MESG
MESTRADO EM ENGENHARIA
DE SERVIÇOS E GESTÃO

Using service design to foster consumer bargaining power and decentralised supply chain operations through a blockchain-based marketplace

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Master Thesis

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2019-09-24

“The present is theirs; the future,
for which I really worked, is mine.”
– Nikola Tesla

Abstract

This dissertation intends to explore innovative uses of blockchain technology in a decentralised marketplace context and design the specifications of the proposed DM by eliciting and understanding the needs of stakeholders in a B2B market context. As buyers, companies can aggregate and form purchasing cooperatives to gain more bargaining power. However, until now, consumers had few mechanisms to cooperate, leading to an imbalance in the buyer-seller relationship and a shift in the economic surplus to the seller.

The proposed DM should be able to aggregate orders, provide stamp offer auctions, allow shipping companies to integrate into the platform and provide a trustworthiness reputation system to platform users. These features are primarily intended to increase trust in the use of the platform while automating as much as possible all operational activities related to payments and fulfilment of the orders through blockchain technology and smart contracts.

We used the design science framework to conduct this research, since it is an appropriate methodology to develop technological solutions to solve relevant business problems. Multi-level service design approach was chosen to develop the service design and some of the artefacts of a decentralised marketplace using blockchain technology. The primary method of data collection was semi-structured interviews conducted with managers and supply chain experts used to deal with operations and procurement processes. Most of the interviewees acknowledged that the aggregation model is an attractive solution that would allow them to aggregate their purchase intentions and be able to negotiate better purchase conditions with suppliers.

Keywords: decentralised marketplaces, blockchain technology, smart contracts, reputation systems, buyer bargaining power.

Acknowledgements

I would like to thank all the help and guidance provided throughout this work by my thesis advisor, Prof. Mário Amorim Lopes, and also thank the whole project team for the valuable insights for completing this work.

A special thank you to all the interviewees who participated in the study for the disponibility and sharing their experience and insights about the project.

I would also to thank my friends for their companionship, especially the ones who spent more time with me in times like these.

I am very thankful to my family, in particular to my mom that is always guiding me, to my father for all my education as man, an to my three mothers for all the support during this journey.

Lastly, I wanna thank me for believing in me and for finish this work, I wanna thank me for never give up and always follow my dreams, I wanna thank me for giving more than I receive and I’m grateful to be alive in such exciting times.

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List of abbreviations

Abbreviation	Full name of term
SCM	Supply Chain Management
DM	Decentralized Marketplace
DLT	Distributed Ledger Technology
IPFS	Interplanetary File System
B2B	Business to Business
B2C	Business to Consumer
FPSB	First-price sealed-bid

1 Introduction

Information technologies and the technological revolution in general have played an increasingly important role in global supply chains and markets in the last decade, yet companies still rely on outdated Supply Chain Management systems, although they remain somewhat reliable to operate their businesses. However, in an increasingly technological and connected world, where supply chains span for multiple geographies and serve thousands of customers around the world, managing these supply chains has become an increasingly complex challenge and has forced the industry to look for new appropriate solutions to solve these problems (Abeyratne & Monfared, 2016; Baker & Steiner, 2015). In recent years, Operational Research methods have contributed significantly to studies in these fields, yet they are still unable to address problems resulting from operations governance, and that affects operations immensely (Korpela et al. 2017). Nowadays, most supply chains are still highly heterogeneous, with little integration of all stakeholders involved and have variable but generally minimal degrees of communication and trust between the actors. These problems can be improved by increasing transparency in the supply chain, namely in terms of provenance and traceability of goods (Abeyratne & Monfared, 2016; Badzar, 2016).

Blockchain technology has been shown to have substantial disruptive potential in supply chains by sharing information in a more secure and decentralised way. It also enables greater visibility and optimisation of all adjacent processes, as well as increased reliability among all stakeholders operating upstream and downstream the value chain (Weber et al., 2016). Noteworthy are the disruptive properties of using smart contracts to manage supply chain processes, enabling to optimise and automate management, financial and governance processes that combined with the immutability and cryptographic security of Blockchain technology, enable the development of more secure and efficient systems than those on the market. For instance, a client could purchase an item directly from the supplier and automatically transfer payments according to the position of the item along the supply chain and the terms agreed.

In the context of marketplaces, the proposed solution in this work allows more efficient and transparent management of all processes, dispensing a third-party for their management, being made in a decentralised way by smart contracts.

Blockchain technology could resolve many challenges of the supply chain industry, such as complicated record-keeping and tracking of products, as a less corruptible and better-automated alternative to centralised databases. Blockchains disintermediate processes and build a real smart economy backed by code and cryptography, enhancing traceability and visibility, improving demand forecasting and fraud prevention (Dujak & Sajter, 2019). Although blockchain technology and cryptocurrencies have received more visibility in the last few years, studies have highlighted that the real disruptive applications are still not commercially available and few organisations have progressed their blockchain solutions beyond the feasibility or prototype stage (Hughes et al., 2019; Litke, Anagnostopoulos, & Varvarigou, 2019).

1.1 Project Background

The work developed is part of Doublechain, a project between FEUP, INESC-TEC and Carnegie Mellon University, which aims to develop a functional prototype of an e-marketplace on top of a blockchain to support supply chain activities, in particular, procurement activities. The project is based on blockchain technology and seeks to create new digital marketplaces that require reconfiguration and readjustment of traditional practices and processes. Furthermore, the project aims to develop a platform on Ethereum's blockchain, with automatic rules of contract execution that can be used by any participant to signal their needs or bid on offers. Buyers can aggregate their orders, and suppliers may bid on the quantities sought, with contracts automatically triggering actions before and after order fulfilment. The fulfilment of these contracts allows the building of a trust/reputation network, as shown in Figure 1.

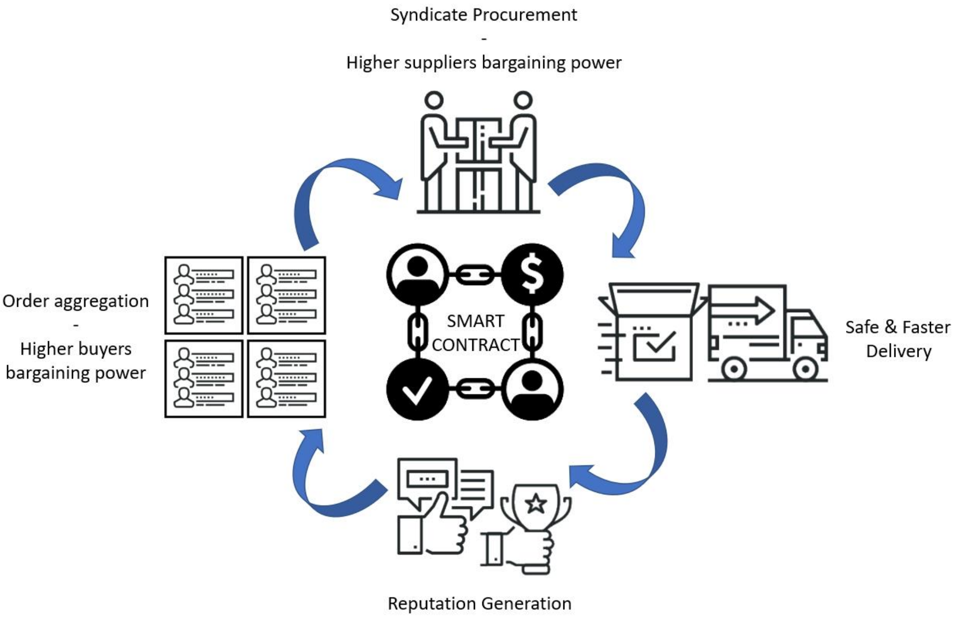

Figure 1 – Overview of the proposed DM

The use of smart contracts automatically enforces the agreed rules, and a distributed trust network (i.e., reputation system) is built on top of contract compliance to improve the market players' confidence. The aim is to extend typical buy and sell platforms exploiting the capabilities of the Blockchain, therefore introducing features once extremely hard to attain.

The most significant innovation of the platform is the ability to aggregate buyers on the platform, which although replicable by other marketplaces, allows platform buyers to get a product or service at a potentially lower price than market prices. In addition, the elimination of intermediaries results in a drastic reduction in the fees charged for each business compared to existing platforms, which could reflect in a potentially significant reduction in the final price of purchased products and services.

From another perspective, the DM platform also innovates by focusing on developing a decentralised marketplace based on customer-push market dynamics, thus reversing the dynamics of traditional marketplaces where suppliers list their products/services that buyers later bid or buy. In a customer-push model, the end customer plays a more active role in the purchasing process, first by signalling their intentions in a market maker logic and then by the suppliers trying to satisfy existing demand. This model, supported by its aggregation capacity, contributes even further to the increase in the bargaining power of consumers.

In previous research, it was hypothesised, supported by economic models (Anand & Aron, 2003; Chen et al. 2009), that implementation with purchase order aggregation characteristics will increase the bargaining power of buyers, resulting in a potential reduction in prices paid for the product or service. On the other hand, it is theorized that this model will provide an incentive to participate mainly for small- and medium-sized companies in medium/high margin markets, as they can sell large quantities of products/services directly without using other intermediaries(DeGraba, 2005; Deng, Jiang, & Li, 2018).

Summing up, this platform contrasts with widespread online markets in the Western world, such as Amazon and eBay, for the ability to aggregate purchase orders and use blockchain technology to automate all established rules for the fulfilment, with minimisation of intermediaries, increased transparency and reliability, and with a high guarantee of immutability. The distinguishing factor of other platforms, including those popular on the Asian continent that already allow aggregation, is the customer-push component, where the customer himself specifies what he wants, not the reverse.

1.2 Research Objectives and Questions

This dissertation intends to explore innovative uses of blockchain technology in a decentralised marketplace context and design the specifications of the proposed DM by eliciting and understanding the needs of stakeholders in a B2B market context. To conduct this research we applied the design science framework (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007; Von Alan, March, Park, & Ram, 2004), since it is appropriate for developing technological solutions to solve relevant business problems. Multi-level service design approach (Patrício et al. 2011) was also chosen to develop the service design and some of the artefacts of a decentralised marketplace using blockchain technology. The core artefacts of this work are the design of a new decentralised marketplace based on blockchain technology and all the related diagrams that can assist the development team and different stakeholders in validating the functional requirements of the platform, such as constructs and system models, like service system maps, service blueprints and other relevant diagrams.

The research questions are the objects of the scientific study and serve as a vehicle for evaluating the appropriateness of the chosen technology and architecture of the proposed DM. This research objectives results in the following research questions:

Are stakeholders willing to aggregate their purchases intentions?

Are suppliers willing to join other suppliers and fulfil orders together?

What are the main criteria to evaluate suppliers performance in the DM context?

To answer these questions we conducted semi-structured interviews (Appendix C) with some stakeholders to collect data and applied Service Design concepts in order to better understand the actual necessities of customers. The methodology adopted is later discussed and explained in Chapter 4.

