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Blockshare: Applying blockchain to the dropshipment model, a case study

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Abstract

Although blockchain has become a popular buzzword lately, real world applications of this technology are still scarce. This thesis studies proposed blockchain solutions for eCommerce found in the scientific literature. A solution for the implementation of dropshipment through blockchain was found , the details of this soluition were worked out and a Magento2 extension which makes use of the Ethereum blockchain was built. To determine whether this application was as useful as the paper the idea was taken from claimed it would be, expert interviews were conducted with programmers to identify how the software architecture holds up to other solutions for the same functionality. Alongside this technical assessment an analysis of the value of the application was conducted by interviewing employees of online stores and corporate economists. They were shown a demo of the application and were asked for advantages and disadvantages of this application specifically and other solutions for the same functionality. They were asked to weigh these advantages and disadvantages to determine whether or not they would want to use the application and whether there are any obstacles to the adoption of the application.

The interviews showed that, both on the technical and the business side, the interviewees found the application improved upon existing models. The biggest downsides were the privacy of the users when information is published on the blockchain and the fact that a blockchain would become too expensive. A solution using decentralised data storage in combination with a blockchain was suggested by one interviewee and could be explored in future research.

Acknowledgements

I would like to express thanks to my supervisor, Dr Fabiano Dalpiaz for his guidance during this project. I would also like to express thanks to Sander de Graaf and 3WebApps for giving me the opportunity to conduct this research at their company and allowing me to use the company's resources to conduct the research. I would also like to express my thanks to my friends and family for their support during this project.

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Chapter 1

Introduction

The eCommerce ecosystem is a competitive one and online retailers need to keep up with the latest technologies in order to retain their customers. Large parties such as *Amazon* have already started implementing drones to deliver packages [39] and *Uber eats* makes it possible to track food deliveries in real time [43].

Another rising technology is blockchain. Initially meant as a way to enable online payments [23], this technology has been said to revolutionize business and the entire economy [12]. Yet, most real world applications remain limited to cryptocurrencies.

This project aims at combining these two fields by looking at the potentials of blockchain for eCommerce retailers. According to Annemarie Buitelaar of *Marktplaats* [33] and *bol.com* [34] blockchain is going to revolutionize the eCommerce ecosystem. In addition, Luke Lappala [35] argues that blockchain can be used to lower prices immensely for consumers as the technology can be used to provide online retailers with more power over entities such as *Amazon* or *bol.com*.

The project started out by conducting an extensive literature study into blockchain, eCommerce (especially trust in eCommerce) and adoption of new technologies. The literature study was then used to identify two different blockchain applications to be built as part of this research project. The literature review was also used to create research artifacts designated to measure factors considered vital in the acceptance of new technologies. Most notably the Technology

Acceptance Model (TAM) by Davis [7] yet this literature study did not turn up any empirical papers testing the merits of proposed blockchain systems which is the central problem statement in this thesis.

Having finished the literature study a collaboration with the company 3WebApps [44] was started as they specialize in implementing eCommerce (Magento2 [46]) systems. To conduct this research a Magento2 application was built which uses a blockchain to allow online retailers to share products called Blockshare. In order to validate the value of this application both developers and business experts will be consulted.

This thesis will first give the details from the literature review described above. This will continue by identifying a problem in the current study of blockchain and eCommerce in Chapter 3. This problem leads to the research questions stated in Chapter 4. The thesis will then detail software architectures which can implement a functionality called dropshipment in Chapter 5 and chapter 6 will then give a detailed explanation of the Blockshare application which implements this functionality using a blockchain. Chapter 7 will then explain how this application is validated and will present results on the performance of this application as opposed to similar applications that do not employ blockchain. These results are then reflected upon and concluded from in chapter 8.

Chapter 2

Literature Review

In preparation for this project a literature study was conducted. In it's initial stage literature Google Scholar was used to search on the following terms related to blockchain developments and eCommerce:

- Blockchain
- Blockchain adoption
- Smart-contracts ecommerce
- Ecommerce trust
- Ecommerce blockchain

Each of these terms was queried separately in google scholar and through them the following relevant papers were identified: Iansiti and Lankhani [12], Buterin [5], Fairfield [9], Kern [14], Pavlou et al[21], and Vijaserathy [30]. Other relevant literature was then found by looking at the references sections of each of these papers and reading papers used by these authors.

2.1 Blockchain: an overview

Before further discussion of the literature it is importent to have a clear understanding on what a blockchain is. According to Seebacher and Schritz [24] the best peer-reviewed definition they could identify was:

" A blockchain is a distributed database, which is shared among and agreed upon a peer-to-peer network. It consists of a linked sequence of blocks, holding timestamped transactions that are secured by public-key cryptography and verified by the network community. Once an element is appended to the blockchain, it can not be altered, turning a blockchain into an immutable record of past activity."

Seebacher and Schritz [24] have found that blockchain is mostly associated with trust and decentralization. [24, p.6], along with subthemes of transparency, privacy and integrity of data and because of these characteristics they has found that blockchain will be disruptive to the service industry [24, p.10]

The first practical instance of a blockchain was introduced in 2008 by Satoshi Nakamoto [23] when he proposed a system called Bitcoin. He claims that the way online transactions have worked so far is troublesome because for one, trusted third parties are required to handle the transaction. Secondly the use of these parties increases transaction costs. In addition, There is no possibility to make non-reversible payments. Because of this merchants must be wary of their customers and fraud is unavoidable.

Physical currencies do not encounter these problems which is why a new electronic equivalent is necessary [23, p.1]. In order to meet this demand he introduced a system we now know as blockchain and the digital currency bitcoin. Nakamoto himself describes the working of Bitcoin as follows.

2.1.1 Coins

Nakamoto [23] proposes a system where a coin is represented by a chain of transactions [23, p. 2]. During a transaction the recipient will sign the hash[1] of the previous transaction and add this to the coin. The original owner will sign the coin with his private key in order to prove he is in fact the owner. According to Nakamoto this introduces the double spend problem [23, p. 2]. This is the problem where users are not able to identify whether a coin was already spent or not which introduces the vulnerability where money can be spent more than once. He mentions the usual way to circumvent the double spend problem is to introduce a mint which is able to track which coins have already been spent which would be the only instance allowed to validate transactions. Instead of this solution Nakamoto wanted to use a system which does not require a third trusted party. He suggests that when all participants in a Peer-to-Peer(P2P) network are aware of all transactions it is impossible to double spend a coin as they can validate whether this coin was already used or not [23, p.2].

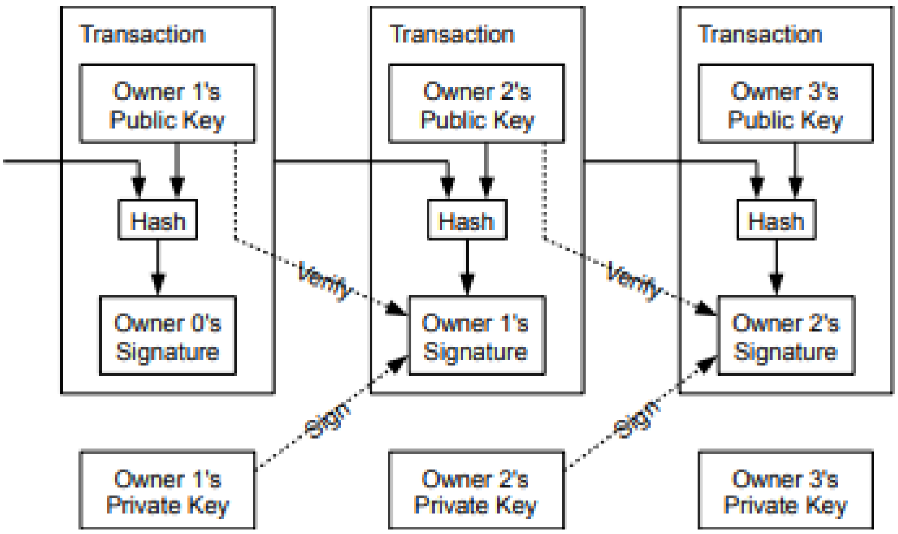

Figure 2.1: The working of blockchain coins [23, p.2]

[1] A cryptographical hash in this context is the result of a one way function used to create a bitstring of a fixed length which can be used to verify the integrity of a document.

2.1.2 Blocks

To start tackling the double spend problem Nakamoto [23] suggests using a timestamp server. A number of items (in the case of bitcoin these would be transactions) are grouped together and hashed. Each block is linked to the previous block by its hash value and thus a chronological chain of blocks comes into existance [23, p.2]. Whenever a new block is made available (about once every 10 minutes) it will be broadcasted to the entire network so all nodes are aware of the transactions that have been completed. This way the validity of a transaction can be verified if the majority of the network has decided to accept the new block into the chain.

2.1.3 Proof of work

The block system described above has the inherent problem that malicious users of the system can still try to create and upload new blocks to the network as quickly as possible and try to double spend as many coins as possible. To counter this problem Nakamoto [23, p. 3] suggests a proof-of-work challenge. The format he suggests is that the hash of a block needs to start with a certain number of zero bits. To create hash values like this a nonce[2] should be added to the blocks. For a secure hash function it should be impossible to calculate a nonce that will result in the required hash output and this nonce can therefore only be found by trial and error. This means that the harder it is to find a nonce, the less chance one node will have to add a new block to the blockchain. Nodes in the network will always take the longest chain as the truth. This way malicious nodes are required to own at least half of all computing power within the network to be able to exploit it [23, p. 2].

2.1.4 Recent blockchain systems

Buterin [5] suggests that people quickly tried using the blockchain for other applications than just financial transactions. He suggests that blockchain can be seen as a state transitioning

[2] A randomized bitstring

system. Each function of the blockchain takes some state as input, computes a transaction and produces a new state as output [5, p.5].

One example of a different use for blockchain is the namecoin system. In this system people can register usernames for the system in a decentralised manner. If you register a username in a decentralised P2P network no one is able to stop a different user from registering that name right after you. A blockchain system where the first person to register a name as a transaction is able to reject later registrations of every username thus solving this problem [5, p. 10].

Bitcoin offers a scripting language which: *“does facilitate a weak version of a concept of ’smart contracts’.”* [5, p. 12] In contrast the Ethereum system has developed a much more complex language to facilitate more complex transactions on the blockchain. They propose a state is more than just the amount of bitcoins in a transaction. A state consists of four fields:

- The nonce
- The ether balance sent in the transaction
- The contract code
- Additional storage

Ethereum also offers what they call messages instead of transactions [5, p. 14]. The differences between messages and transactions are that messages can be created by contracts, the Ethereum message can contain data and the recipient can respond to the message. Because of this more complex applications can be built upon the Ethereum blockchain than on the Bitcoin blockchain.

Crosby et al. [6] take this even further than just smart contracts. They suggest using smart contracts to create smart property. Crosby et al. [6] mention that smart contracts can be used to represent artifacts ranging from physical objects such as cars or houses as well as non-physical objects such as shares in a company [6, p.8]. They list several other uses of blockchain technology such as using a blockchain as a public notary service [6, p.14] and decentralized storage through blockchain [6, p.15]. Crosby et al. [6] have an extensive list containing blockchain applications and they mention that the applications of blockchain are endless.[6, p.8]. Yet in our everyday lives blockchain applications are not that common yet. So what is preventing people and companies from adopting blockchain technologies?

2.2 Blockchain security

Since blockchain systems are often used to manage sensitive assets it is no wonder people worry about the security of such systems. Which Vijaseraty [30] mentions as an important factor for the adoption of eCommerce. As explained by Nakamoto [23] the POW system should suffice to ensure the security of the blockchain. However, malicious nodes are not the only thing end users may have to worry about. As Vasek et al. [29] state any large platform is followed closely by scammers who try to earn money from the early adopters. They found over 300 scams involving bitcoin. These range from traditional ponzi schemes [29] to scam wallets and miners. These scams have already made more than 11 million dollars in 2015. Aside from direct dangers to end users of the system, blockchain systems can also be used by malicious users to create threats to other systems. Ali et al [2] introduce a technique where a botnet can be controlled using the bitcoin blockchain. This technique would greatly enhance the abilities of botnet exploiters to issue commands to their network without being detected.

