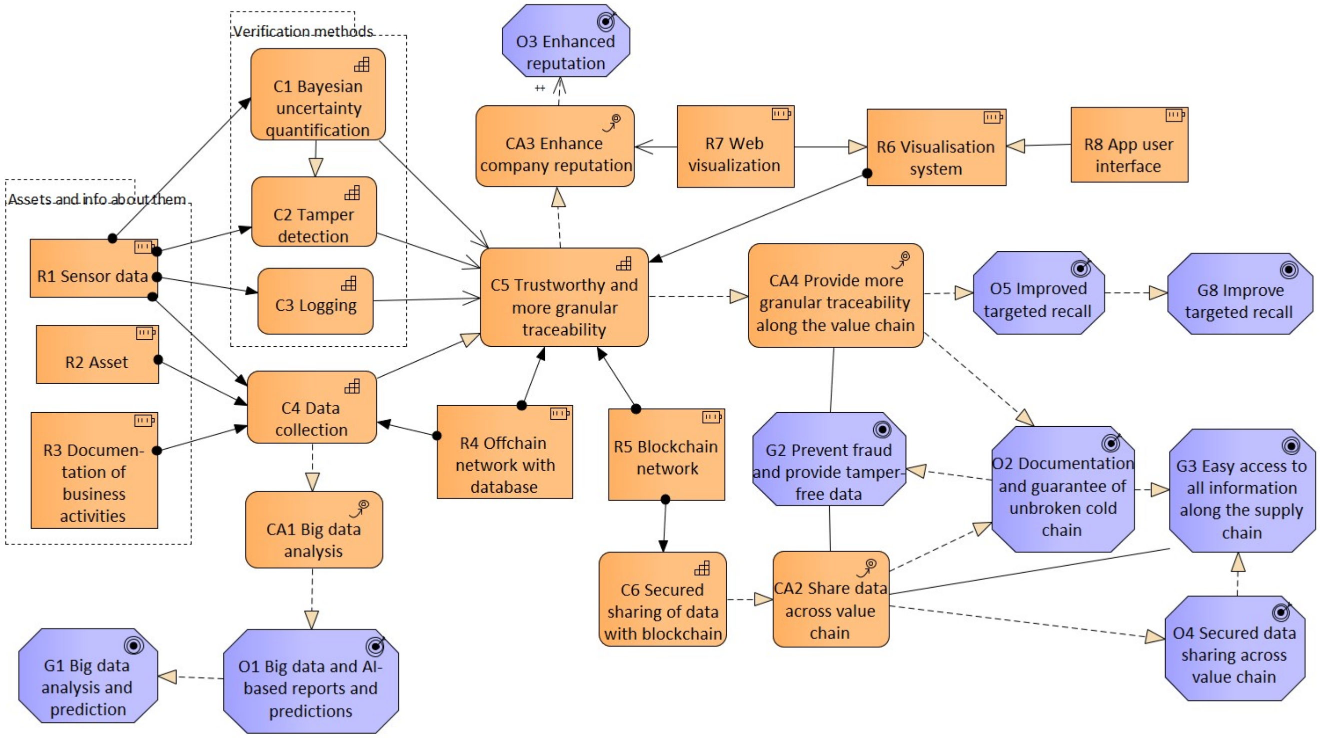

Figure 4: The ArchiMate strategy diagram.

using blockchain technology for value co-creation of a seafood supply chain. Our work confirmed observations from the earlier work [17][25]. For instance, motivation models are effective tools to find similarities across the value chain and between involved enterprise systems. The value co-creation process demonstrated that ArchiMate models are also a handy tool for change management, e.g., the shift of business goals can be propagated to detailed technical design models.

Our approach is similar to the work of Feltus et al. [3]. While Feltus et al. focus on ArchiMate value co-creation extension as a shared language supporting the communication among the IS designers (with IT-background), our work applied ArchiMate motivation models for the communication between business stakeholders (with non-IT background and no deep insight into technical aspects) and IS designers. The motivation concepts capturing the higher-level business goals proved to be suitable level of abstraction and common language for communication.

Blockchain is a disruptive technology with many potential benefits and impacts. ArchiMate modelling helps the identification of the most suitable blockchain application in the business context we studied. According to the value creation perspectives defined by [3], our work is in the perspective of the *method of value co-creation*; and the value co-created (*value-in-use*) is the end-to-end blockchain traceability system that utilises the blockchain benefits in the supply chain, interconnects the enterprise information systems and business processes to create an unbroken cold chain, and harmonises individual goals in the value chain.

Our approach falls into the category "enterprise modelling for blockchain applications" as listed in [5]. Many articles exist addressing the application of blockchain for supply chain traceability and describing related systems, such as [15][16][23], but very few discuss modelling a blockchain system at the high level of business goals or processes. To the best of our knowledge, we are not aware of similar work reporting work on applying ArchiMate motivation modelling for blockchain-based value co-creation.

The interviews and conversations we had so far were with stakeholders on the upstream side of the supply chain, i.e., until the fish is processed as finished products. Special concerns due to cultural and regulatory differences in different countries are not integrated in the current models, where only western stakeholders have been interviewed. This represents potential threat to validity to our result as differences in regulations, rules and culture may have implications to our models and set additional requirements to the system. We need further interviews to have a complete analysis of the whole supply chain. In addition, the models we presented in this paper were only evaluated informally through observation and conversation with stakeholders, which were rather objective impression based on verbal feedback from stakeholders. A more rigorous evaluation shall be performed to provide quantitative measures, e.g., through a user acceptance survey with likert scale, similar to the approach adopted in [17].

6 CONCLUSION AND FUTURE WORK

In this paper, we have demonstrated how ArchiMate motivation and strategy models help capture the business goals and identify requirements on a joint blockchain-based application that facilitates value co-creation in a global seafood supply chain. Blockchain is used to interconnect the information systems of the involved stakeholders and provide added value to the existing business processes, including support for a transparent and trustworthy seafood supply chain, and the potential for big data analysis and sustainability analysis and reporting.

We experienced ArchiMate as an effective tool for overcoming barriers of understanding the problems and requirements, as well as a tool for communication with users and facilitating the validation of the system requirements. The preliminary results from the design process have indicated the feasibility and value of applying ArchiMate motivation modelling in supporting understanding and strategic planning of the blockchain-enhanced supply chain as a whole. The use of the ArchiMate motivation and strategy models has helped stakeholders and system designers capture the big picture of the value chain and assisted in the understanding and identification of why and how blockchain can and should be utilised.

Furthermore, our experience indicate benefits of modelling (abstraction, prioritisation) for business stakeholders as well as the impact of models and enterprise modelling in practice. In particular, the modelling approach can increase people's capability to understand complex matters regarding the adoption of emerging technologies and the perception of "the models as the enterprise and what that means for the way they (inter)act" [6].

Further architectural and technical system design and modelling will be supplemented and aided by other types of models and viewpoints. Based on that and the work described in this article, a Minimal Viable Product (MVP) will be developed, and will serve as the validation of the design of the system. Future workshops are planned to evaluate the requirements and the prototype, as well as adherence to the stated business drivers and barriers.

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