1.3 Thesis outline

This dissertation is structured in 6 chapters. Chapter 2 overviews the state-of-the-art in blockchain technology and other relevant blockchain projects, points out the challenges that can exist when implementing such a solution and its integration with the SCM industry and decentralised marketplaces. It also examines the importance of the reputation and feedback systems on the context of this type of marketplaces. Chapter 3 introduces the challenges associated with this work context and introduces the challenges associated with the proposed decentralized marketplace and reputation & feedback systems. In Chapter 4 we present in detail the methodology adopted in the development of the dissertation and the resulting artefacts. Chapter 5 analyzes the data gathered in the semi-structured interviews in order to design the system artefacts (service system maps, context diagrams, sequence diagrams, among others). Chapter 6 details the platform's operational and design options along with an overview of the smart contract architecture of the proposed DM. Chapter 7 wraps up the dissertation with an examination of the accomplished work and its shortcomings and presents the conclusions.

2 Theoretical Background

This chapter gives a background on the blockchain technology, its advantages and limitations, as well as high-level descriptions of how smart contracts work. Further analysis of implemented projects using this technology is also made to provide a clear view of the different possibilities of implementation frameworks and their relevance in supply chain management. A definition of supply chain management and decentralised marketplaces is also given, together with a brief overview of the state-of-the-art of blockchain technology and reputation systems applied in the context of this work.

2.1 Blockchain Technology

The first Blockchain technology reference appeared during 2008 financial crisis when an unknown person or entity called Satoshi Nakamoto proposed a system for electronic transactions without relying on trust using cryptography and other underlining concepts (Nakamoto 2008). Often confused with Bitcoin, who has published in Nakamoto whitepaper as a decentralised peer-to-peer payment system that prevented the double-spending problem, Blockchain is the technology behind, not the product. Some of the concepts behind this novel technology are not totally new, such as distributed file systems proposed by Levy and Silberschatz (1990), or the concept of a chain of blocks secured through cryptography already proposed in 1991 by Haber and Stornetta (1991). As described by Xu et al. (2018), blockchain technology is a trustless distributed data structure of an ordered list of blocks that contains a list of transactions, and every block is linked to the previous one as described by a hash, a pointer referencing the previous block, as shown in Figure 2.

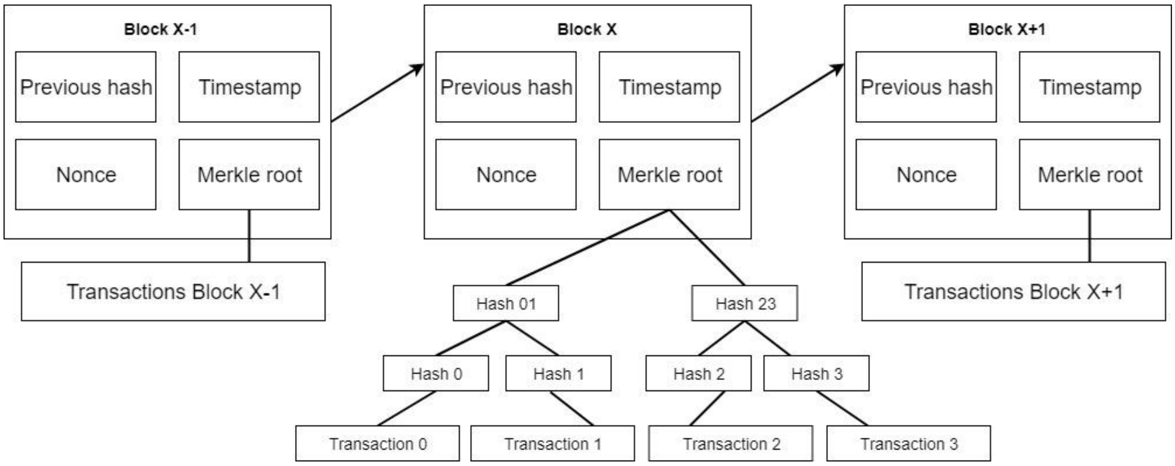

Figure 2 – Hashing process in the Bitcoin Blockchain. Adapted from Nakamoto (2008)

The key characteristics of the blockchain technology allow peer-to-peer network based communication, decentralised and chronically recorded distributed ledger, immutable and tamper-proof records and elimination of intermediaries (Erdenebold et al. 2019). Often Blockchain technology and Distributed Ledger Technology (DLT) are used interchangeably. According to Swan (2017), DLT is the general form of the technology, where a shared database is updated by consensus and records timestamped data with unique cryptographic signatures, leading to a secure, auditable history of transactions. On the other hand, a blockchain is a specific form of the technology with additional technical details, adding the sequential update of the database through blocks of data secured cryptographically with hashes which links the blocks together. Overall, there are three separate types of blockchains as described by Buterin (2015): public, private, and federated/consortium (permissioned).

- A public blockchain is open to everyone and is generally considered to be “fully decentralised”. In this type of blockchains, anyone can read, make transactions, have their transactions included on (if valid), and anyone can participate in the consensus process to add new blocks. The first example of a public blockchain is Bitcoin (Nakamoto, 2008).
- A federated/consortium blockchain is controlled by a consortium of organisations or individuals and is often considered “partially decentralised”. In this type of blockchains, can be restricted the right to read and to send transactions. As an example, we could have a consortium of 10 financial institutions, each of which operates a node and of which half of them must sign every block in order for the block to be valid.
- A private blockchain is a closed system and is similar to a traditional database but with the setup of a blockchain. An individual or enterprise own this type of blockchains.

While Buterin (2015) used the terms public and private, Xu et al. (2018) use the terms permission and permissionless. Permission will mean what an actor is allowed to do on the blockchain. A public, or open, blockchain will mean one that is accessible to all and the opposite is then a private blockchain that only certain actor can use. Different setups have different characteristics, and this thesis focuses on the permissionless blockchain.

2.2 Ethereum and Smart contracts

Similar to Bitcoin, Ethereum is a public blockchain network where users can transfer data using a cryptocurrency named Ether. In addition to trading cryptocurrencies, Etherum (and other similar blockchains) also allow the creation of smart contracts. Buterin (2014) defines smart contracts in his whitepaper as “systems which automatically move digital assets according to arbitrary pre-specified rules.” Smart contracts have the potential to decentralise many of the processes that industries rely on today and improve on many existing business solutions. Often they are used to transfer funds from one place to another if some criteria are fulfilled, without the need of a middleman. A typical example of a smart contract-enabled service is escrow, which can hold funds until the pre-specified rules in the smart contract have been fulfilled.

Ethereum uses its own programming language, Solidity, to code smart contracts, which leads to some precautions while deploying them in the network since they are not flawless. In 2016, a bug in the code of a smart contract let a group of hackers steal US$ 60M from that contract, in an episode known as DAO attack (Siegel, 2016). This lead to a hard fork of the Ethereum blockchain, with a majority of miners voting to revert the chain to its state before the attack.

Every single operation that takes part in the Ethereum network, be it creating contracts, making message calls, utilising and accessing account storage and executing operations on the virtual machine takes some amount of gas. Gas is a unit that measures the amount of computational effort that it will take to execute certain operations and is used to calculate the number of fees that need to be paid to the network in order to execute an operation (Wood, 2017).

Smart contracts can also be used for issuing digital tokens on top of the blockchain, ERC-20 standard in Ethereum network, allowing the tokenisation of an asset and the creation of new decentralised projects (Vogelsteller & Buterin, 2015). These tokens represent an asset on the blockchain, and the market itself sets their price.

Another use of smart contracts is the decentralised applications (Dapps) that can also implement a token (Raval 2016, pp. 3-7). Dapps do not have a single point of failure since there is no server to take down. Data is decentralised in a Dapp across all of its nodes.

Xu et al. (2019, pp. 18) address the issue that smart contracts can usually only examine state that is stored on the blockchain ledger but cannot access information in the external world. Since inputs from the real world are needed, oracles are often invoked to bring external state into the smart contracts on the blockchain. Another issue is the gas costs to store data on the blockchain, and they suggest users to minimise the amount of data they store on-chain. A common practice is to store hashed data, metadata, and some small-sized public data on-chain and to keep large or private data off-chain. Solutions such as the Interplanetary File System (IPFS) are listed as alternatives to store data off-chain.

2.3 Examples of smart contracts platforms

The following list is not exhaustive, as there is a growing number of blockchain platforms available that if explored in their full extent and applicabilities, would heavily expand the scope of this thesis. Nevertheless, it is given a particular focus to platforms that allow the use and development of smart contracts.

Hyperledger Fabric

Hyperledger Fabric is a permissioned blockchain infrastructure, co-developed by the Linux Foundation and IBM, that facilitates the execution of smart contracts in their platform. The platform is designed to provide a framework with which enterprises can put together their own individual blockchain network. Hyperledger is deemed to be a reasonable choice for enterprises who wish to create smart contracts, but need to comply with data protection laws that require them to be know (Davies, 2018). Hyperledger does not have its own token system, limiting the kind of smart contracts that can be deployed in the platform.

Quorum

Quorum is an open-source permissioned Ethereum fork. The objective of Quorum, according to JP Morgan Chase, is to make as little modifications as possible to the Ethereum Go client and to allow for more effortless synchronisation with future versions (Hacket, 2016). It functions very similarly to Ethereum, but with some distinctions providing permissioned network, private transactions, high speed and high throughput.

Stellar

The Stellar Network is a decentralised blockchain platform built to enable high-speed, low-cost cross border transactions and also supports a limited smart contract functionality. Stellar is more straightforward and easier to use than other networks, and it is designed to facilitate simple smart contracts, outperforming Ethereum both in terms of speed and security (Baliga, 2017). However, if the plan is to develop more sophisticated smart contracts for Dapps, for example, it may not be an adequate choice.

EOS

EOS is a smart contract platform that facilitates the development of Dapps by providing an operating-system-like set of functions and services for developers. It focuses on developer experience and cheap transactions, actually charging no transaction fees. It is probably one of the strongest competitors to Ethereum. (Rosic, 2018)

Cardano

Cardano is a decentralised public blockchain project that claims to develop a smart contract platform which seeks to deliver more advanced features than other any protocol previously developed", as stated on their website (Cardano, 2019). It is based on scientific research, peer-review and academic validation of its technology. Its transaction throughput is on par with Ethereum.

NEO

NEO is often called the "Chinese Ethereum", and is a smart contract project that uses blockchain technology and digital identity to digitise assets, automate the management of digital assets and to realise a "smart economy" with a distributed network by providing smart contract-powered decentralised services and applications. (Rosic, 2018). NEO smart contract platform has all the advantages of an Ethereum Virtual Machine, without crippling their developers with programming language barriers.

Table 1 summarises and compares the Blockchain platforms described before and some of its characteristics.

Platform	Blockchain			Smart Contracts Language
	Type	Blocktime	Transactions per second (TPS)	
Ethereum	Public	15 s	15-20	Solidity
Hyperledger Fabric	Private	n.d.	>1000	Go, Java, Javascript
Quorum	Private	n.d.	100-150	Solidity
Stellar	Public	5 s	1000	Various Languages
EOS	Public/Private	0,5 s	<5000	C++, C
Cardano	Public	20 s	5-10	Solidity, Plutus
NEO	Public	15 s	<10000	Various Languages

Table 1 – Smart Contracts Platforms Comparison (Blockdata, 2019)

2.4 Blockchain use cases in SCM

LeMay et al. (2017) define SCM as "the design and coordination of a network through which organisations and individuals get, use, deliver, and dispose of material goods; acquire and distribute services; and make their offerings available to markets, customers, and clients." Blockchain technology has tested successfully in different industries in the last few years, such as finance or energy. Some solutions have been proposed for supply chain management in a theoretical manner, but only a few are starting to have significant results in a real-world context.