2.3 Blockchain Adoption

Even though the paper on Bitcoin was published in 2008 and there were already papers discussing a database resembling blockchain in 2001, the amount of blockchain systems(with the exception of cryptocurrencies) remains scarce. According to Iansiti and Lakhani this is because blockchain is a foundational technology rather than a disruptive one [12]. According to them the adoption of blockchain is likely to follow the same path as TCP/IP when the internet was coming up [12]. Meaning that it will not offer revolutionary new business models and will instead change the foundation of current business models are built upon and aim to make them more efficientsou. According to them it could take decades for blockchain technology to be fully embraced by society. Iansiti and Lakhani continue by proposing a framework which can be followed to map the adoption of foundational technologies. The framework consists of two dimensions: novelty and complexity. Novelty represents how new the implementation of a system using the technology is and how much effort it will therefore require to be understood by potential users while complexity shows how much cooperation will be needed to create value for the foundational technology.

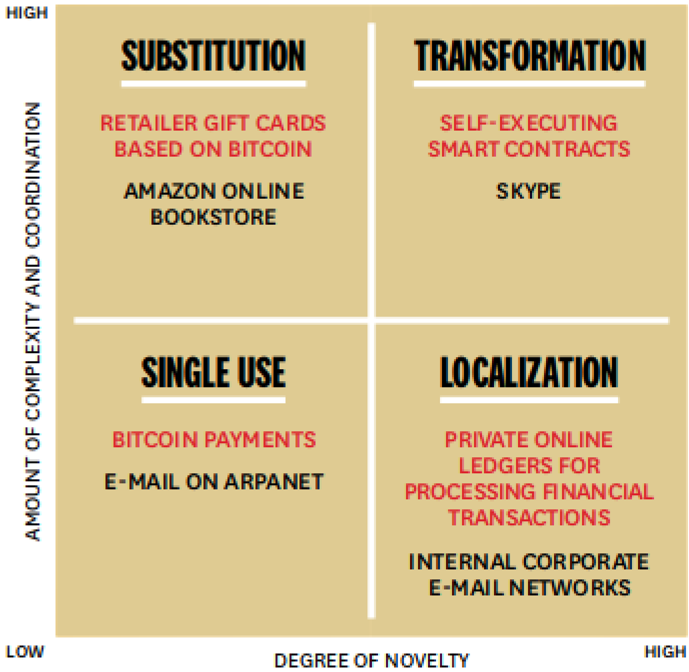

Figure 2.2: The framework from Iansiti and Lakhani [12]

On the other hand, Francisco and Swanson [10] state that especially in the field of supply chain management the general public is ready for the transparency and traceability provided by blockchain. This is corroborated by Skilton and Robinson [26]. They used normal accident theory [22] to show how faults in supply chains are caused by accidents [26]. They explain that transparency is necessary in complex supply chain networks to create traceability [26]. This means the use of a blockchain in supply chain management should greatly reduce the amount of accidents and subsequently the amount of catastrophic events in the supply chain. The model used by Francisco and Swanson [10] is built upon the Universal Theory of Acceptance and Use of Technology (UTAUT) and suggests that in order for blockchain to be adopted more quickly the technology would need to demonstrably increase performance and should still be easy to use. They also suggest that if people are able to trust the technology and the organizations working with it, this would lower the entry bar for the technology to be accepted by the public.

A more traditional model used to explain the adoption of technology is the Technology Acceptance Model (TAM) [7]. This framework suggests that the adoption of new technologies relies on two factors: the usefulness of said technology and its ease of use. The TAM model suggests that users who perceive the new technology as useful and as easy to use will be willing to work with the system. In comparison to the model by Iansiti an Lakhani [12] the TAM has much more foundation in the scientific literature. It was based on the theory of Reasoned behaviour [3] and has been able to show how a persons opinion can change their attitudes and thus their actions. Over time the TAM has been used to explain the adoption of many different technologies such as Lederer et al [15] who showed the TAM can effectively explain the adoption of the world wide web and Vijaseraty [30] who has adopted the model to be more useful for eCommerce. As such scientists have also tried to explain the adoption of blockchain through this model.

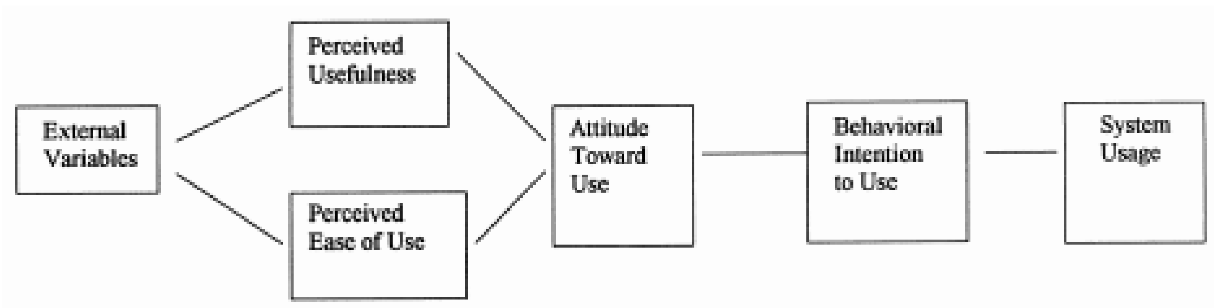

Figure 2.3: Technology acceptance model [15]

Regarding blockchain and the TAM not much has been written yet. Thiruchelvam et al [27] has written that blockchain applications will mostly fit within the usefulness category of the model, which should increase the intention to use them. Meanwhile Li [16] has combined the TAM and the innovation diffusion theory [31] and is planning to use it to explain the adoption of blockchain, this research is still ongoing.

Kern [14] has conducted thorough research into the TAM combination with blockchain. He also generated a blockchain specific TAM (Figure 2.4). Wherein he conducted a survey, mostly among students [14, p.27], which confirmed that his adaptation of the TAM is also a valid model for the adoption of blockchain [14, p.38]. His research indicates that the level of knowledge is of paramount importance in the acceptance of blockchain by the public which could be a strong indicator why this technology is still being implemented reluctantly. Especially when Iansiti and Lankani's model is used to link this lack of knowledge to the complexity dimension [12].

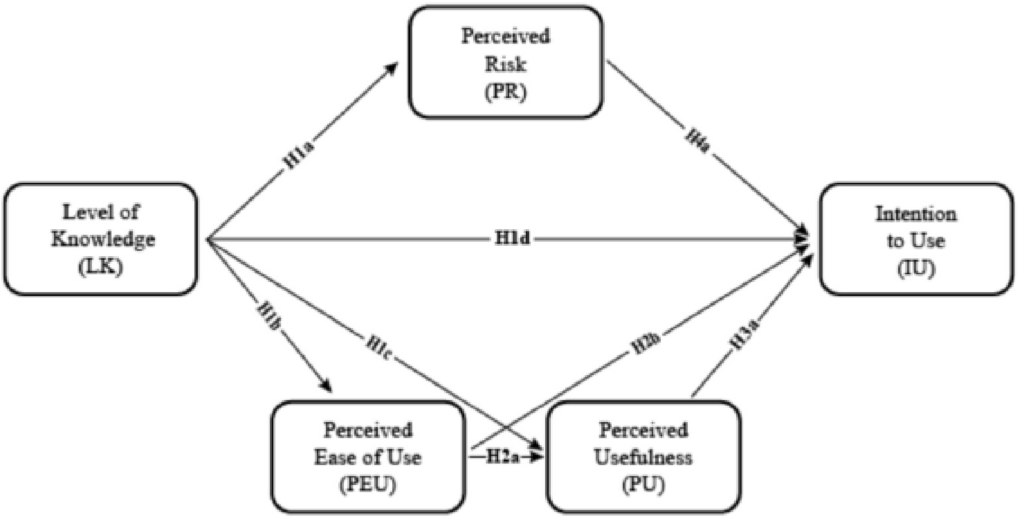

Figure 2.4: TAM for blockchain [14]

2.4 Differences between blockchains

After Bitcoin became more popular other blockchain systems have been established by different companies. This makes it important to research these different blockchains and decide which one would be best for one's application. Valenta [28] has created an overview of differences between the blockchains: Ethereum, hyperledger and Corda. He lists the following points as the main differences between the blockchain. Ethereum requires that all nodes need to reach a consensus over all transactions, permissionless consensus, [28, p.3] while Hyperledger and Corda only require the involved parties to reach consensus over the transactions, permissioned consensus [28, p.3]. A second difference is the way smart contracts are used within the different blockchains. All three of the blockchain systems offer the use of programming languages to create smart contracts yet Corda also offers the possibility to use legal prose in the contracts [28, p.6]. A third difference is the existence of built-in currencies. Of these three blockchains ethereum is the only one that has a built in currency. This is because the other blockchains do not require miners to validate transactions and as such do not need to reward these miners in the process [28, p.7].

2.5 eCommerce Trust

Another major aspect of eCommerce is the trust of consumers. Oliveira et al. [20] show that, as of 2017, 38% of the European population between 16 and 74 years old have made purchases online. Although this varies dramatically from country to country. Their paper mentions two main causes for people to refrain from buying products online:

- Buying products online lacks human warmth
- Consumers do not trust online vendors

In their paper they mainly address the question: Does trust in online vendors influence consumers decisions to buy online? [20, p.153] They explicitly looked at the Portuguese economy for this paper as only 15% of the Portuguese people have made purchases online. They compared several models and papers based on trust to assess which factors influence online trust.

Their findings corroborate that trust correlates directly to people's decisions to make purchases online. In their survey they have also found that elements concerning trust are related to:

- The general inclination of the consumers
- The look/feel of the website
- The likeability of the online vendor
- The integrity of the online vendor(more specifically, a lack of integrity as a negative effect)

- Interactions with the online vendor

Meanwhile, Aïmeur et al [1] claim that only 20% of the people trust eCommerce websites. They claim this has mostly to do with the fact that they use personal data. Many users think it is unfair that companies profit from their personal data [1, p.368]. One source of this distrust is the use of privacy policies. These lengthy legal documents are hardly ever read by the users of the software [1, p.368]. They have conducted an experiment where they have changed the look of privacy policies to test whether users would interact with them more. They propose a framework where the privacy is regulated through a central authority who will provide online services with your data when requested. The user determines how much information he/she wants to share with the central authority who will then ensure this level of privacy with the online services [1, p. 370-371]. Their results show that the use of this system benefits the readability of privacy policies, the assumed benevolence of services, the profit of these services and the trust of users in the service.

Another problem that was identified by Fairfield [9] is that it is not always possible for online service providers to let the user determine how much information is shared. The online service provider needs some information to ensure he can send products to your house or to ensure he will get paid for his service. In addition he found that this system still requires users to trust another online service. A decentralized trustless system could therefore be a better fit and might hold the same benefits as the system designed by Ameur et al [1].

In contrast Shankar et al [25] have chosen a more wholesome approach to eCommerce trust by looking at all stakeholders involved. They chose the definition of trust by Luhnman [17] which states: *" trust can be seen as the belief by one party about another party that the other party will behave in a predictable manner."* [25, p.327] They state that in online trust the firms website acts as a salesperson, it is meant to convince the customer of the reliability of the firm [25, p.327]. Shankar et al have identified 7 different stakeholders related to an eCommerce firm which can be found in Figure 2.5. Each of these stakeholders have different interests in the eCommerce firm. A full list of the trust perspectives of each stakeholder can be found in Table 1 of Shankar et al's paper [25, p.329]. Shankar et al [25] continue by providing a literature study into the characteristics of trust in many different fields and transform this into a conceptual model which bases online trust on Website Characteristics, User characteristics and Other Characteristics. Their conceptual model claims that online trust will affect the Intent to act, Satisfaction, Loyalty and Firm performance for each stakeholder [25, p.336]. As such it is important for eCommerce firms to look at trust to enhance their business opportunities.