Provenance aims to provide every physical product with a digital passport, which could prove that a product was what it claimed to be and had the origin it claimed. It tried to solve the problem of selling fake goods, fraudulent use of certifications and provide transparency. Stakeholders handling the goods through the supply chain could then log the actions taken on the goods through an app, be it some production process or certification (Project Provenance Ltd., 2015). In 2016, a pilot project was conducted in Indonesia to enable the traceability in the fishing industry. By using mobile phones, blockchain and smart tagging, Provenance successfully tracked fish caught by fishermen (Hannam, 2016).

ShipChain, (2018) is a fully integrated logistic ecosystem using a permissioned Ethereum side-chain to track a product from the moment it leaves the factory, to the final delivery on customer's doorstep. The project aimed to combat fraud and reduce losses in the shipping industry. When a shipment order is launched, automatically is initiated a smart contract. Waypoints were recorded then in the smart contract, and when finally delivered the contract would be completed. The use of smart contracts defines how to handle disputes, and reduce detention costs, waiting cost of employees, and chargebacks with receivers.

Maersk, one of the world shipping companies, also successfully tested the use of blockchain applications in international logistics. TradeLens is an open and neutral platform jointly developed by Maersk and IBM, helping users to gain a comprehensive view of their data and collaborate as cargo moves around the world, helping to create a transparent, secure, immutable record of transactions in order to foster greater collaboration and trust across the global supply chain (Maersk, 2019). The solution is based on the Linux Foundation's open-source Hyperledger Fabric.

Bext360 is an organisation focused on developing technologies to improve social sustainability in supply chains (Knapp, 2018). Their Software-as-a-Service (SaaS) platform uses Stellar blockchain to record timestamps and value of transactions on a real-time basis, providing a traceable fingerprint from producers to consumers. It creates records of the origin of products such as coffee, seafood, timber, minerals, cotton and palm oil to provide unsurpassed blockchain traceability and quantifiable measurements for sustainability. Once entered into the system, these physical assets are instantly represented as tokens and stored in the blockchain to facilitate payments, yield smart contracts and track assets through the supply chain. The platform uses machine vision and artificial intelligence to ensure proof of origin, quality analysis and sorting—beginning at collection. Stellar's application ensures secure and transparent payments directly to the farmers when their products are evaluated and sold (Verhoeven et al. 2018).

SUKU (2019) is a blockchain-based trading platform that aims to make supply chains more transparent, efficient, and accessible. It intends to offer a supply-chain-as-a-service platform that allows frictionless transactions between all participants, including manufacturers, suppliers, distributors, retailers, and consumers. The SUKU platform is composed of public Ethereum and permissioned Quorum. This means that each node on the network consists of a permission Quorum blockchain node and a public Ethereum blockchain node.

2.5 Decentralised marketplaces and reputation systems

So far, only a few solutions have been developed specifically to target decentralised marketplaces. According to van IJzendoorn (2017), one of the principal characteristics of a decentralised market is the inexistence of intermediate parties. Major electronic commerce marketplaces, such as eBay and Amazon, operate in centralised configurations, providing a single point of failure for hackers, and weak privacy guarantees for users maintain the confidentiality of their information or in managing their reputation systems. Nevertheless, academia has started introducing some formal models for decentralised marketplaces. Soska et al. (2016) use Distributed Ledger Technology (DLT) to implement a decentralised anonymous marketplace, displaying a design resistant to Sybil attacks (an attacker gets multiple identities to create unreal transactions). In the last years, some decentralised marketplaces were developed, such as BitBay and Particl, but none of these platforms provides a group buying option, which is a non-trivial feature in the context of decentralised marketplaces.

A growing need for reputation systems has naturally emerged, accompaning the growth of such marketplace models as more people and services interact online. Today, despite the many solutions that come from academia and the real world, each reputation implementation have its problems. A widely used solution is the implementation of reputation systems that rank users according to their trustworthiness (Gefen, 2000; Einav et al. 2016;). Electronic markets such as eBay and Amazon provide systems that allow sellers and buyers to rate each other, allowing the other marketplace actors to analyse the seller’s reputation before making a purchase. In this case, eBay allows users to leave positive, neutral or negative feedback about the transaction, and rate also other order parameters (e.g. accuracy, shipping time), while Amazon allows its registered users to write reviews on products and rank them using a 5-star scale (Liu & Munro, 2012).

Nevertheless, these companies use centralised systems, and they have the control of the rating platform. For this reason, several researchers studied and proposed new reputation models, mainly in P2P networks. ReGret was designed as a reputation system oriented to e-commerce environments and incorporates multiple contextual attributes and classifying information analysis as coming from an individual, social, or ontological dimension, to increase the reliability of the calculated reputation (Sabater & Sierra, 2001). Chang et al. (2014) rely on trust and reputation to filter unfair feedback and assess supplier reliability through a multi-criteria decision-making framework. Dennis & Owen (2015) proposed a reputation system based on blockchain technology and applicable to multiple networks. Their system quantifies reputation in P2P networks by removing the human opinion from the transactions, and storing a single dimension reputation value (i.e., 0 for not completed or 1 for transaction completed). Valls et al. (2016) introduce a privacy-preserving reputation system where ratings are anonymous but reliable since all the ratings are signed only by users that used the service before. Furthermore, the system rewards good raters and users can receive special status on the platform.

3 Problem Characterization

Following the previous literature review, it is possible to ascertain the importance of the role of blockchain technology and smart contracts in the SCM and operations context. This chapter describes the problem in this work context and introduces the challenges associated with the proposed decentralized marketplace and reputation & feedback systems.

As previously stated, this work intends to design and specification of a decentralised marketplace by eliciting and understanding the needs of stakeholders in a B2B market context. Furthermore, this work arises based on previous works undertaken by the project team and during the team meetings. Until now, consumers had few mechanisms to cooperate, leading to an imbalance in the buyer-seller relationship and a shift in the economic surplus to the suppliers. The main objective identified for the development of the proposed DM was intending to promote the increased bargaining power of buyers, enabling them to aggregate their purchase proposals and potentially reducing prices of products purchased through this platform in comparison to other marketplaces already in the market.

This work also intends to assist the development team in making the right decisions and meeting the needs of the potential users of the platform. In this context, were collected the system requirements and the main features of the proposed DM.

3.1 Properties of the decentralised marketplace

The proposed DM should be able to aggregate orders, provide a seal-bid auction system, integrate with shipping companies, provide a decentralised user feedback system to increase trustworthiness between actors and fully automate all operational activities related to payment, fulfilment and order delivery, and to explore the implementation of the blockchain technology in a DM context. As mentioned in the literature review, order aggregation characteristics may increase buyers' bargaining power, resulting in a possible reduction in prices paid for the product or service. In addition, the elimination of intermediaries can result in a drastic reduction in the fees charged for each business compared to existing platforms. On the vendor side, this model can encourage small and medium enterprises to participate in medium / high margin markets as they can sell large quantities of products/services directly, without the need for other intermediaries. However, it is still necessary to understand better the consumers' predisposition to the aggregation model envisioned for the platform and to define what parameters to apply in the feedback system in order to develop a fair reputation system for all stakeholders in the platform.

The underlying blockchain technology should have as few barriers to entry as possible and should preferably be a system in which anyone can participate. Moreover, information inputs for transactions may come from many different sources and in different formats. Given the heterogeneity of this information, it is necessary to provide self-sustaining means to reach consensus on a single, highly reliable source. Thus, it should be possible to verify these transactions, even if their inputs are unknown, in order to ensure transparency and auditing of all DM processes.

In short, the proposed DM should have control over the supply chain operations, from product origin to end consumer. It should also record all product, service, finance and information flows between actors in a decentralised manner, triggering actions automatically according to predefined conditions in smart contracts and reducing entropy in all interactions along the supply chain.

3.2 Reputation and Feedback Systems

One of the direct implications of the inexistence of intermediaries in a DM context is the subsequent need for a trust system capable of ensuring peer reliability. As discussed in the literature, this may pose a problem regarding potential security and resilience issues against the use of strategies to deceive or manipulate the platform (Lucking-Reiley & Spulber, 2001; Wigand, 1997). Hereupon, the proposed DM should be able to resist manipulation and collusion attacks by malicious participants, such as bad-mouthing attacks (e.g., participants colluding to force negative feedback on a third party), ballot-stuffing attacks (e.g., participants voting more than once to manipulate reputation scores), or whitewashing attacks (e.g., participants re-joining the system with a new identity resetting a poor reputation) (Schaub et al. 2016).

The reputation system aims to reduce the effects of asymmetric information between buyers and suppliers by rewarding the users who comply with agreed terms and punish the fraudulent agents. In order to generate reputation scores, it is crucial to define a method to compute the reputation and its attributes. Furthermore, the reputation system of the DM should be mainly oriented to suppliers evaluation as buyers have less interest in acting fraudulently.

In order to address the challenges identified concerning the proposed DM, as well as the design and the specifications of the platform, in the next chapter, the adopted methodology is further explained.

4 Methodology

This chapter contains the research methodology adopted in this study, as well as the methods used in data collection and service design. It also contains the research model, which is used to create structured, logical stages together with their input, throughput, and output throughout the research process.

Due to the novelty and explorative nature of this project, the Design Science Research (DSR) Framework (Hevner et al., 2004.; Peffers et al. 2007) will be used to conduct the research, aiming contributions both to the project context and to research. This research methodology focuses on understanding organisational phenomena in context, and develop solutions in the form of artefacts that solve identified business needs.

Subsequently, the proposed solution must be iteratively developed and validated by the selected stakeholders and the project team. The developed solutions are later added to the knowledge base and serve as a basis for future research, but also could be used practically in similar business contexts. Hevner et al. (2004) defined seven guidelines to conduct IS research that are used to conduct this study and set in the design science framework, as shown in Figure 3.

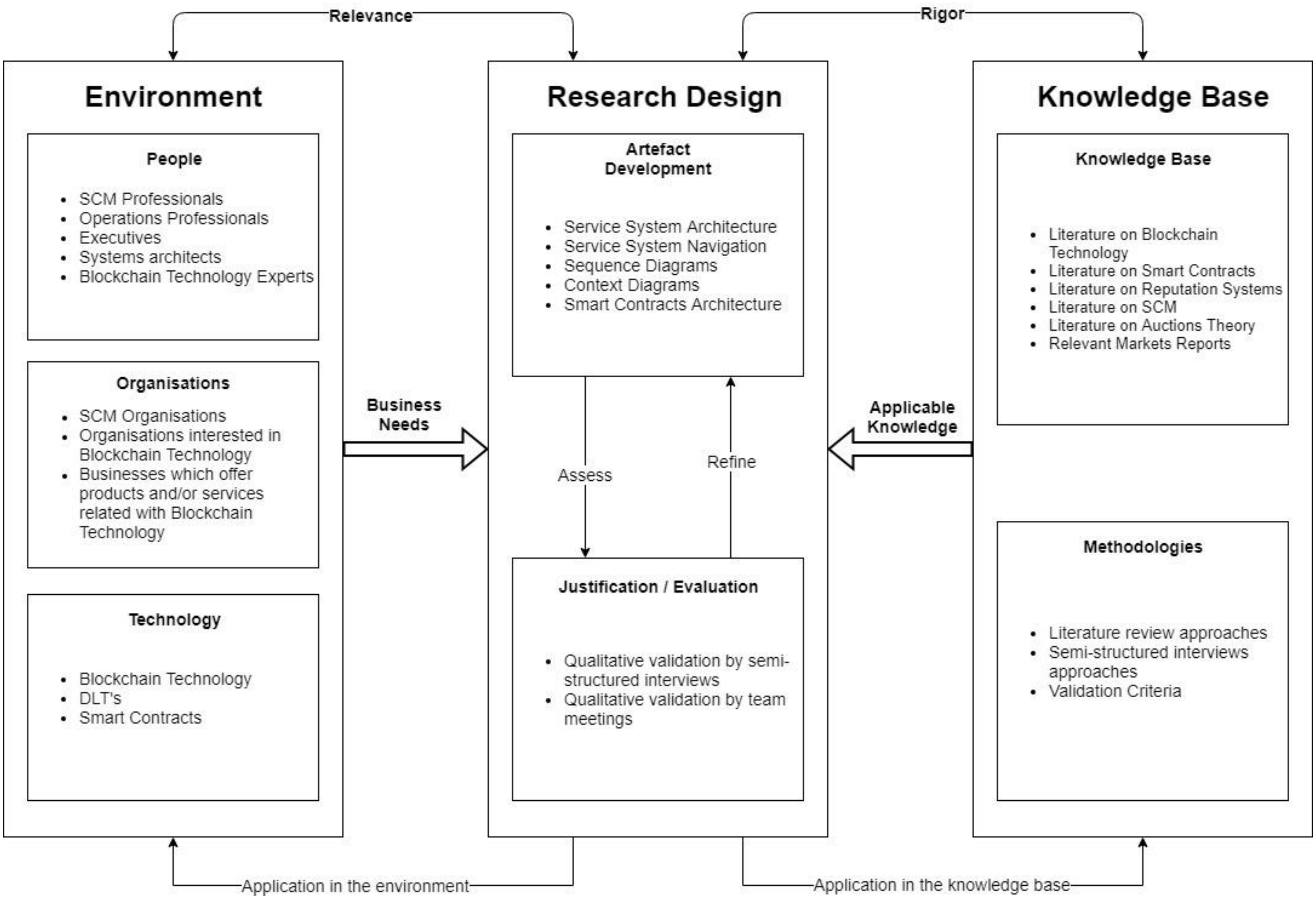

Figure 3 – Research design science framework (Hevner et al. 2004)

4.1 Research Design Method

The aspect of iteration plays a significant role when applying design science research (Peffers et al., 2007; Von Alan et al., 2004). A problem-centred approach is the best fit in this research context since the idea for the research results from the observation of the problem by researchers and businesses within this work domains. As the research design science framework shows in Figure 3, the study goes through several stages. The stages processed in this work are depicted from the Peffers et al. (2007) design science cycle shown in Figure 4 and include the activities: Definition of Objectives, Design and development, Demonstration, Evaluation and Communication.

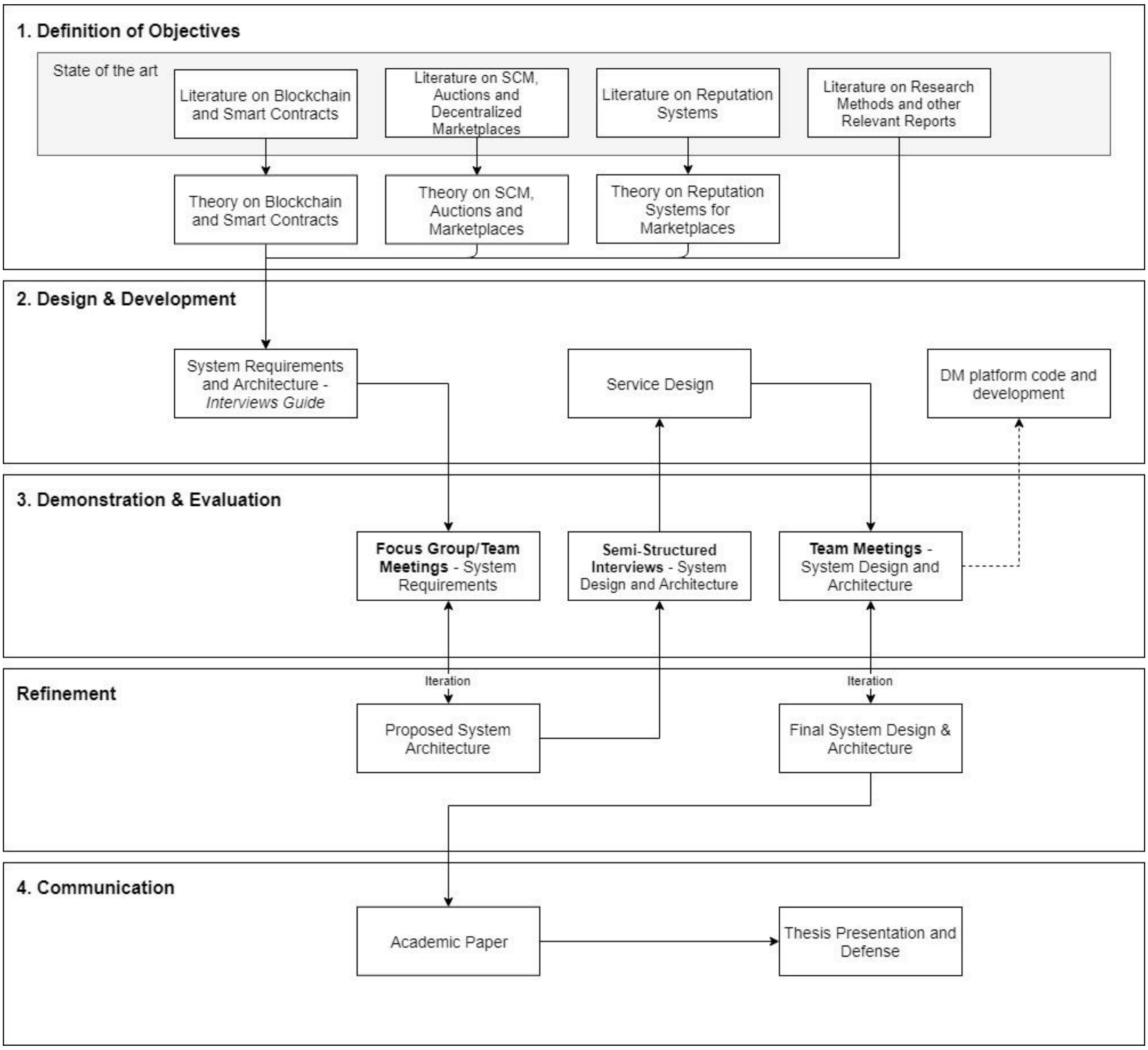

Figure 4 – Research and development model

After identifying the problem and motivation, it is essential to define the performance objectives for the solution and the system requirements. The research started with the literature review stage, aiming to gather existing knowledge from the available scientific knowledge base. The literature review phase also aims to identify possible gaps in current research. The results of the state-of-the-art overview, as well the elicited requirements gathered during the team meetings, were used to support the construction of the interviews script and design the system artefacts. As already stated, the core artefacts of this work are the design of a new decentralised marketplace based on blockchain technology and all the related diagrams that can assist the development team, such as constructs and system models, like service system maps, service blueprints and other relevant diagrams.

The design and development stage will gather the theoretical results, derived from the previous stage, to assist in the collection of the system requirements and assist in the development of the system architecture artefacts of the decentralised marketplace. To design the artefacts of the proposed DM were used concepts of the Multi-Level Service Design approach, namely the service system and the service encounter (Patrício et al., 2011).

The data collected from the semi-structured interviews was then analysed and validated during team meetings. This data was then used to answer the previously defined research questions. The outcome is a final version of the system architecture and main design characteristics of the decentralised marketplace.

In the evaluation stage, is validated the system architecture developed in the previous stages. This validation occurs in the development stage due to the creation of artefacts, which are used in the creation of other system artefacts as algorithms and prototypes. The artefacts are validated with the information that resulted from the semi-structured interviews to the stakeholders. Semi-structured interviews are preferred for this study because it creates the possibility to gather non-conventional information and real-world problems descriptions that are not identified already. The team meetings focused on validating the correctness of the different developed artefacts for the decentralised marketplace, their applicability and the system architecture and elements as a whole.

In the last phase, are disseminated the problem and the importance of the problem to the scientific community and general audience, as well as the artefacts and utility and novelty of the proposed solution. The design and effectiveness of the developed artefacts are presented by means of an academic paper and dissertation presentation to a jury, researchers and other relevant audiences.

4.2 Data Collection

During the data collection phase, it was necessary to understand the current service process from the potential customers' point of view in order to get a deeper understanding of their experience, attitudes, problems and needs. Qualitative research was seen as an appropriate approach to acquire this type of information. The primary method of data collection was semi-structured interviews conducted with managers and supply chain experts used to deal with operations and procurement processes. It is important to note that they were not necessarily blockchain experts, given the emerging nature of the technology, but they did need to be able to understand its technological attributes and to contextualise its potential use in supply chains and operations management. In total, were conducted six interviews with managers and supply chain experts (Table 2).

ID	Industry	Organisational role	Location
A	Construction	Project Manager	Denmark
B	Construction Services	Co-founder/Architect	Portugal
C	Chemical industry	Sales Account Manager	Portugal
D	Industrial automation services	Sales and Marketing Director	Portugal
E	Retail (B2B)	Key Account Manager	Portugal
F	Retail (B2C)	Category Manager	Portugal

Table 2 – Summary of interviewees

The purpose of the interviews in the present study was to get a better understanding of what functionalities of the platform could be more attractive to the customers/stakeholders, mostly in a B2B context. The average interview took 20 minutes and were conducted over phone calls and Skype according to convenience and geographical constraints. The interview questions were divided thematically into three main parts, but the structure of the interviews was maintained flexible. (Appendix C)

The first part is focused on demand aggregation, to study the propensity of each stakeholder to participate in bulk buying initiatives both from the buyers and sellers perspective. It aims to answer the research question "Are stakeholders willing to aggregate their purchases intentions?"

The second part is focused on understanding their availability to team up with other suppliers and fulfil more and larger orders. This part aims to answer the research question, "Are suppliers willing to join other suppliers and fulfil orders together?"

The third part and final part was devised to examine the most important KPIs to evaluate the suppliers' performance in order to develop the decentralised reputation system. The last part aims to answer to the last research question, "What are the main criteria to evaluate suppliers performance in the DM context?"