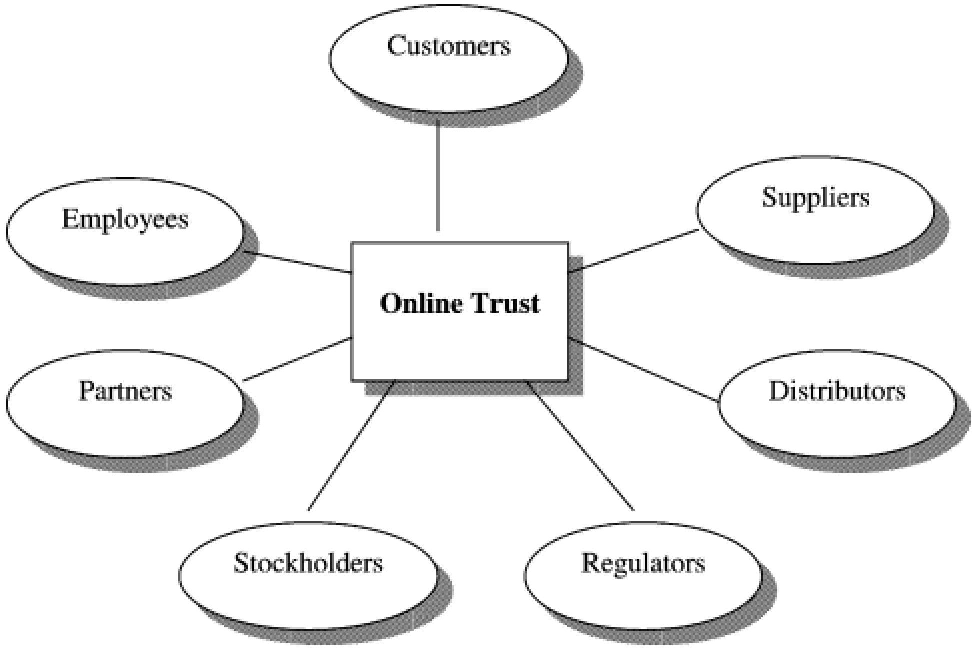

Figure 2.5: stakeholders for ecommerce [25]

As the TAM model has been applied to blockchain [14] it has also been applied to eCommerce. Vijayasarathy [30] has found that the TAM model is not as adequate in describing Business to Customer(B2C) commerce through the internet as it would be for business settings. This is because the 'ease of use' and 'usefulness' are not the only things regular consumers look at when they shop online [30, p.748]. They therefore suggest combining the TAM with the theory of planned behaviour(TPB) by Azjen [4]. This theory tries to explain human actions not by 'usefulness' or 'ease of use' but by 'attitude towards behaviour', 'a subjective norm' and 'perceived behavioural control' [4, p.182]. According to Mathieson [18], these factors were left out intentionally by Davis [7] when designing the TAM to ensure it's generalizability. Mathieson continued by using a questionnaire to see which of the models (TPB and TAM) explains the intention to act in a certain way the best. His study concludes that both models are efficient in explaining this. He did find that attitude towards a system is better explained by the

TAM. Vijayasarathy [30] used this theory in combination with the TAM which leads to a more personal form of the TAM which incorporates factors such as privacy and normative beliefs about the use of a system. The remainder of their research uses a questionaire to validate the model. Their research shows that these factors are indeed significant for the adoption of a new technology [30]. In a way this also explains Mathieson's results stating that both the TPB and the TAM are efficient at predicting intention [18] and thus the combination also yields better results as both models (the TPB and the TAM) explain a part of the intention.

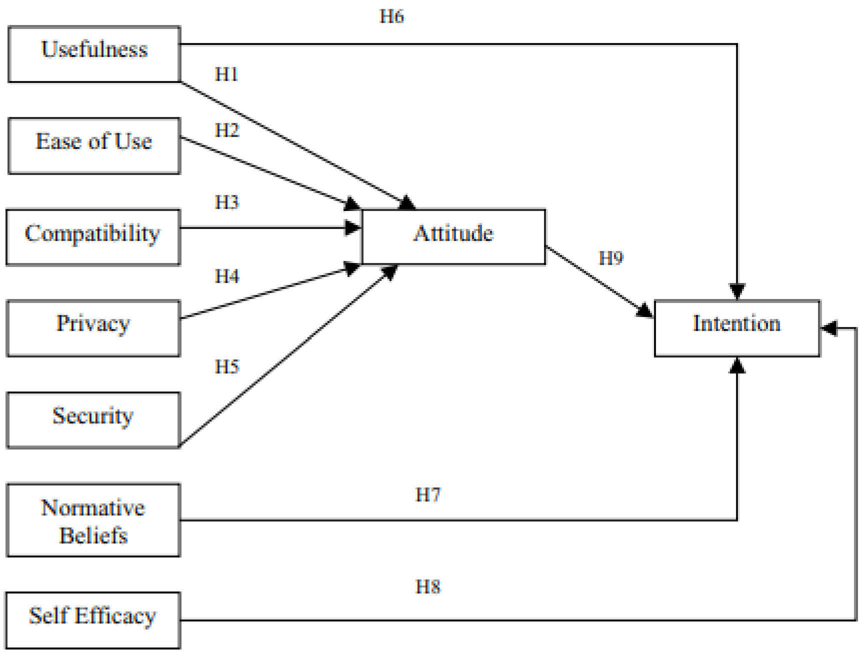

Figure 2.6: TAM model augmented with the theory of planned behaviour [30]

2.6 Proposed blockchain solutions in eCommerce

Dennis and Owenson [8] have done research into reputation systems in use in many different types of online activities. In their paper they explain how reputation systems work online. Showing how eCommerce reputation systems are often multidimensional(the client can rate several aspects of the experience) while Peer to Peer(P2P) reputation systems often are not [8]. Dennis and Owenson [8] have also found that in many cases eCommerce reputation systems are in need of a centralized authority while in P2P reputation systems this is not necessary. In their research they have found several problems in the existence of these reputation systems which include:

- The calculation of reputation in these systems often gets determined by one party and they are free to change the algorithm if they like
- It is not possible for users to know whether a party has interacted with the party they are rating
- It is not possible to prevent users from creating multiple accounts and rating the same party multiple times

They go on by explaining proposed types of reputation systems and the possible attacks that can be issued against such a system by a malicious party to increase their own reputation. The paper explains that there is a motive for an attack against a reputation system as an online vendor with a high online reputation will have a revenue which is about 11.2% higher than the competition [8, p.3] This was also found by Jsang et al [13] who have run an experiment where they simulated an online market with and without a reputation system. Their study concludes that a market where strangers buy from each other can not become healthy [13]. In comparison Melnik et al [19] have found the same result in an empirical study on Ebay auctions, in particular one about a 1999 gold U.S. Dollar [19, p.3]. Their results also show a positive relation between eCommerce trust and the willingness of potential customers to pay for an item, even though it is only a very slight increase [19, p.10].

Dennis and Owenson [8] propose the use of a blockchain reputation system. Their system is mostly focused on sharing a file and if the end users both have received the file correctly it can be added to the blockchain as a reputation score of one [8]. This would ensure that every reputation within the system is indeed based on a transaction in the blockchain. Dennis and Owenson [8] also propose to use IPv4 addresses to identify users and solve the multiple accounts problem. They state that IPv4 addresses are getting harder to come by so someone who wants to try and trick the system will need a lot of resources to pull it off. However IPv4 addresses are not identifiers for single computers or users, which means a different solution will need to be found to solve the multiple users problem.

If the system is expanded in order to allow users to rate vendors multidimensionally based on an existing transaction of a purchase in the blockchain, every transaction on the blockchain is guaranteed to pertain to an actual purchase and the attackers would need to set up multiple accounts and start making actual purchases. The open nature of the blockchain would easily reveal how many users a store has that hate it or love it and how many reviews/purchases these users have made at different online stores, which could verify their account. For example, positive reviews from users that never leave reviews anywhere else are more suspicious than bad reviews left at the same store by users that regularly purchase items at many different stores.

In contrast, Pavlou et al. [21] have written a paper detailing how the entire ecommerce infrastructure can be simplified through blockchain. They claim a system called buying.com can give manufacturers and consumers the ability to communicate, allowing people to directly order from the manufacturers and using it to lower prices. They also claim that their system can turn every garage into a micro distribution centre as this is one of the main problems plaguing online vendors. The paper goes into a lot of detail regarding delivery optimization, which will be outside the scope of this research yet does not discuss ways for existing companies to start interacting with their new system. This endeavor is not supposed to be of a scientific nature but rather a commercial one which could explain why they have chosen not to address these issues. The gaps in their research however should still be addressed and empirically tested.

2.7 Smart contracts

eCommerce introduces a fundamental flaw in the way online contracts are set up as explained by Fairfield [9]. He claims that other than in the current physical purchases, online purchases leave the consumer helpless. The consumer has no choice but to accept the terms of the contract posed to him by the online vendor. According to Fairfield [9], the online vendor is able to issue a legally binding contract while the terms the consumer would like to see can be completely ignored by the online retailers. He even claims eCommerce stores have set up their websites specifically to enable as little choice as possible in anything other than the amount of items a client would like to order and apparently the courts are unable to protect consumers: *" Consider the routine online disclaimer of warranties, which has eviscerated consumer protections offered by the Uniform Commercial Code "* [9, p.44].

These issues are mostly related to personal information which consumers might not be willing to share. The big problem here is that it is not possible to exchange property online without giving personal information as an online payment is mostly a group of parties all agreeing to pay and/or exchange goods at some point in the future which requires all parties to know the identities of all other parties in order to enforce this contract [9, p.46]. This is not the case for physical sales.

Fairfield claims this problem can be solved through the use of smart contracts. In his words: *" Instead of just clicking " I Agree, " consumers could actually contract again "* [9, p.43]. He claims that the use of blockchain can ensure that the contract can be enforced without other intermediaries and can also keep the information regarding the consumer private. Other consumer rights (such as refunds) could also be enforced through the use of smart contracts left completely to the vendor.

Huckle et al. [11] take the idea of smart contracts even further by combining the idea with the Internet of Things (IoT). They propose multiple systems which could benefit from the use of blockchain and IoT. A few systems uses for blockchain and IoT that they propose are:

- Reserving a space in a car park
- Check the refrigerator and do daily shopping
- Creating a decentralized exchange for foreign currencies
- Checking the fuel in a car and automatically paying for new gas

These scenarios describe ideal situations of the way blockchain technology could be used and may sound like something from science fiction if the technology would be adopted fully by the public.

Chapter 3

Problem Statement

Many eCommerce companies wish to implement upcoming technologies in order to keep up or get ahead of their competition. These companies do not have the resources to start integrating technologies such as blockchain. They are now faced with the question of how they can still try to implement blockchain applications without having to make a massive investment. This case study offers a solution where a software development company called 3WebApps [44] will take over most of this process by developing a blockchain application called Blockshare which online retailers could readily use. The tasks this solution manage should show the owners of eCommerce companies that they can either improve upon their existing business practices or reduce the effort they need to conduct their business.

A second part of the current problem surrounding blockchain solutions for ecommerce is that although there are solutions presented in the scientific literature none of these solutions have been implemented in an experimental setting to confirm the performance claimed by the authors.

In cooperation with 3WebApps [44] it was decided that the most interesting case to work out was that of drop-shipment through blockchain implementations as described by Pavlou et al [21]. From their personal experiences they already know how dropshipment works at this moment. If a seller wishes to sell through different channels such as *Amazon* or *bol.com* he will have to create a different plugin for each different channel through which he wishes to sell. The practice of selling in this fashion is a massive business, amazon has close to half of all online sales in the US [40] and about half of that in turn is sold through third parties [41]. This makes it very attractive for businesses to incorporate these channels into their own websites. As such 3WebApps preferred this business case the best and requested the creation of this particular application.

Chapter 4

Research questions

Although the initial aim of this project was to build multiple blockchain applications described in Chapter 2 it became clear that this is infeasible in the time alotted time for this project.Therefore only one implementation from chapter two was implemented. The reason to build the blockchain application instead of using mockups would be twofold: firstly 3WebApps requested a proof of concept to show that the application was not just theoretical but could actually be built and secondly to give an effective demo to test subjects as this would be more meaningfull than a mockup. As the research has narrowed down for a number of different blockchain applications to a single blockchain application the initial research question:

RQ: Do the proposed blockchain solutions actually solve the problems they were intended for in a useful way?

Has been revised, and is now as follows:

RQ: Do potential users want to use a blockchain version of the dropshipment functionality?

According to the TAM by Davis [7] this requires the blockchain application to either fulfill a need for these retailers or make their current business practices easier. These factors were assessed both from a business and a technological point of view and as such the following subquestions were established:

- SQ1: Does the software architecture of the blockchain application provide any additional benefits/drawbacks over traditional models
- SQ2: Does the blockchain variant of the application solve a problem for online retailer?
- SQ3: Does the blockchain variant of the application reduce efforts for online retailers?
- SQ4: Does the blockchain variant of the application create new threats for online vendors?