4.3 Analysis of the interviews

All interviews were recorded and transcribed for analysis. The transcripts were managed and analysed using the NVivo10 software for qualitative data analysis. All transcribed interviews were carefully read and coded (Figure 5). Coding is one of the fundamental approaches to qualitative data analysis, helping researchers to organise and categorise data, thus setting the stage for further analysis. These codes are labels that assign meaning to the data collected during the research (Miles et al. 2014).

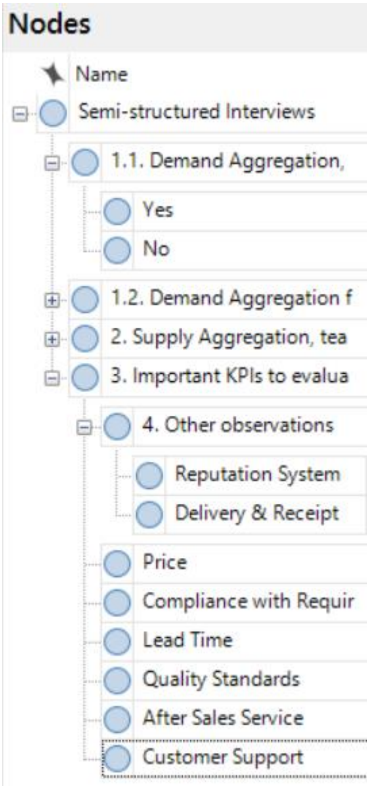

Figure 5 – Code hierarchy example

5 Results and Findings

In this chapter, the data gathered during interviews is analysed in order to validate the system requirements gathered in the previous stages, and later support the design of the system artefacts such as service system maps, context diagrams and other relevant system models. After validated with the selected stakeholders, these artefacts are then used to guide the development team in implementing functional and non-functional requirements of the proposed DM

5.1 Mapping stakeholder feedback into functionalities

As stated before, this work arises based on previous works undertaken by the project team and during the team meetings.

Moreover, it is necessary to validate the gathered system requirements and functionalities with the selected stakeholders. The main scope of this semi-structured interviews is to understand the consumers' predisposition to the different aggregate models envisioned in the platform and to obtain accurate data on the evaluation of suppliers to assist the development team in the development of the proposed DM. The main research questions are answered with the use of the following sub-questions:

5.1.1 Demand Aggregation (Buyer Side)

Q1: As a buyer, would you be interested in a solution that would allow you to aggregate your purchase intentions in order to obtain better negotiate conditions?

Most of the interviewees (5 of 6) acknowledged that it is interesting a solution that would allow them to aggregate their purchase intentions and be able to negotiate better purchase conditions with suppliers. Only the interviewee B answer that would be not interested, since in engineering projects where is necessary to subcontract other services there is a powerful notion of responsibility associated to the projects and higher control over the contracted services is essential. However, some interviewees alerted for the fact that this model is more indicated for standardised products, since the more technical the product, the more complex will be the acceptance conditions and personalised specifications. It is essential to keep in mind the different payment times and receiving conditions, being necessary to define well who will make the acceptance of the products. One interviewee noted:

"The direct answer is yes, of course, because whatever would lead to better-negotiating conditions, we would be interested at the outset. The problem is the difficulty of achieving this since often each case is a case. That is, we are all interested in the same product is easy to have, but after the purchase conditions, both payment, delivery, etc, will always be more difficult to align among all. Moreover, it is proper that each company has its own way of operating and often these small differences are what influences the final price." (Interviewee A)

5.1.2 Demand Aggregation (Supplier Side)

Q2: As a supplier, would you be interested in a solution that would allow your customers to aggregate their purchase intentions with others?

In this case, not everyone agreed with the idea to allow their customers to aggregate their orders in order to obtain bulk discounts. Although 2 interviewees (B and C) admit that would be an interesting solution to sell more substantial quantities of products and improve resources allocation in services-oriented businesses, others appeared to be a bit reluctant to lower their margins with loyal customers, and that would require a great rigour in the margin levels of their products: *"just for potential future customers. Not current customers, because they are already loyal."*

It is important to note particular applicability of this aggregation model in the services business industry, as stated by interviewee B:

" it is very interesting to have a group of companies that come together to hire services that are common to and among them. An example (...) where many different companies want someone to do a health inspection of a disease in eucalyptus that appeared (...) so does it for everyone all at once and gets better results of course. A study of 5000 euros is better than five studies of 1000 euros, so the product/service you buy can be even better."

The interviewees A and F did not see applicability in their business context or did not want to answer this question.

5.1.3 Supply Aggregation

Q3: As a supplier, would you be interested in a solution that would allow you to team up with other suppliers to satisfy more orders/customers?

In general, the interviewees perceived the potential in teaming up with other suppliers to fulfil more substantial orders/services that other way they could not fulfil alone. The interviewees A and B stated that this already happens in "joint venture" projects, where companies join forces together in some large construction projects. In these specific cases, it is crucial to define the roles and responsibilities of each of the intervenients in the project. Blockchain technology characteristics could improve and decentralise these aspects through smart contracts, and other technologies like AI and IoT.

Interviewee E stated the importance of this model in the SME context: *"Probably in the context of small and medium enterprises, it will be an attractive solution, as they will have different leverage when operating together, rather than operating separately. In the context of multinationals that want to reduce or extinguish competition and that have a different capacity for internal tools to do so, it will probably not be so helpful to act in a "collusive" way."*

Interviewees D and F did not see applicability in their business context or did not want to answer this question.

5.1.4 Supplier evaluation KPI's

Q4: From the list of KPIs presented, what are the most important parameters in your perspective for assessing supplier performance?

In the supplier evaluation context, were analysed the three most important KPI's referred by the interviewees during the interviews. The most mentioned parameters were the Price, Lead Time and Quality Standards. Other indicators, such as compliance with the requirements or customer support and after-sales services, were also mentioned, bur deemed less critical.

The majority of the interviewees mentioned the price as one of the most critical parameters, with 4 in 6 interviewees, considering it the most important factor. Some characteristics of the platform, such as aggregation, can be favourable in this aspect both for buyers and suppliers. As stated by one of the interviewees: *"If it is something that is not very critical, the price at the start will always be one of the first, but if it is something more critical, it is no longer and we move to quality standards."*

In more technical products and services, some interviewees also mentioned that it is necessary to have a better prior understanding of the clients' requirements and an excellent customer service: *"I think there are important services, like pre and after-sales. Pre-sale services are support in choosing the product(...) you want to buy something, and I will evaluate if this is the best for you. I do that a lot with my clients, and it is vital."* (Interviewee B)

5.1.5 Other relevant observations

Some interviewees mentioned some concerns with the reputation system, as well as with the necessity of customer evaluation services. It is necessary to develop a fair reputation system for all the involved parts and preferentially in a decentralised way.

Interviewee B stated: *"Who controls the veracity of the evaluations? (...) the problem is the person who made the evaluation lies in the evaluation and gets registered. Who is the judge? Who comes to fix this?"*

6 Designing System's view of the Marketplace

Following a clear definition of the scope and requirements of the DM in previous chapters, this chapter details the platform's operational and design options. In short, the proposed DM should be able to aggregate orders, provide seal-bid auctions, allow shipping companies to integrate into the platform and provide a trustworthiness reputation system to platform users. These features are primarily intended to increase trust in the use of the platform while automating as much as possible all operational activities related to payments and fulfilment of the orders through blockchain technology and smart contracts.

6.1 Service System Design

Some concepts of the Multi-Level Service Design were used to design the DM service, namely the service system and the service encounter (Patrício et al., 2011). The context diagram (Figure 6) and the sequence diagram (Appendix A) of current DM were drawn based on previous works undertaken and during the team meetings, intending to assist the development team in the DM development.

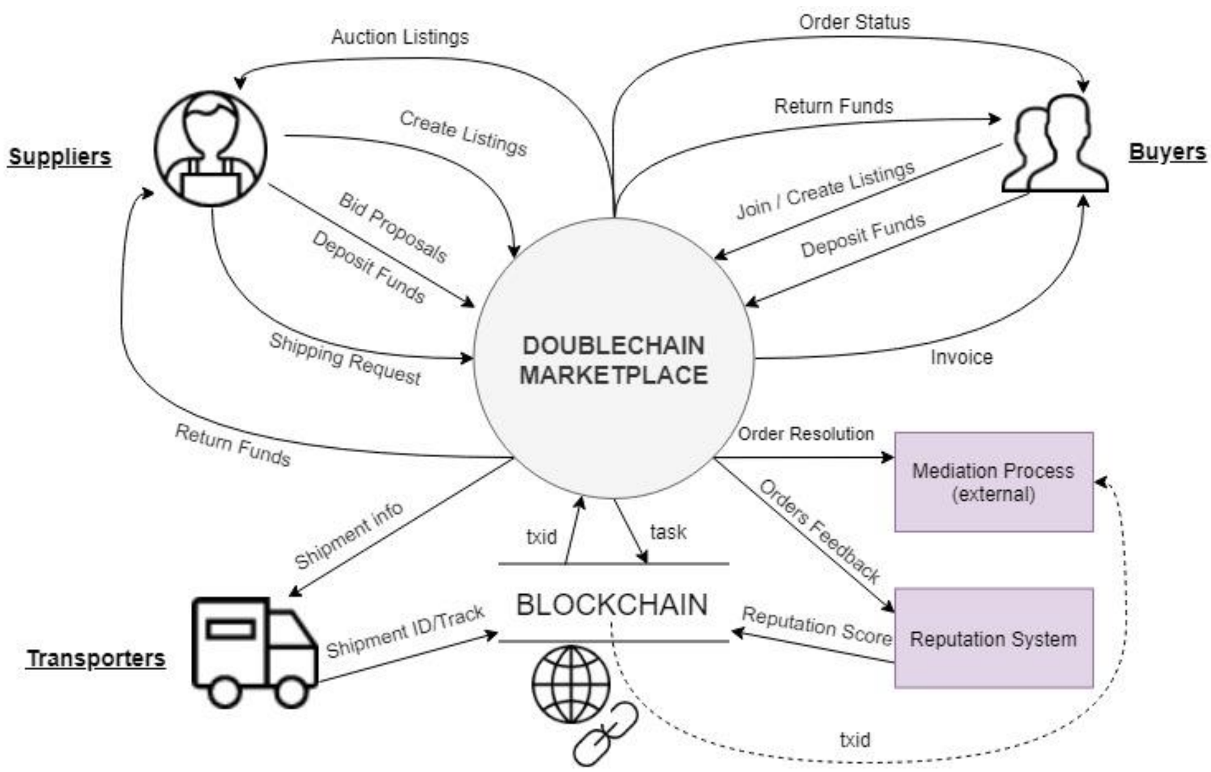

Figure 6 – DM context diagram

Two tools were used to design the service system, namely the service system architecture and service the system navigation. The service system architecture for the DM shows the main activities in the service design and which service interface is responsible for its execution (Fig. 7, Appendix B).

One of the primary design considerations of the proposed DM is the implementation o a first-price sealed-bid (FPSB) auction method, where bids are hidden, but the results should be made public in order to be consensual and easily verifiable. In this context, FPSB auctions feature several desirable aspects, such as ensuring fairness in the transactions process and boosting the potential economic surplus for buyers. Also, the demand aggregation model increases buyers' bargaining power and can reduce the products/services prices substantially, leading users to prefer this type of platforms. Although sellers may not be able to extract as much value from auction when compared to buyers, it can be argued that the system will be fairer as rational suppliers can bid a price that is economically viable and yet still be able to increase their market share due to demand aggregation property.

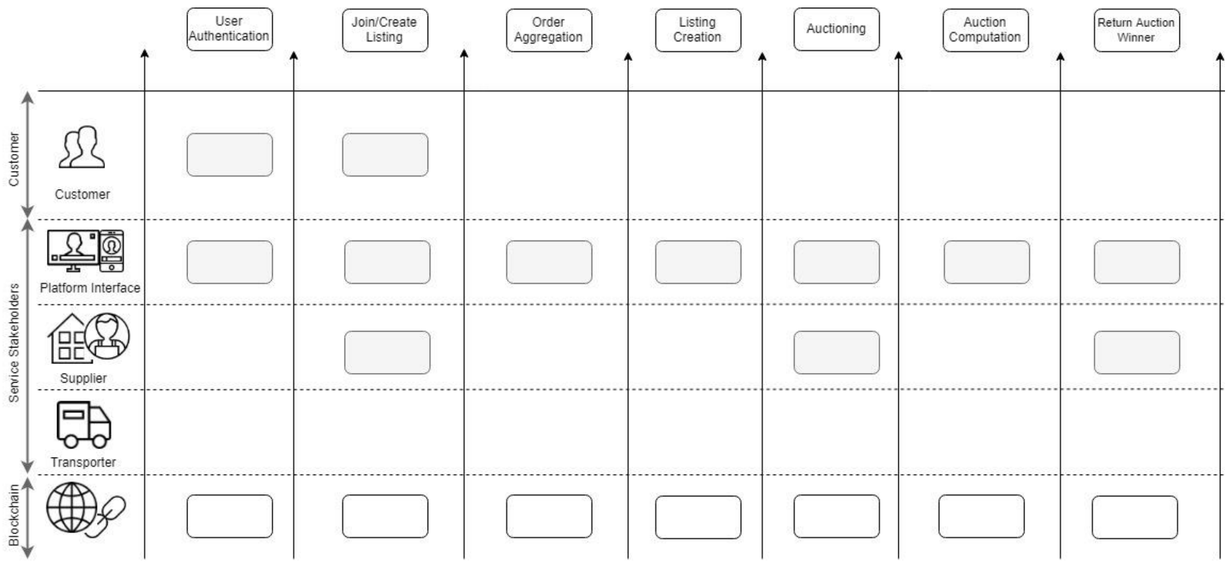

Figure 7 - DM service system architecture

The proposed DM relies on a smart contract framework, in which orders are placed and managed in a decentralised way. In this framework, each auction corresponds to an *auction listing contract*, and each customer can choose whether to create a new auction listing or join an existing one. Thus, processes such as *order aggregation* and *auctioning* result in the generation and execution of functions in smart contracts, which as the process unfolds lead to meeting customer needs. Given the fact that auctions on the platform imply holding funds in escrow, it benefits significantly by reducing the involvement of intermediaries in payment and fulfilment processes. This disintermediation provides high levels of trust, security and transparency, allowing open verification to all actors of the platform. After confirmation that the orders have been delivered, special clauses can be used to trigger automatic events such as release escrow funds in the smart contracts (Weber et al., 2016). Finally, data resulting from these processes, along with the degree of fulfilment of orders and the feedback from buyers, are fed into the reputation system in order to calculate the suppliers' reputation (cf. Figure 8, Appendix B).

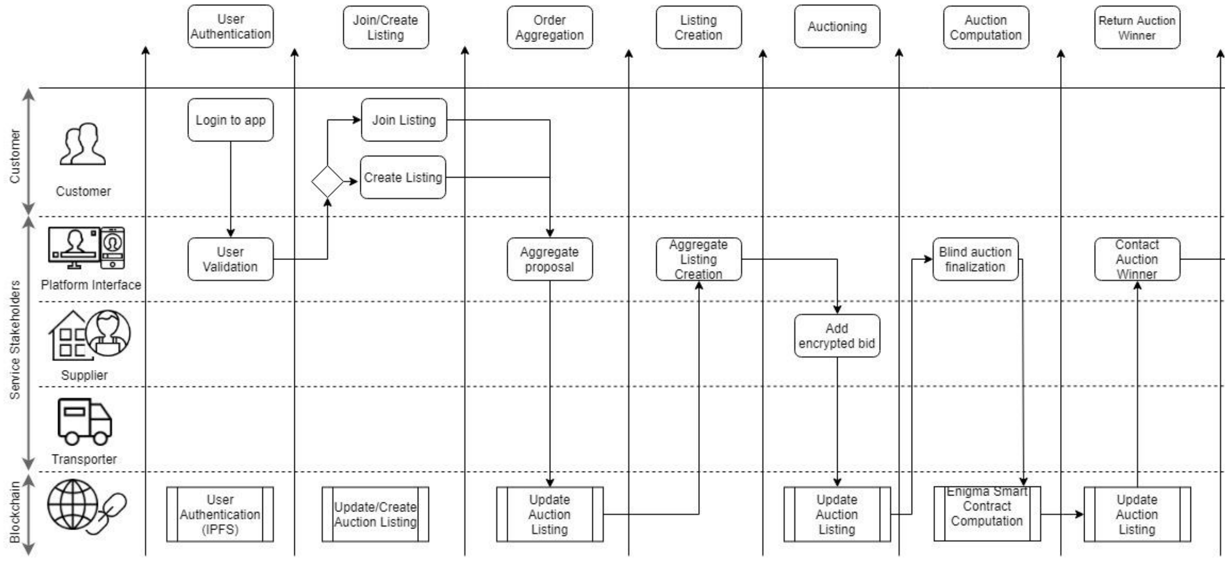

Figure 8 - DM service system navigation.

In the chosen design, the order aggregation between suppliers was not explicit, since this study could not conclude whether it would be a feature appreciated by most suppliers, and therefore the focus was on buyer aggregation.

Figure 9 shows the Service Experience Blueprint for the reputation system calculation phase, assuming that the customer will evaluate the supplier.

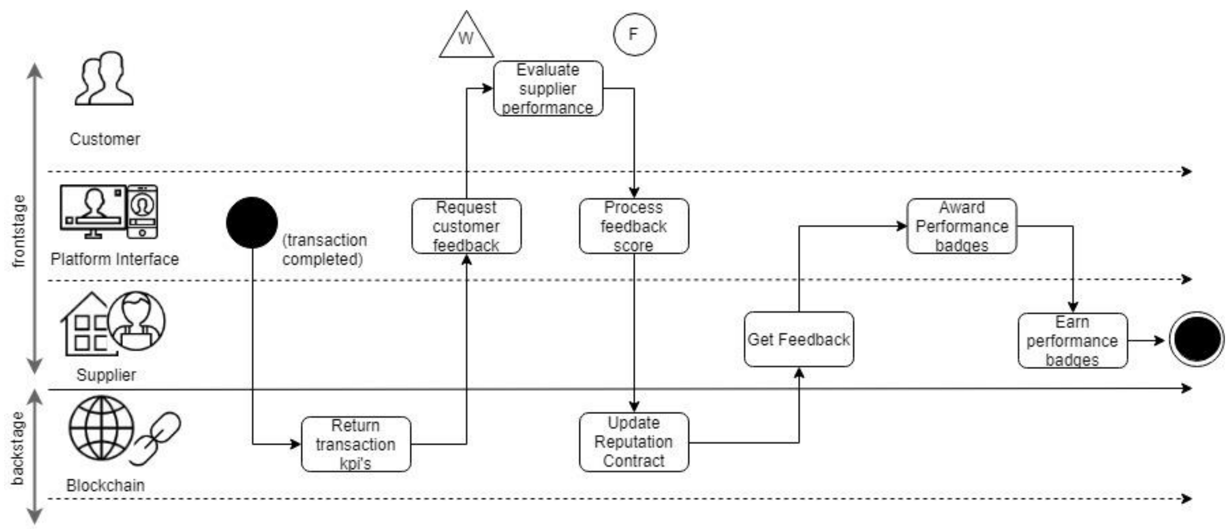

Fig.9 - Reputation system Service Experience Blueprint

The supplier’s fulfilment metrics (KPIs) are automatically calculated once delivery is complete. They are calculated on a per buyer basis, which means that a buyer only has the option to provide feedback after the calculation of the metrics related with that shipment.

Furthermore, the buyer will be incentivised to leave feedback in the form of a rating of 1 to 5, which may award additional reputation points to the supplier. Some of the problems with this method are the subjectivity associated and the propensity to unfair ratings. Although, contrarily to typical e-commerce websites, this information lasts in the blockchain and does not need a central point to maintain and share that information. In this case, costumers have to provide a transaction key in order to evaluate the suppliers' service, proving they received the request transaction. The results of fulfilment or rejection of orders will generate relevant data and metrics from all the actors involved in the process. Thus, this data collection allows the reputation management system to be integrated into the whole system, both as a measure of each participant's performance as well as a quality assessment metric for the services provided.

In order to allow for honest feedback reviews should be blinded - a supplier will not be able to determine who gave him a particular feedback, although all feedback on that account should be visible. A measure of honesty in the subjective evaluation by the buyer will be made automatically in the system via a comparison with the fulfilment metrics. If there is a significant deviation from the supplier’s score, the buyer will be flagged and with the potential of the supplier earning badges beside that. A certain number of flags may lead to the automatic inability of that address to participate in further listings. It is important to note that a buyer should only be able to review a supplier until a given period of time following shipment reception and confirmation, in order to allow good performing suppliers to be compensated for their efforts. If the buyer does not evaluate the supplier during this time frame, the system proceeds with the reputation score calculation with the previously calculated metrics.

Finally, reputation system indicators such as contract compliance provide to participants with real-time information about the quality of goods and services associated with the suppliers, without directly revealing any identities.

6.2 Smart Contracts Architecture

In the proposed DM, *auction listing* contracts are created in an on-chain re-usable factory contract *(listing factory)* that guarantees the uniformity of the contract definition. A factory contract is an on-chain template contract, similar to a class, and is used as a factory that generates contract instances by calling a function (Xu et al., 2018). Every time a function is called this way, an extra cost is incurred for deployment,. In order to reduce this cost and optimise function calls between contracts, we resorted to a proxy contract, *listing interaction*, to interact directly with the other smart contracts (*tracking token, reputation management, etc.*) and reduce contract instantiations (cf. Figure 10).