Each of these questions will be addressed both on a technical and on a business level, by giving an overview of threats/benefits to the business of online retailers and an overview of threats/benefits to developers.

4.1 Research method

To address these research questions design science [32] will be used. The way this is implemented can be seen in Figure 4.1. The literature provided in chapter two demonstrates the first two sections of a design cycle for this research method(problem investigation and treatment design), which complements the problem statement in chapter three, these researchers have identified problems in the practice of eCommerce and have proposed a treatment to tackle the problems they have identified. However they have not validated their treatments which will be the point of this research. In other words, this thesis aims to test a solution proposed in earlier research to see if it has the merits described in the paper by Pavlou et al [21].

As Pavlou et al's [21] design does not provide much detail chapters five and six will give a more detailed description of the artifacts used to validate the proposed treatment(treatment design). Chapter seven will describe the validation process and explain the results of this validation(treatment validation). The treatment will not be implemented in a production environment during the course of this study and as such the treatment implementation is left to future research.

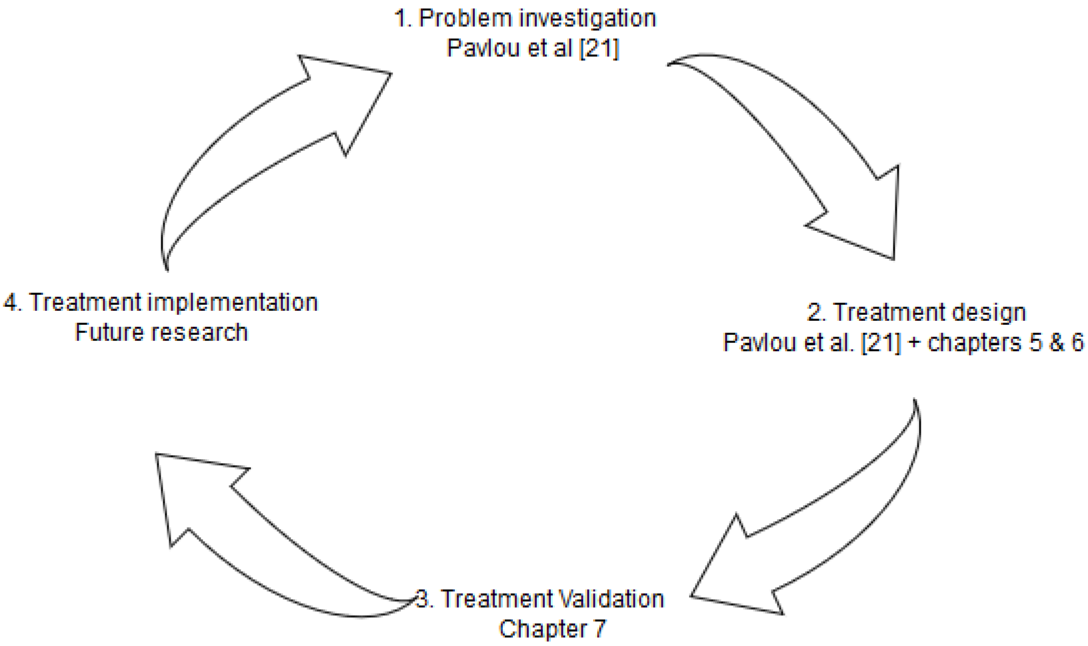

Figure 4.1: Instantiated design cycle

Chapter 5

Architectures for the case study

Before considering the blockchain variant of the application described in the problem statement, the research requires an exploration of different architectural models that could implement dropshipment. An analysis of these models might showcase that a blockchain solution might not present as the best implementation for this functionality which would render the application useless. Three different models for implementing dropshipment were distinguished:

- The Custom APIs model: This model represents the usual way drop shipment is implemented at this moment. Every platform has created it's own API and requires users of the platform to implement the API.
- A Centralized model: This model allows for the implementation of a single API to a centralized server. This server collects all the products and platforms can retrieve them from this system. The platforms than push orders to the centralized server where the sellers can retrieve those and deliver to the client.
- A Decentralized model through a blockchain: The essence of this model is the same as that of the centralized server yet instead of using one central server a blockchain is used to create a decentralized network that collects all products and orders.

After describing the Models the a short analysis on the merits of each particular model will be given.

5.1 The Custom APIs model

As I has built several connectors for 3rd party platforms in the past, I am quite familiar with the way these platforms allow users to connect to them. At this moment these platforms have developed their own APIs[1]. If a user wants to sell products on this platform he usually has to create a product feed containing all relevant information on the products he wants to sell on these platforms. Often these feeds are delivered in the form of an XML document. The user than has to provide a URL where the platform can retrieve said feed and depending on the platform this feed will be retrieved either once or multiple times a day. Many of these platforms offer either a REST or SOAP interface to retrieve orders placed on the platform. Some platforms don't do direct sales but only referrals to the original seller, these logically do not implement APIs to retrieve orders. An example of a product feed definition can be found at [50]. One issue in this model is that each of these platforms has a different standard for the product feed and the order retrieval API This requires the user to create a specific implementation for each of the platforms the user wishes to sell through. This can be seen in Figure 5.2. The upper blocks represent different platforms while the bottom blocks represent different online stores. Each of these stores is connected to all the platforms with a separate connection they will have to maintain themselves.

5.2 A centralized model

One way to adapt this model that seems more logical is through the introduction of a centralised server. All parties who wish to sell information through certain platforms could upload their product information to the centralised server, this server could then share this information with the platforms the user wants to sell through. This would resolve the need for users to implement a specific API for each platform. It could also make it easier for platforms to find products to sell as they could ask sellers connected to the central server if they can sell their information. One variant of this model is the one used by Channable [49]. They have a centralised server

[1]Application programmable interface: An interface which allows systems to communicate with each other

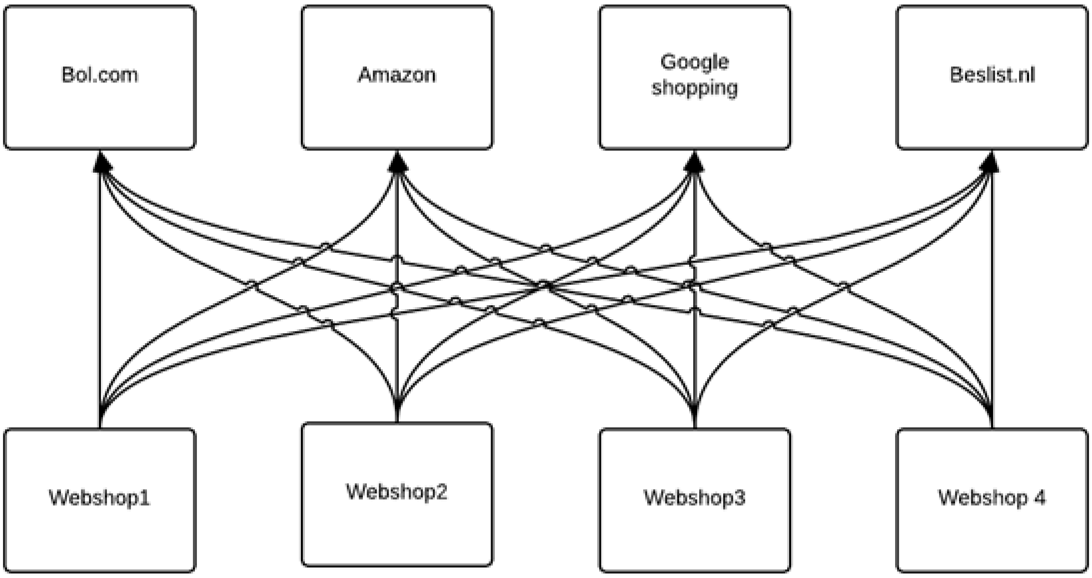

Figure 5.1: The Custom APIs model

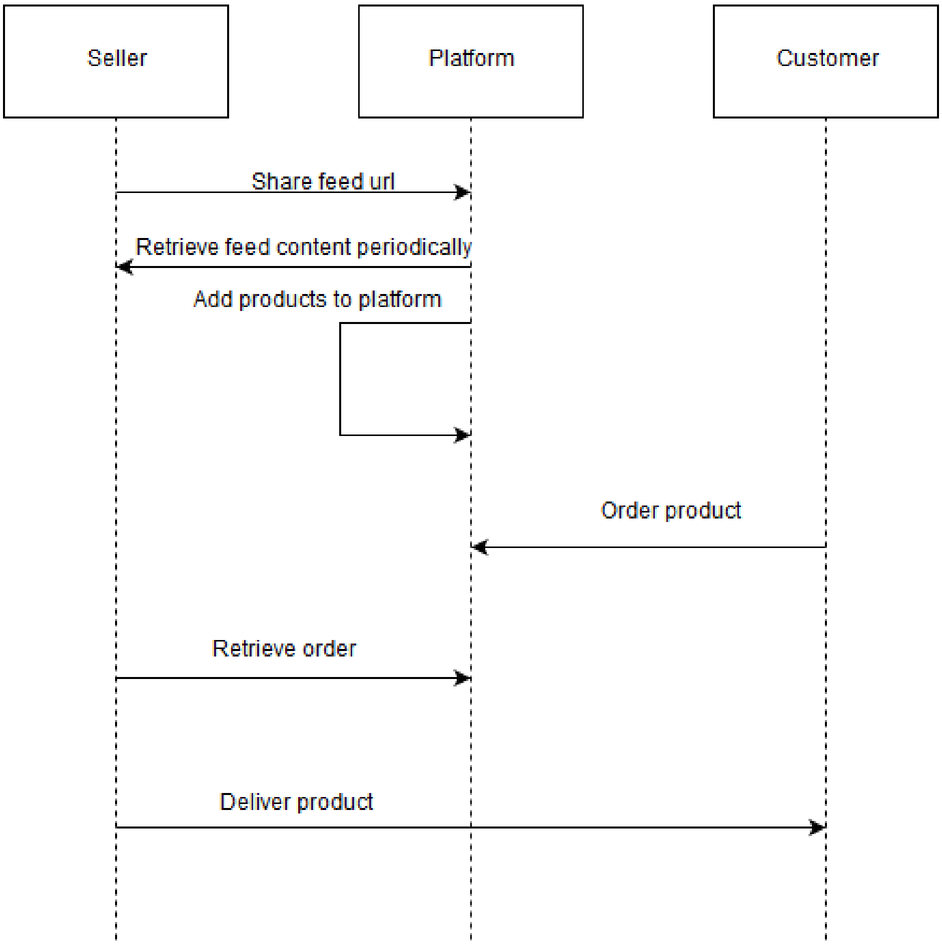

Figure 5.2: Sequence of the Custom APIs model

which has implemented the APIs of several platforms and will make the product feeds available for the platform the user wants to sell through. Figure 5.3 shows how unlike Figure 5.2 each of the bottom blocks now only has to build one connection to publish their products.