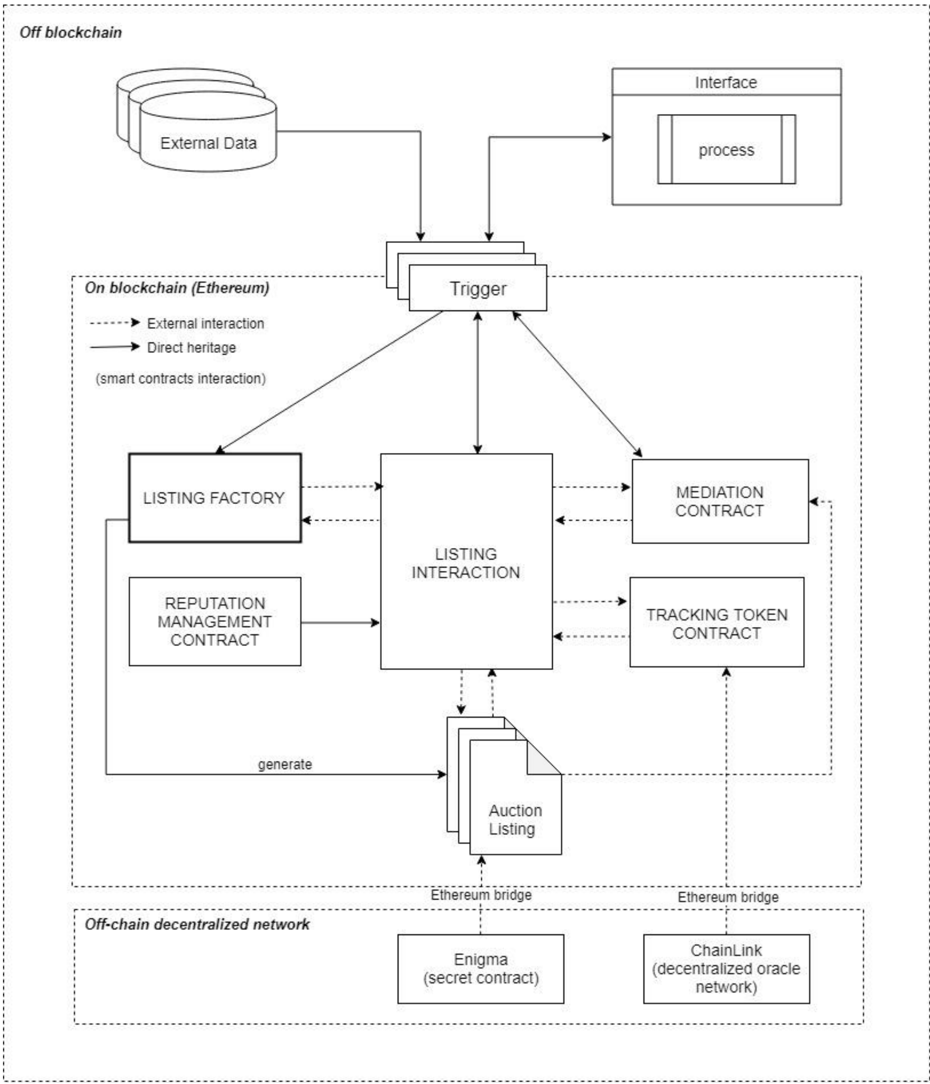

Figure 10 – Smart Contracts architecture.

Moreover, the system must be capable of enabling encrypted computations over the bidding system and mitigating some privacy limitations in public blockchains. In this case, we employed "secret contracts" together with the previously mentioned Ethereum smart contracts. For this propose, we used the Enigma Blockchain (Zyskind, Nathan, & Pentland, 2015), since it enables a direct connection to the Ethereum Blockchain and is one of the few permissionless blockchains with privacy-preserving characteristics. Indeed, this platform is capable of maintaining stateful encrypted contracts, allowing encrypted data to persist between tasks, and enabling full bid privacy for the blind auctions in this DM context.

Since some external data interaction needs to be connected to the closed execution environment of smart contracts, we used a decentralised oracle network, Chainlink (Juels et al. 2017). Usually, oracles are invoked to bring external states into the blockchain. This can be particularly important during the fulfilment and delivery stages, where these oracles can act as a bridge to the Ethereum blockchain, becoming a trusted party for the data gathered from the external world (Xu et al., 2019).

7 Conclusion and future research

This dissertation aimed at exploring innovative uses of blockchain technology and design the specifications of a customer-push decentralised marketplace. Despite some contingencies, it was possible to obtain useful insights for the project to be carried out.

The research started with an extensire review of the literature to understand the state-of-the-art on blockchains, decentralised marketplaces and other relevant topics for the work.

Based on the literature review and the relevant information obtained during the team meetings and previous work conducted, it was possible to define the necessary requirements to design the proposed DM and construct the interviews script in order to get a better understanding of what functionalities could be more attractive to the customers/stakeholders, mostly in a B2B context.

Moreover, due to the novelty and explorative nature of the project, we used a Design Science research methodology to conduct this work. We collected inputs from relevant stakeholders through semi-structured interviews with six managers and supply chain experts experienced in dealing with operations and procurement processes, but not necessarily blockchain experts, given the emerging nature of the technology. The data collected from the semi-structured interviews were then analysed and validated during team meetings, and then used to shape the functional requirements of the platform. The outcome is a final version of the system architecture and main design characteristics of the decentralised marketplace.

After analysing the semi-structured interviews data, it was possible to reach some useful insights for the research questions. On the buyer side, most of the stakeholders acknowledged that it is interesting a solution that would allow them to aggregate their purchase intentions and be able to negotiate better purchase conditions with suppliers. However, some interviewees alerted for the fact that this model is more indicated for standardised products, since the more technical the product, the more complex will be the acceptance conditions and personalised specifications. It is essential to keep in mind the different payment times and shipping conditions, being necessary to define well who will receive the products.

On the supplier side, not everyone agreed with the idea to allow their customers to aggregate their orders in order to obtain bulk discounts. Some interviewees admit that would be an interesting solution to sell more substantial quantities of products and improve resources allocation in services-oriented businesses. However, others appeared to be a bit reluctant to lower their margins with loyal customers since that would require a great rigour in the margin levels of their products.

In general, the interviewees perceived the potential of teaming up with other suppliers to fulfil more substantial orders/services that other way they could not fulfil alone. Some interviewees stated that this already happens in some projects, where companies join forces together in some large construction projects. In these specific cases, it is crucial to define the roles and responsibilities of each of the intervenients in the project. Blockchain technology characteristics could improve and decentralise these aspects through smart contracts, and other technologies such as AI and IoT. It was stated that this model could be particularly beneficial to small and medium enterprises obtain a larger market share and participate in more deals.

In the supplier evaluation context, we analysed the three most important KPIs referred by the interviewees. The most mentioned parameters were the Price, Lead Time and Quality

Standards. Other indicators, such as compliance with the requirements or customer support and after-sales services, were also mentioned, bur deemed less critical.

The majority of the interviewees mentioned price as one of the most critical parameters, with 4 in 6 interviewees considering it the most important factor. Some characteristics of the platform, such as aggregation, can be favourable in this aspect both for buyers and suppliers.

In more technical products and services, some interviewees also mentioned that it is necessary to have a better prior understanding of the clients' requirements and an excellent customer service.

Some interviewees also mentioned some concerns with the reputation system, as well as with the necessity of customer evaluation services, supporting the necessity to develop a fair reputation system for all the involved parts and preferentially in a decentralised way.

One of the significant limitations of this study was the difficulty in finding potential stakeholders that would agree to participate in the study. Reasons such as lack of time, confidential information warnings or not answering at all limited the number of responses collected. Nevertheless, the insights from this work underpin some of the project team's assumptions and create a stronger foundation for future project development.

Furthermore, the developed artefacts contribute to the knowledge base of this work and serve as a basis for future research, but could also be used practically in similar projects and business contexts.