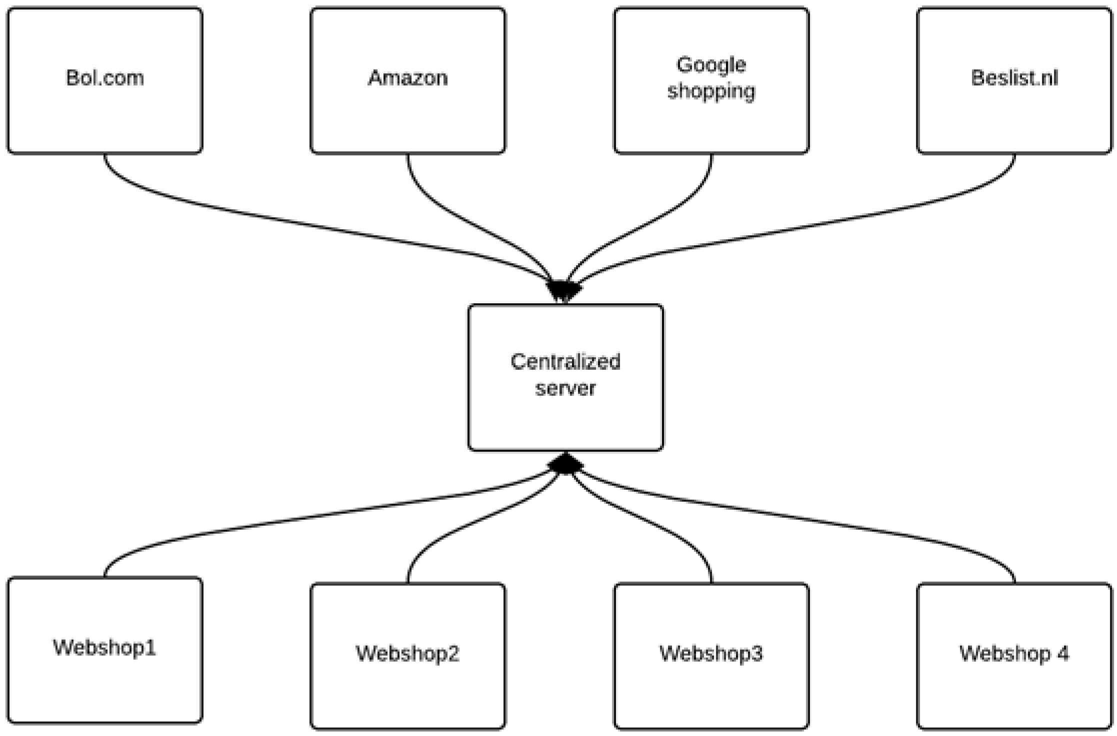

Figure 5.3: Centralised model

5.3 A decentralized model through blockchain

A third way this functionality could be implemented is through a decentralized network. In this model there would be no centralized source of information. Users of the application could publish their products onto the blockchain. These products would than become visible to all nodes connected to this blockchain and they could do with these products as they wish. The same could be done for orders. The publishing of an order could also allow others sellers in the blockchain to immediately update their stock of this product to prevent them from selling too many. This solution would make it much easier for other online retailers to start selling other seller's products. With this system any seller could easily start selling products of other sellers, creating more opportunities for small sellers.

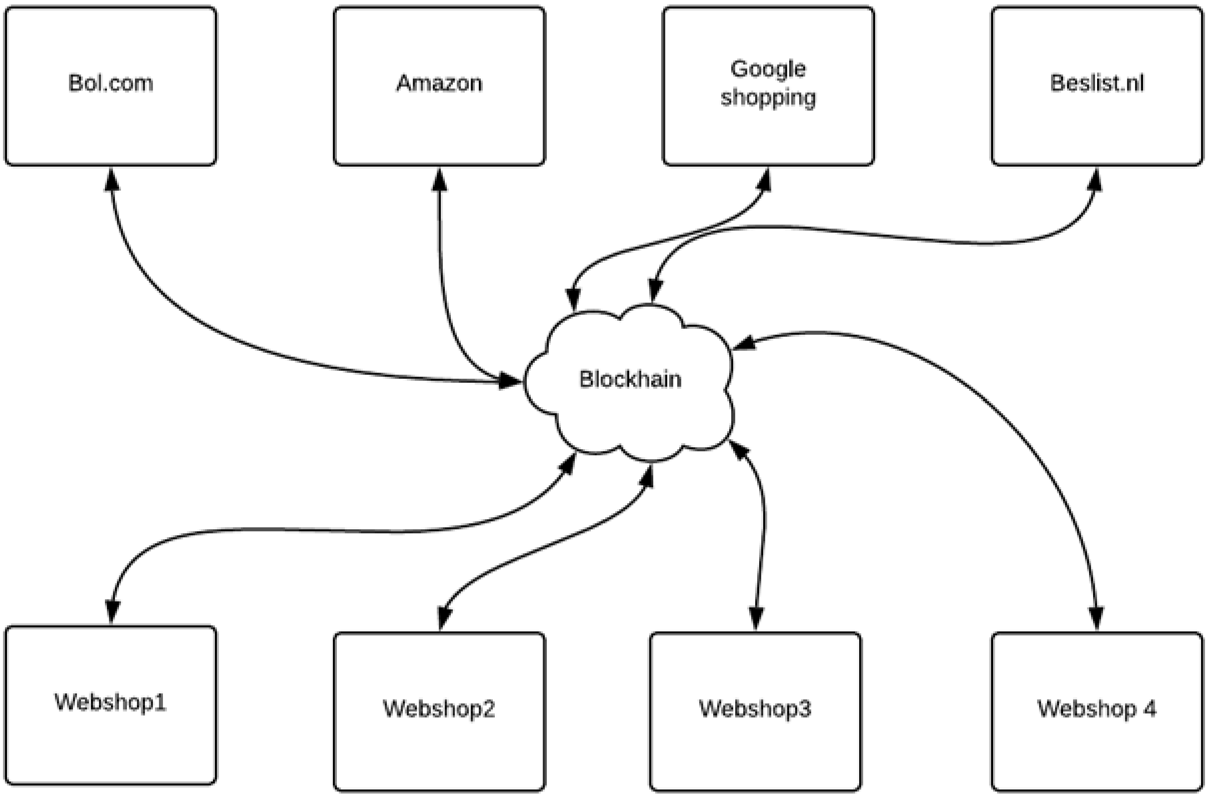

Figure 5.4: Blockchain model

5.4 Comparison of the architectures

The main benefit for platform owners to use the Custom APIs model is that they can determine how their own API works. This is a benefit for them as they don't have to trust a third party to implement a foolproof system for them. This model has no real benefit for small sellers. They need to implement an API for every platform that they connect with and need to maintain all these APIs in case the platforms decide to make a change. This is also the main drawback of the model. In terms of performance the system could respond rapidly however many implementations only update their systems once a day.

The other models both solve the main drawback of the first model. Both of these models allow the small sellers to implement just one API and sell through multiple platforms using this implementation. Platforms lose the ability to dictate their own API to sellers but as most information will be the same across all APIs this does not change their implementation much while making it a lot easier for small sellers.

The big drawback of the second model is that it centralizes all possible issues. This ensures that the central party needs to be trustworthy and needs to ensure the security and availability of his system. A situation where a hacker changes prices in the central server and starts ordering products far below market value would be disastrous for the sellers.

The blockchain model attempts to solve both of these issues. The blockchain allows users to publish their information onto the blockchain which makes it accessible for all participants and the blockchain itself ensures the integrity of the data and the availability of the general system even if a some nodes would drop out.

The drawbacks in the blockchain model lie in the fact that it doesn't have the same potential in performance as the other two models and that all information becomes accessible to all participants on the blockchain. Some users might value their privacy more and choose that this is not an option they feel comfortable with.

Chapter 6

Blockshare: A blockchain application to enable dropshipment

Having presented the different models for dealing with the dropshipment functionality, this chapter will detail the blockchain version of the eCommerce application called Blockshare. Firstly a decision on the framework and programming language to work in had to be made. The most common platforms for eCommerce applications at the time of writing are either WooCommerce or Magento [47]. Both of these platforms are extensible so it is possible to add the Blockshare extension to either of these systems. Both of these platforms were written in PHP [54] so this programming language seems the most obvious to work with. Since 3WebApps specializes in Magento webshops it was decided to develop the application as a Magento2 extension in combination with the ethereum blockchain.

This chapter will first give an outline on what Magento (sec 6.1) is and how it is structured. The chapter will continue by explaining why and how the ethereum blockchain was used (sec 6.2). The details of Blockshare will then be explained in the remainder of this chapter (sec 6.3).

6.1 Magento

Magento is an eCommerce solution covering all basic necessities for an online retailer. The system covers the creation of products, managing customers and orders and the design of the store. The system is set up so developers can personalise the store both in design and technical terms.

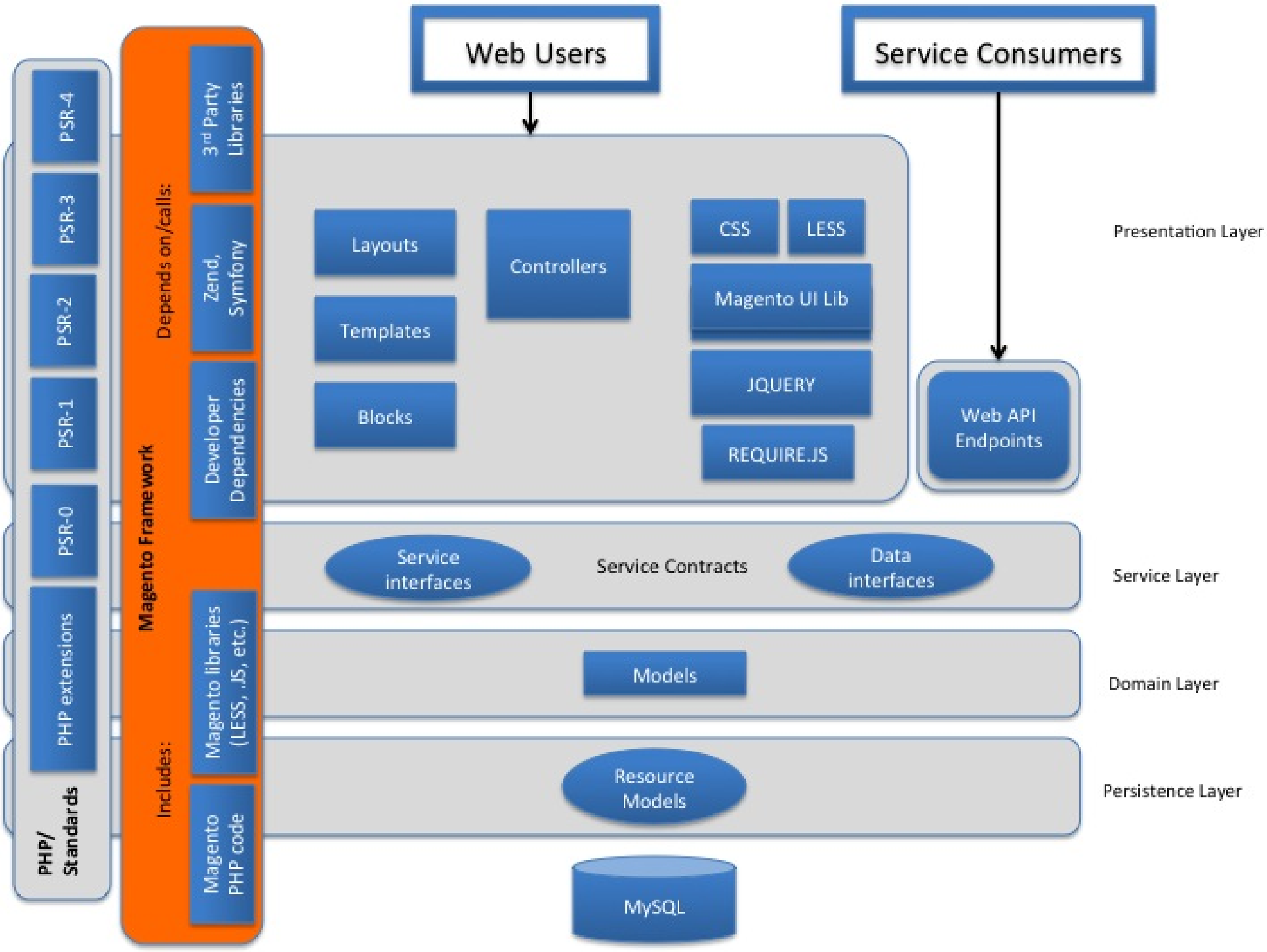

Figure 6.1: Magento architecture [55]

Figure 6.1 shows Magento's own architectural diagram. The Figure shows how Magento is a complex system. The Persistance and domain layers show the flexibility of the system in terms of the database, allowing the creation of models to create application in the way the user wants. The presentation layer details all aspects of the way the user interacts with the system, most notably the controllers and Web API Endpoints. The architecture only shows generic elements of the architecture. This is because all elements in the system are extensible and can be changed by a developer if they want to.

Magento2 is designed using parts of the symfony framework [48] and as such Magento2 works as an MVC framework. Separating several actions in controllers as specific URI endpoints. Several controller actions have been predefined by Magento but can either be overridden or hooked into using actions and observers. Magento also offers the possibility to create entities to be created in the database and offers a range of standardised GUI elements that can easily be implemented into a personalised action. The use of these elements will deal with most of the overhead of the application making it easier to focus on the technical implementation of the blockchain application.

A blockchain to use for Blockshare also needed to be chosen. A look into the documentation of several blockchains revealed that Ethereum had a straightforward contract language and could quickly be set up [36]. The ethereum blockchain also has a Json[1] RPC API which will ensure easy communication with the blockchain through a PHP application. This is why the ethereum blockchain was chosen for Blockshare.

6.2 Ethereum

The Ethereum blockchain [42] is a blockchain app platform allowing the creation of smart contracts in a contracting language called solidity [37]. This language has the form of an Object Oriented programming language and is therefore generally easy to learn for a developer. The software required to run an ethereum node can easily be installed on any system. For example, on a linux based system ethereum was easily available through a package manager [36]. Once the system is running it can easily be interacted with through an RPC API. This RPC API is accessed through HTTP and thus can easily be used by web applications. When the Ethereum software is started a port can be given to the software from where the system will run and be accessible on the network. The user can interact with the blockchain by accessing http://[ip_address]:[port_number]. HTTP POST calls can be send to this address containing a

[1] Javascript object notation

```
{"jsonrpc" : "2.0",
 "method" : "eth_getTransactionByHash",
 "params" : ["0x93941560352d39d537faab239d796bcc0889188e45e9ac2cceb3d5db7978c668"],
            "id" : 1
```


Figure 6.2: Ethereum Json

Json body which tells Ethereum what command to execute. This body contains the API version, the method the call should execute and parameters required for the execution. For example Figure 6.2 shows the body of a call which retrieves a transaction on the blockchain by its hash. The current version (2.0) of the API is used, the method is called eth_getTransactionByHash and the parameters are the hash that is looked up by the system and an id of the call. Further documentation of the Ethereum API can be found can be found in the reference [51]. This application will use the following commands to send messages over the ethereum blockchain:

- eth_sendTransaction: This function will create a smart contract on the ethereum blockchain
- eth_getLastBlockByNumber: This function is used to query previous blocks
- eth_getTransactionReceipt: This function is used to check if the contract has reached the blockchain

6.3 Application design

The developed application consists of two types of interaction between online stores. The stores share products and they share orders. Further differences between these interactions are that the sharing of products is an interaction between just the employees of the online stores while the sharing of products is mostly an interaction between the end customer and the original publisher of the product. These interactions are separated in different classes within the application. The sequence diagram shown in figure 6.3 shows how these parts interact with each other. In this Model the publisher uses the product publishing interaction to showcase his products on the blockchain, the seller will then query the blockchain for products and add the ones he likes to his own product collection. This constitutes the product publishing

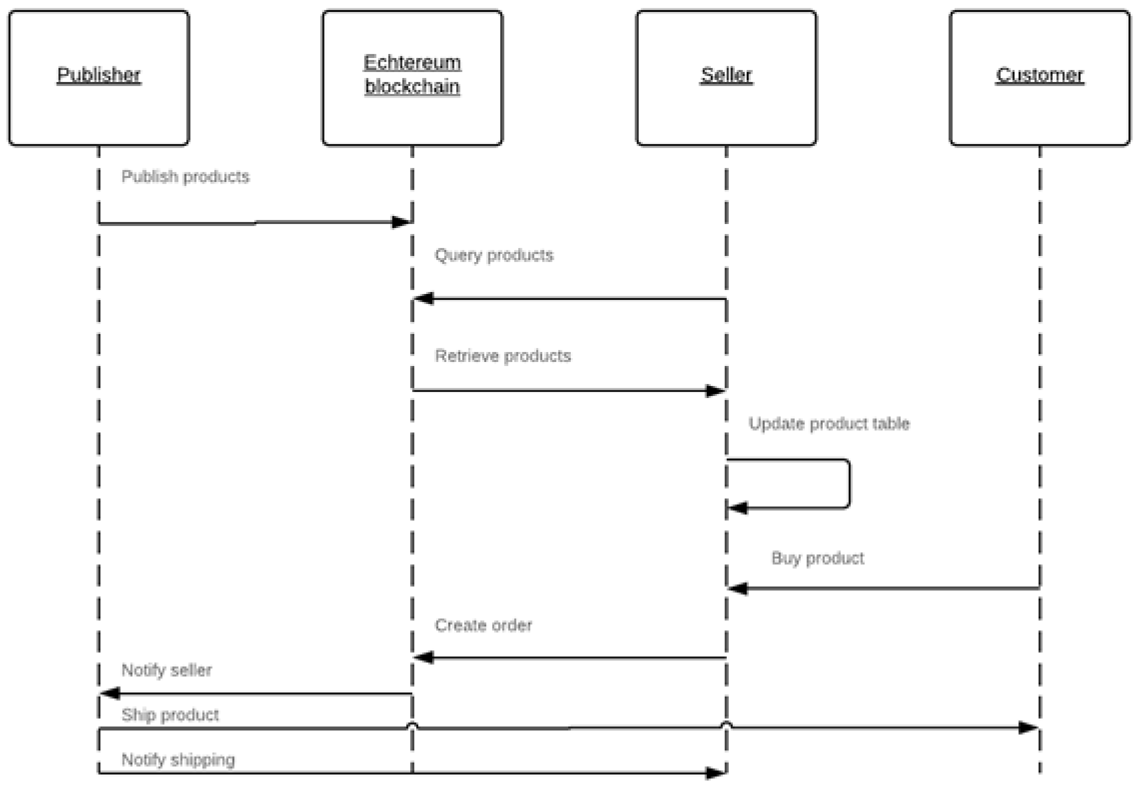

Figure 6.3: Sequence diagram

interaction. When the seller makes a sale of someone else's product an order will be published on the blockchain. The Publisher will query the blockchain to check if there are new orders for him and if he finds new orders on the blokchain he will create them in the backend of his Magento system so they can be fulfilled. This is the order handling interaction.

6.3.1 Product publishing

The product publishing functionality consists of two different controllers. One for publishing and one for retrieving products. The product pushing controller can be called from a button on the product detail page. This controller gathers the required fields from the product in the database, compiles them into a Json string and publishes this Json string onto the blockchain. A Json string was chosen for this functionality as it gives more flexibility to the selected product attributes than a contract with a number of preselected attributes. The controller will then push the product onto the blockchain and check if it has reached the chain by querying the

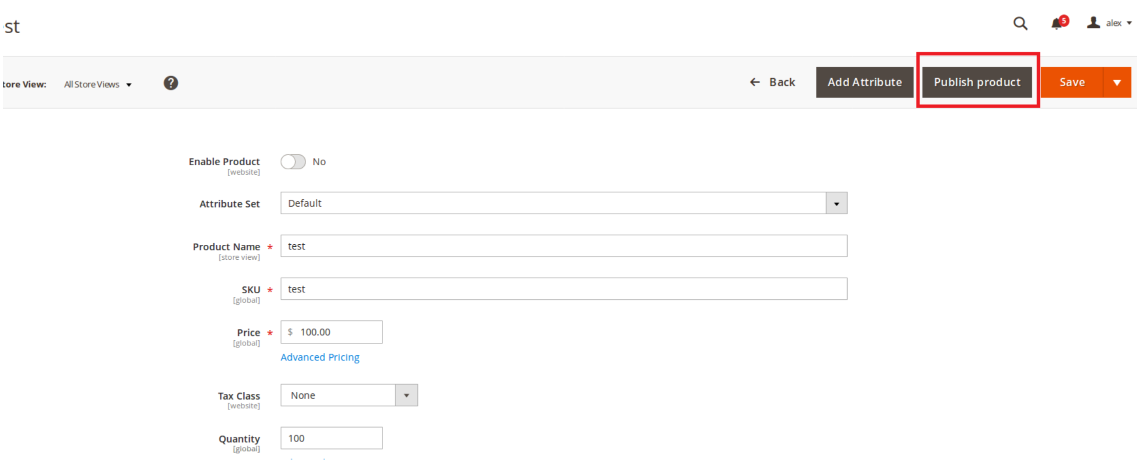

Figure 6.4: Product detail page with publish button

Figure 6.5: Product import screen

transaction receipt.

For retrieving the products a separate screen was added to the Magento admin Layout, this screen will query the blockchain once it is loaded. For this it keeps track of how far it has previously looked at the blockchain and will retrieve everything after that. To save them into the Magento system a separate database table was created in the system using the Magento entities. The product import screen is equipped with an import function which will call a separate controller. This controller collects the selected blockchain products and will add them to the product collection of the seller. The seller can then start featuring them in his store.

The contract created is only a simple one. It only assigns the Json string to a variable on the blockchain. Checks on the validity of the product that is published are done in the Magento application itself(both on publishing and on importing the product) in an effort to reduce the load of miners on the blockchain that will need to create the contract.

6.3.2 Order handling

For the order handling no separate screens needed to be created. Magento events were used instead. Magento already has a checkout screen which allows the customer to buy a product which will then create an order. When a product is bought by a customer the *checkout_onepage_controller_success_action* will be dispatched. The developed Magento module has subscribed an observer to this event and as such this observer will then be called. This observer collects all the order data relevant to each particular seller included in the order. The observer than publishes the order onto the blockchain again as a Json string to allow for more flexibility. In the same way as during the product publishing this contract is only very simple and is used only to store the data on the blockchain and not to conduct any logic on the blockchain.

To retrieve the orders from the blockchain a cronjob[2] has been enabled through Magento. Every 10 minutes the system will check if new orders for that seller were published onto the blockchain and the observer subscribed to this cronjob will then add this order to the Magento backend so the seller can fullfill it.

[2] A piece of code which is executed periodically

Chapter 7

Artifact validation

The artifacts described in the previous chapters were evaluated both on a technical level and on a business level. To evaluate Blockshare on a technical level expert interviews with software developers/architects were conducted. In this interview all the architectural models from chapter 5 were described to the interviewee. The interviewee was then asked to score quality attributes of the software architecture using a 100 dollar test. In this test the interviewee was asked to split 100 dollars across the three implementations, giving the implementation which will perform best on a certain quality attribute the most points. The following quality attributes were assessed:

- Performance: Potential for speed at which the model can function?
- Security: How easy is it to manipulate data stored in the application?
- Privacy: How much personal data would be accessible to the public?
- Scalability: How much effort would it cost to add platforms or sellers to the system?
- Maintainability: How much effort would it cost to change the existing functionality?
- Availability: How likely is it that the system will go down?
- Transparency: How clear is it what all parties do with the data?

As these are themes repeatedly found in literature surrounding both eCommerce and blockchain. Once they have scored an attribute the interviewee was asked why they have scored the attributes like this and after their explanation they were asked if they wanted to change their scores. The scoring system will be split between the product publishing and the order handling for which the interviewee will have to score the same quality attributes. Once he has finished scoring the architectures the interviewee will be asked to identify any potential added benefits or threats each architecture might have. The scoring form can be found in Appendix A. In order to find which attributes are most important to the application the interviewee was also asked to give a priority in the range of one through ten, one being the least important and ten being the most important. This is done to give more weight to certain aspects of the implementation than others. One example of why this is relevant is that the shipping process is a relatively slow one and the reason for this is not because of the software. The speed at which orders are sent through should not be relevant to the shipment process.

To evaluate the business aspect of Blockshare semi-structured interviews will be performed. The questions for this interview can be found in Appendix B. The interviews will be held with managers/owners of online stores and corporate economists and the main goal of the interview is to check whether these managers would use an application like this given the chance and to see what potential issues they see in Blockshare. The basis for these evaluation questions lie in the TAM [7]. Therefore the questions aim to ask whether Blockshare fulfills a need for a retailer. The ease of use in this application will most likely depend on the exact implementation and not specifically on the blockchain implementation therefore questions surrounding this topic will be limited to asking whether maintaining multiple plugins for multiple platforms could be solved with this application, yet this could also be seen as fulfilling a need/solving a problem. Besides the original TAM the versions specifically for the eCommerce [30] and Blockchain [14] applications will be integrated into the application. The model for eCommerce states that privacy and security are also important factors in the acceptance of a new technology. The Blockchain model also states that risk(of which security and privacy would be a subset) and the level of knowledge on blockchain technology are seen as factors that inhibit the acceptance of a new technology. To combat the effects of the level of knowledge will have on their acceptance of the model the interviewer will first establish how much the subjects know about blockchain technology and if they don't understand how the application will work the interviewer will give a brief overview of what a blockchain is. The resulting questions will then be used to address the research questions. The results from these interviews are mostly in the form of a list of benefits, threats and mitigations to these threats. As more interviews were conducted more benefits/threats and mitigations were found and subsequent interviewees were asked to give their opinion on these points found by earlier interviewees.