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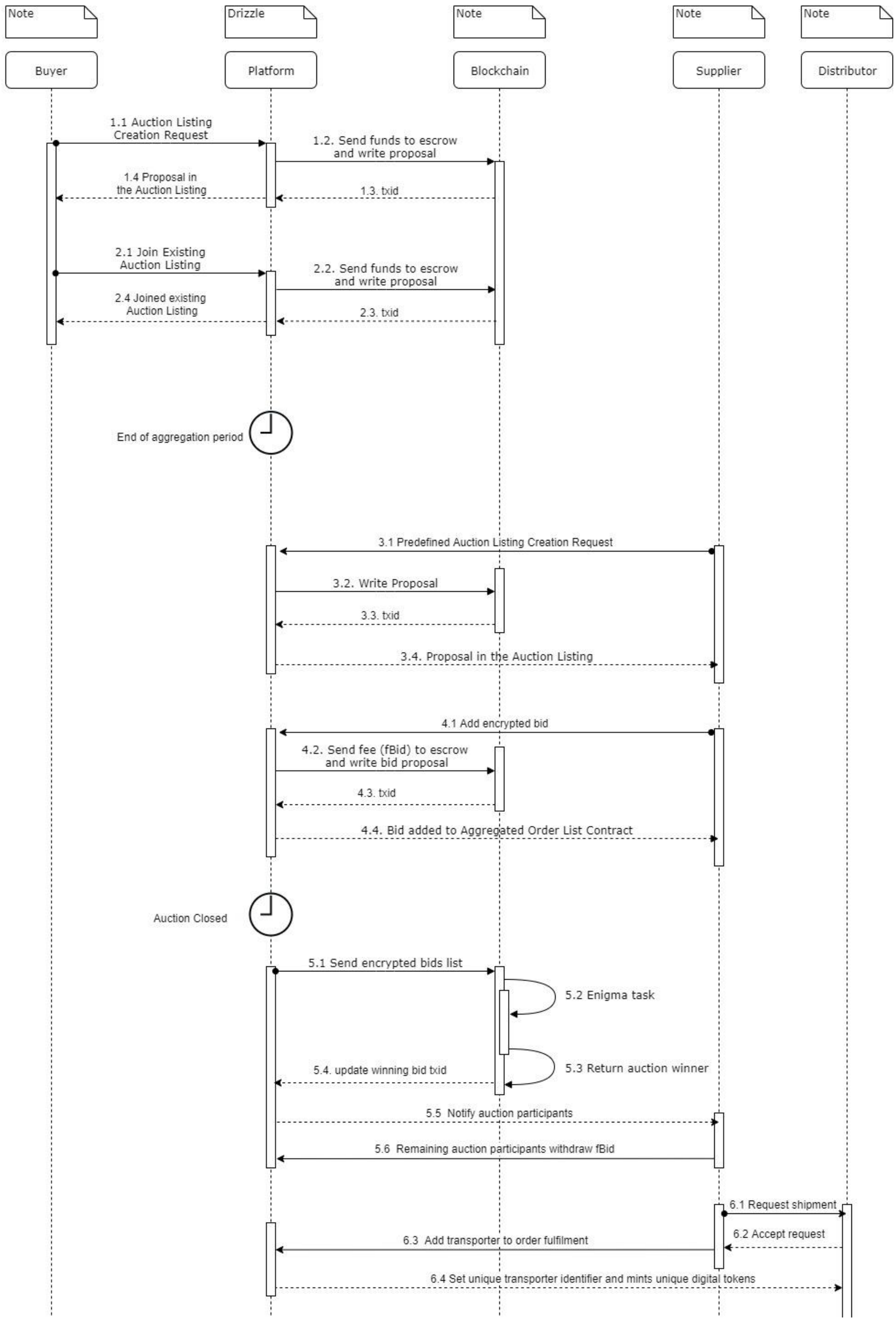
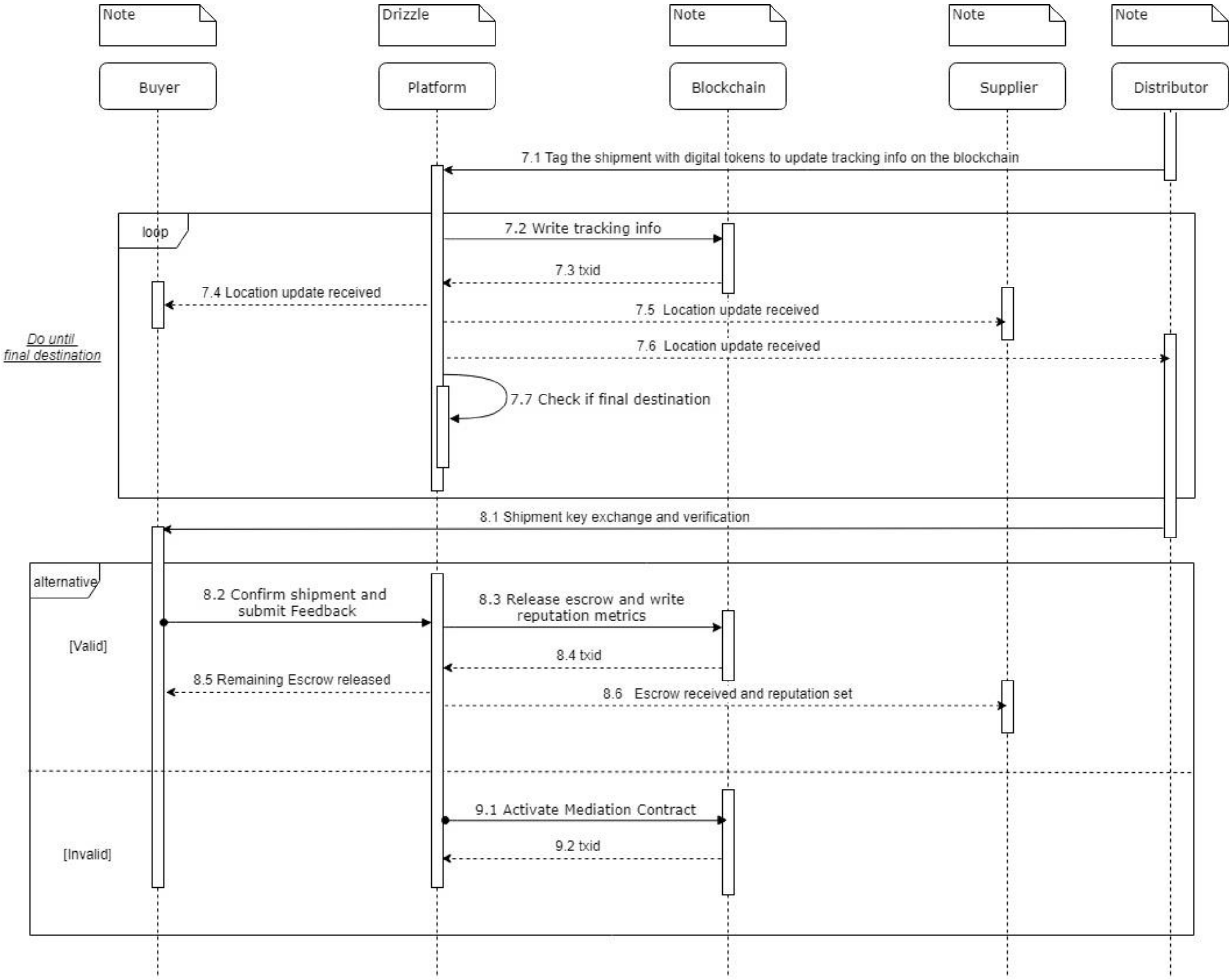
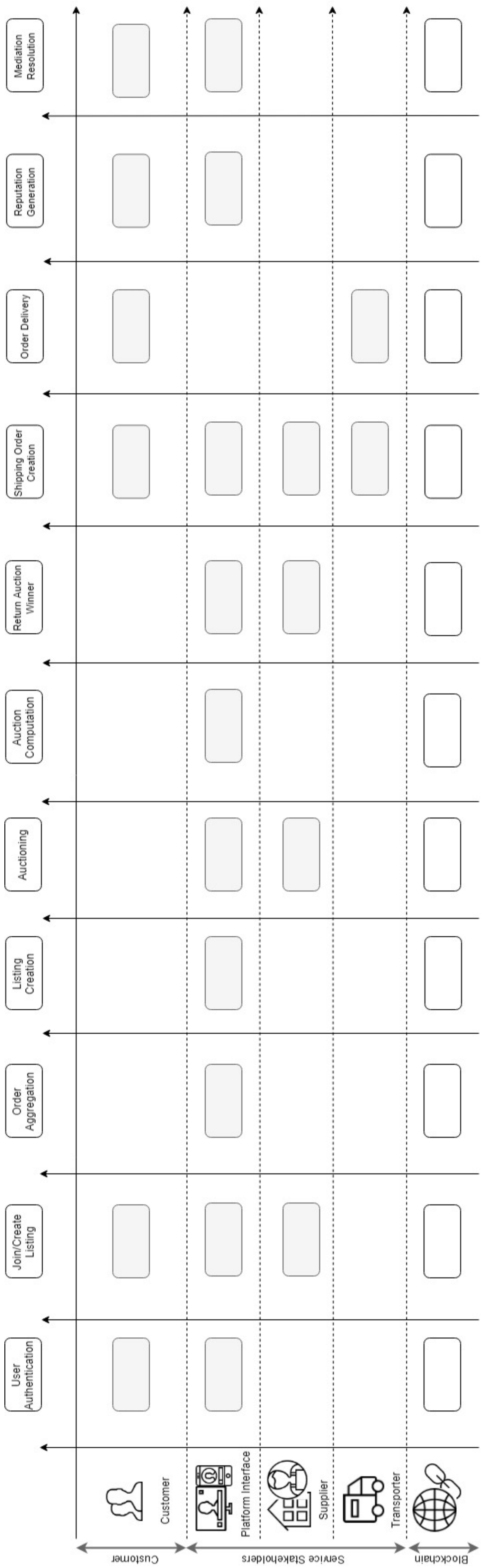
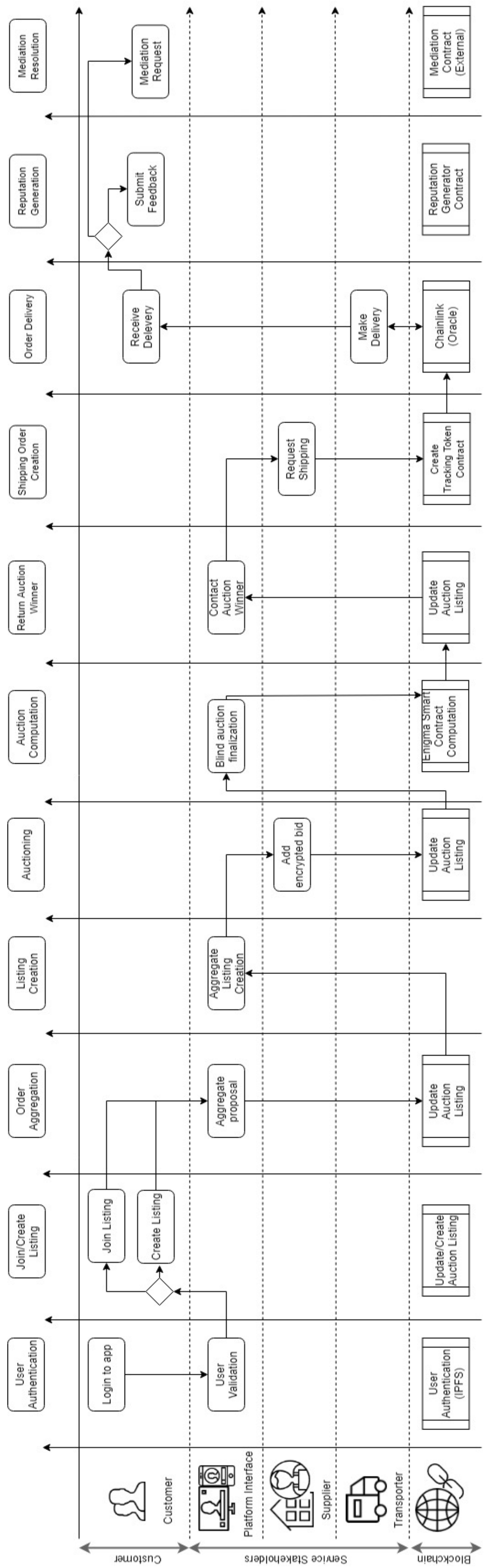
APPENDIX A: System Sequence Diagram




Note
Drizzle
Note
Note
Note
Buyer
Platform
Blockchain
Supplier
Distributor
7.1 Tag the shipment with digital tokens to update tracking info on the blockchain
loop
7.2 Write tracking info
7.3 txid
7.4 Location update received
7.5 Location update received
7.6 Location update received
Do until final destination
7.7 Check if final destination
8.1 Shipment key exchange and verification
alternative
8.2 Confirm shipment and submit Feedback
8.3 Release escrow and write reputation metrics
[Valid]
8.4 txid
8.5 Remaining Escrow released
8.6 Escrow received and reputation set
9.1 Activate Mediation Contract
9.2 txid
[Invalid]

APPENDIX B: Service System Architecture and Navigation





Customer
Service Stakeholders
Blockchain
Customer
Platform Interface
Supplier
Transporter
User Authentication
Join/Create Listing
Order Aggregation
Listing Creation
Auctioning
Auction Computation
Return Auction Winner
Shipping Order Creation
Order Delivery
Reputation Generation
Mediation Resolution
Login to app
User Validation
Join Listing
Create Listing
Aggregate proposal
Aggregate Listing Creation
Add encrypted bid
Blind auction finalization
Contact Auction Winner
Request Shipping
Receive Delevery
Make Delivery
Submit Feedback
Mediation Request
User Authentication (IPFS)
Update/Create Auction Listing
Update Auction Listing
Update Auction Listing
Enigma Smart Contract Computation
Update Auction Listing
Create Tracking Token Contract
Chainlink (Oracle)
Reputation Generator Contract
Mediation Contract (External)

APPENDIX C: Interview Guide

QUESTIONS

Buyer Aggregation

1.1. As a buyer, would you be interested in a solution that would allow you to aggregate your purchase intentions in order to obtain better negotiate conditions?

1.2. As a supplier, would you be interested in a solution that would allow your customers to aggregate your purchase intentions?

Supplier Aggregation

2. As a supplier would you be interested in a solution that would allow you to team up with other suppliers to satisfy more orders / customers?

Suppliers evaluation

3. From the list of KPIs presented, what are the most important parameters in your perspective for assessing supplier performance?

Price	Level of nonconformities
Importance for Business	Quality Standards
Lead Time	Customer Support
Requirements Compliance	Payment Terms
After Sales Service	Others; Which are

4. Other observations