7.1 Artifact implementation

In order to evaluate Blockshare described in chapter 6 it needs to be available for demonstrations with test subjects. To facilitate this a VPS was arranged which runs two Magento2 instances. One of said instances will be used as a host site. This site will function as the owner of the product and publish the product on the blockchain. The second instance functions as the seller. It will be used to import the product from the blockchain and sell it to customers.

7.2 Results

Having completed the interviews the following results were found. Just as the interviews were split into a technical and a business perspective so to have the results been split into a technical and a business perspective. An overview of all interviewees can be found in Table 7.1.

7.2.1 Technical interview results

The results of the interviews were analysed and on most accounts the blockchain implementation has scored best out of the three options. The means for each of the technical interviews can be found in Figure 7.1, More details on the results of each quality attribute can be found in Section 7.1.1. The explanations are all accompanied by a boxplot showing the distribution of

Identifier	Interviewee type	Specialty
t_1	technical	eCommerce development
t_2	technical	eCommerce development
t_3	technical	eCommerce development
t_4	technical	Computer science student
t_5	technical	Business informatics student
t_6	technical	eCommerce development
t_7	technical	eCommerce development
t_8	technical	blockchain development
b_1	business	eCommerce manager
b_2	business	eCommerce marketeer
b_3	business	corporate economist focusing on blockchain
b_4	business	corporate economist
b_5	business	corporate economist
b_6	business	corporate economist

Table 7.1: interviewee identifiers

interviewee answers. Both the means graph and the boxplots show the results of the 100 dollar tests. It should be noted that the interviewees all mentioned that more specific implementations could change these values. For example if the centralised server model has backup servers the availability would already be much better according to the interviewees. The research method states that the interviews would be split in a section for product publishing and one for order handling yet the results were almost identical for all quality attributes except for privacy. When it came to privacy. As such the results will only discuss both these functionalities for privacy, the rest will give a general impression of the application.

The quality attributes were ordered using the priorities(1 through 10 with 1 being the least important and 10 being the most important) offered by the interviewees:

- Security: 9.2
- Availability: 8.8
- Transparency: 8.4
- Maintainability: 8.2
- Scalability: 7.6

- Privacy 7.4
- Performance 7.2

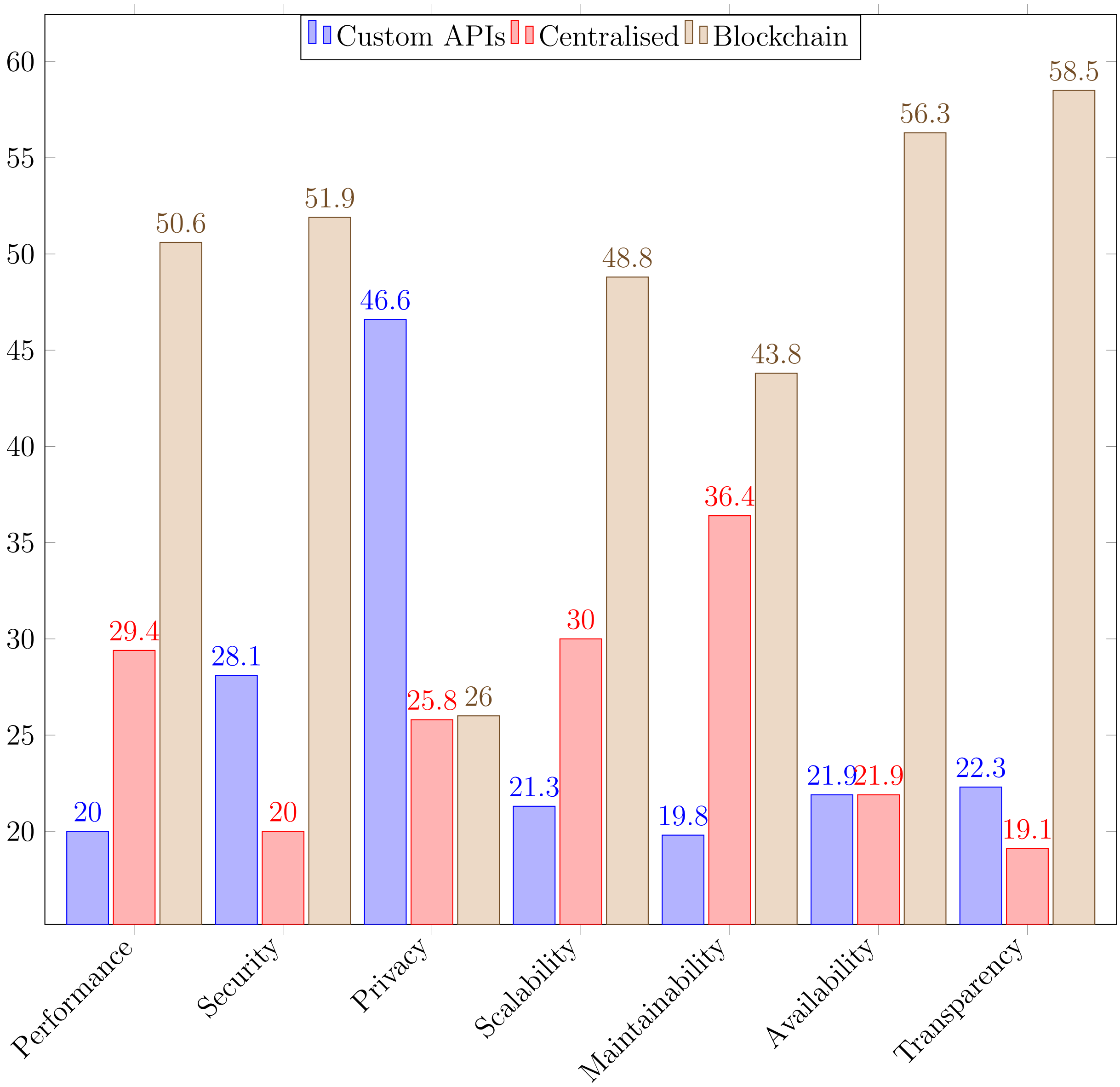

Figure 7.1: Technical interview means

Security

When it comes to security the interviewees agreed that the decentralized storage of a blockchain would make it hard to tamper with product attributes such as price. They were very negative about the centralised model. As with many of the attributes in this chapter the interviewees mentioned that this would create a single point of failure. This point was first brought up by interviewee t_1 and was reinforced by all other interviewees. If the central server was hacked all orders for all stores could be manipulated. Both of the other models would protect against this yet the Custom APIs model would probably not retain the information the hacker changed/deleted while the blockchain model would. Figure 7.2 shows how the median value of the blockchain is still considered as high as the maximum values for the other models yet the figure also shows a huge spread in the answers between the interviewees ranging from 10 to 90 for the blockchain model.

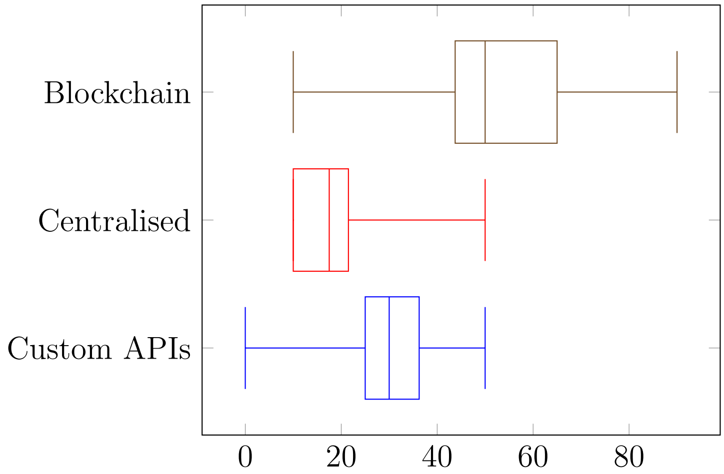

Figure 7.2: Results Security

Availability

When it comes to availability the arguments behind the choices were very similar to those for security. The interviewees agreed that a centralised server would constitute a single point of failure again while the custom APIs and the blockchain model would only lose one node if they go down. Yet surprisingly the interviewees did rate the blockchain model much higher in availability. This was explained by interviewees t_1, t_7 and t_8 by saying that even if a node in the blockchain goes down the other nodes can still receive orders/publish products which the unavailable node can then recollect once he comes back online and no information will be lost. Figure 7.3 shows how the even the lowest values of the blockchain model are equal to the highest value of the other models signalling that interviewees were convinced the blockchain will outperform the other models on this point.

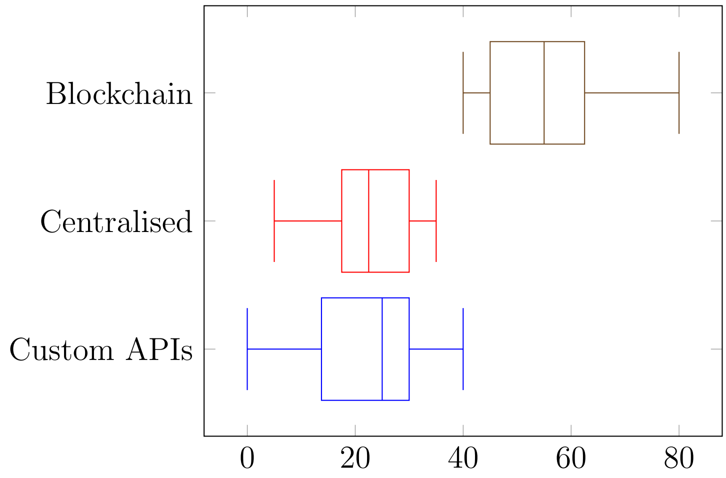

Figure 7.3: Results Availability

Transparency

The blockchain application appears most transparent to the interviewees. Interviewees t_7 and t_8 mentioned that storing the information publically shows transparency. They also agreed that a centralised API that handles your information is a lot less transparent. Using the custom API's the sellers can see that their products are displayed and check nothing is wrong which also makes this system transparent. They thought it was important for the system to be transparent as a seller would probably like to know who is selling his products and has access to them. Figure 7.4 shows that even though there is much spread between the values of the blockchain system it's median value is still as high as the highest values of the other models. The custom APIs model and the centralised model seem to perform equally in the lower half of the respondent range according to the Figure.

Maintainability

When it comes to maintainability the interviewees generally agreed that the blockchain and centralised server model were equivalent. Interviewee t_3 disagreed with this resulting in the very low minimal score of the maintainability of the centralised server in Figure 7.5. He stated that this complicated maintainability for the platforms while it would improve for the stores that connect to the server. This is also the reason for the high maximum score in maintainability

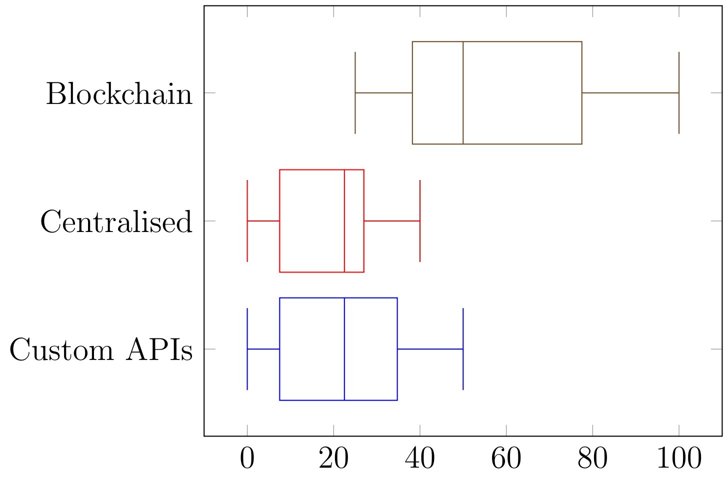

Figure 7.4: Results Transparency

for the custom APIs in this figure. The interviewees generally agreed that the custom APIs would be harder to maintain than the blockchain and centralised implementations.

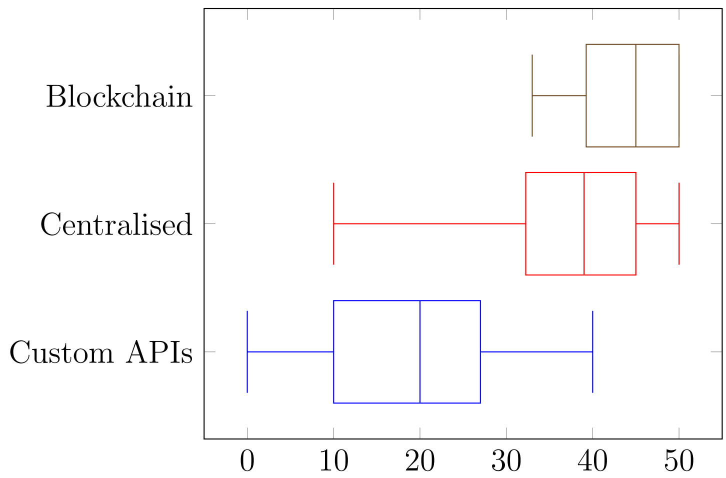

Figure 7.5: Results Maintainability

Scalability

When it comes to scalability the interviewees thought the centralised server and custom APIs where somewhat equal. The centralised server would have issues in handling traffic from many sources which results in them having to invest in hardware that can handle such traffic. The Custom APIs model makes it harder for stores to scale up in the amount of platforms they use and thus impact scalability. These problems would both be solved in a blockchain model. The interviewees did agree that the blockchain model would cause nodes to invest in large data storages as they would all need to store the entire blockchain especially interviewee t_8 was very critical on this point. Figure 7.6 shows how the blockchain model's minimum value is equal to the 75th percentile value of the centralised model and the maximum value of the Custom APIs model. The figure also shows much less variance in the values of the custom APIs demonstrating more consensus among interviewees with the exception of a few outliers.

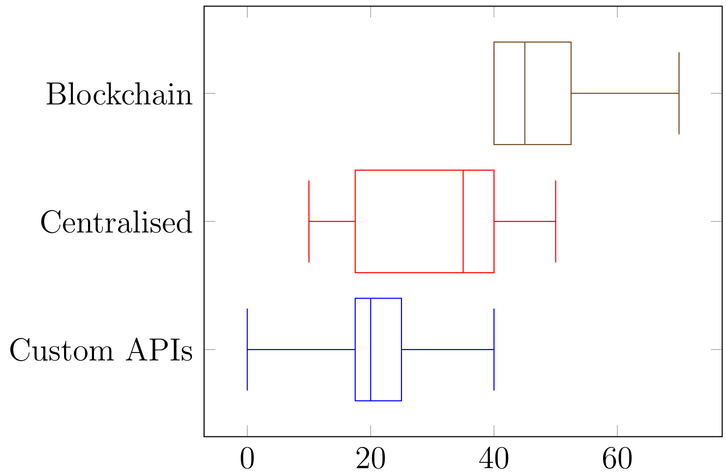

Figure 7.6: Results Scalability

Privacy

Privacy was the only attribute where there was a significant difference between importance of the order handling and product publishing yet still not in the values. All interviewees mentioned that when it comes to privacy they would not like it if their name and the products they buy would be publicly available yet a seller would probably not mind more people knowing what types of products he sells. They agreed that a centralised server adds another party to the system which makes it more likely personal information leaks from the system. Which makes the Custom APIs more favourable in this case. When it comes to the blockchain model the interviewees agreed that information that is stored publically does not ensure privacy. Yet they did agree that the cryptographic nature of blockchain would be able to mitigate this issue, this insecurity on the implementation could explain the spread in values for the blockchain in Figure 7.7. Interviewee t_2 even thought the cryptography used in blockchain constituted no difference from the custom API model using an https connection to transport the data. They also were not sure about legal requirements for handling privacy of orders to see if it would even be allowed to send them over a blockchain.

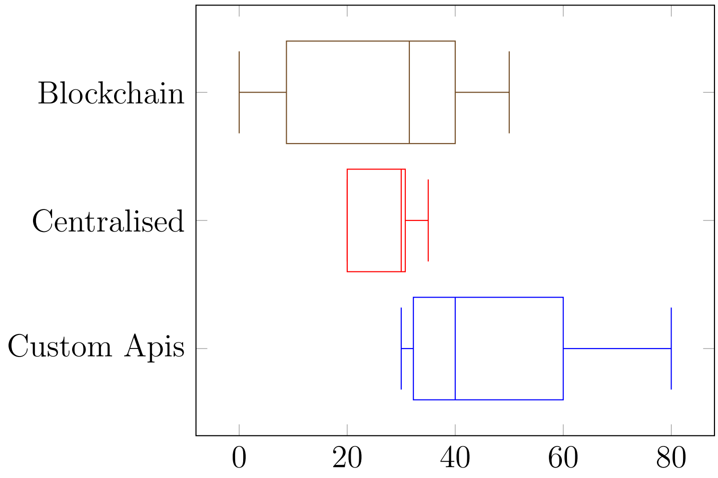

Figure 7.7: Results Privacy

Performance

The interviewees agreed that performance was not that important in a system like this, ordering it lowest of all attributes. Orders need to be handled somewhere during the day so a system which tracks them as soon as they are created is not a priority. The same goes for products. They often aren't changed for long periods of time. The results show that the blockchain model would perform best which was an unexpected result. They thought the centralised server would also perform well. A central server would do be able to function through one API and so quickly send all data. The Custom APIs model would require many different APIs to be called resulting in a slower system. This was mentioned by interviewees t_2 and t_5. The blockchain model would require the orders/products to be mined before they would be accessible on the blockchain. In my opinion this would slow the system down yet the interviewees disagreed but gave no clear undisputable reason for this.

Decentralized data storage

Interviewee t_8 was very well informed on the topic of blockchain and explained how the proposed blockchain solution would actually have some major issues. He explained how the application

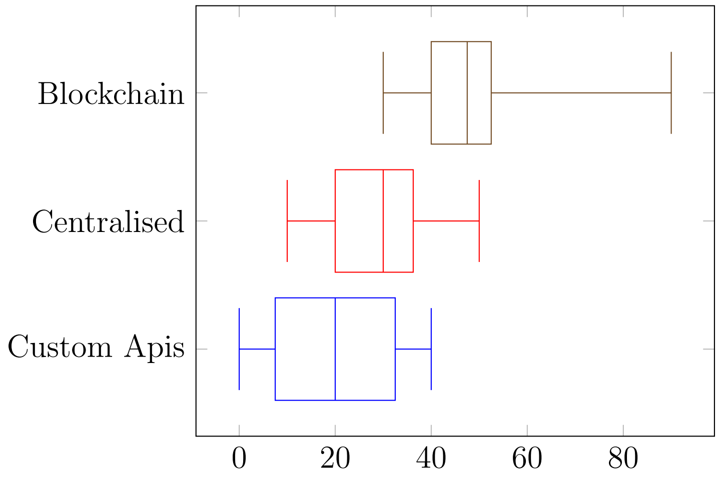

Figure 7.8: Results Performance

would store too much data on the blockchain which would not be feasible unless retailers would pay incredulous prices for this data. To counter this he offered a solution using decentralized data storage. In the model he suggests using a blockchain only to verify the data but not to publish it. One example could be to have the data downloadable as a product feed from the sharing store. A link to this feed could then be published on the blockchain alongside a hash which verifies the content of the file. The same could be done for orders. This greatly reduces the effort needed from the blockchain to support the application. Interviewee t_8 was only interviewed nearing the end of the research and as such has not had a chance to fully work out the model or ask many other interviewees about this model as most interviews had already been conducted at this time. In a similar fashion one business interviewee pointed out that using Interplanetary file sharing might be able to handle an implementation like this [52].

7.2.2 Business interview results

The business interviews were focussed on four points: The benefits of the blockchain application, the threats of using this application, willingness to use the application. In response to the threats identified by the interviewees some solutions that could mitigate these threats were suggested and the interviewees were asked if this would change their willingness to use the system. Some threats and benefits were identified beforehand and during the interviews the interviewees were asked to bring up their own thoughts on the threats and benefits of Blockshare.

Which lead to the following identified benefits and threats of Blockshare.

Benefits

The main benefit of the application is that it takes a lot of work away from the merchants in terms of getting platforms to sell their products. Interviewee b_2 mentioned that they made product-feeds [50] for multiple platforms by hand. As their store contains thousands of products this is a time-consuming and inefficient practice. This application would ensure that only one feed is required that all platforms could use by simply pressing a button. An advantage interviewee b_1 saw as an advantage is that this format allows them to add custom attributes to their published products which a feed such as the one from google shopping [50] would not allow. This interviewee owns a store that sells products which have a personalizable aspect. Normal shopping-feeds would not allow this personalizable attribute to be included in the file while the blockchain application would theoretically be able to do that. However in it's current form Blockshare does not have this functionality yet and it would be up to the platform developer to also implement a way to include these attributes onto their platform yet it would not be a theoretical impossibility.

Another benefit identified is that smaller platforms can more easily connect to this system. When stores have to actively pursue platforms they want to publish on it is much harder for starting platforms to get stores to publish onto their stores. When the stores offer products themselves it becomes much easier for starting platforms to build a product portfolio. Even other small stores that might not necessarily act as platforms could consider selling some products from other stores. This would mean that the online retailers could sell through even more channels. Interviewees b_1, b_4 and b_6 both explicitly mentioned this as an advantage.

Threats

The interviewees were asked what types of threats they saw in the use of this application. All interviewees agreed that they would not be certain in what way the privacy of their users could be guaranteed. To the interviewees it would naturally be important that the software complies to laws concerning privacy such as the AVG or GDPR. They were not knowledgeable enough about either to give a definitive answer on whether the specific application would be in compliance with these laws but thought sharing a readable order on the blockchain would probably violate their users privacy. It is imaginable that when an expensive item is sold that a user would not wish for this information to become known to anyone with access to the blockchain.

A second issue they found was in the trustworthiness of their sellers. This was first brought up by interviewee b_1 and reinforced by all the others. One of the benefits described lay in the ability to sell through smaller platforms yet the way the application works now is that it is not clear which entities are offering the seller's products in their own stores. The interviewees were not too enthousiastic about not being aware where there products are being sold and counted this as a threat/risk to the application.

Another threat lies in the payment of the products after they have been ordered through the blockchain. Larger platforms could be trusted to pay what they are owed yet when smaller platforms or stores sell products the original sellers will have to trust that this store pays them what they are due. This is not something that the interviewees liked. This in combination with the trustyworthiness lead to them wanting to be able to check orders before they ship them to the customer.

Interviewee b_3 called the upsides of the application for small vendors blatantly obvious yet the real problem in selling the application lay in convincing large platforms to use the system. To them the large platforms would not gain that much by using the application, this was mentioned again by interviewee b_6. For them it would mostly cost time to implement and they would have to discard systems they have spent a considerable amount of time building whilst not getting more functionality in return. They stated that once a few large platforms would decide to cooperate with a system like this all platforms would quickly follow but convincing those platforms would be the biggest threat to the application.

Interviewee b_3 also mentioned how the support for the application would be an important factor in the adoption. As this is a new technology with which the users will not be familiar it might deter them by thinking that a small group of developers might quit developing the application. If there is a chance that their business grows dependent on the application this could be an important factor.

Interviewee b_4 also mentioned an accounting error made in the application design. He said the application should create a closed ledger containing all sold products. Especially if the system would be used by platforms to check the stock of products that are sold. In order to implement this the system would also have to account for the sale of the sellers own products. In order to keep the quantity and identifiers of sold products correct these would also have to be published on the blockchain even though the other order information would not necessarily need to be included.

Interviewee b_5 mentioned how a potential for this application is the fact that clones of this application will quickly be built. This results in a version of the Custom APIs model with different blockchain implementations. If this happens the entire point of the application will be defeated and this would render the application useless. The interviewee mentioned that to combat this it would most likely need to be picked up by the biggest platforms as they can then set the standard.

Solutions

To tackle the privacy issue a solution where the order information is encrypted was suggested. To do this the public key used by the original seller can be used to publish this encrypted information onto the chain. Then the only one who could decrypt the information would be the holder of the private key i.e. the original seller. This solution would work as long as no other entities are able to decrypt this information yet if this were possible it would already violate the integrity of the entire blockchain. So as long as the security of the blockchain is trusted this solution could be trusted as well. The interviewees have no background in computer science and can not be expected to comment on how this would ensure privacy but they did mention that if it is possible to share this information in a way that only those who need the information can access it this would solve the privacy issue on a practical point even if it doesn't solve the issue from a legal point of view.

When it comes to the issue about of the trustworthiness of sellers an authorization structure was suggested. A user can only sell products once he/she is authorized by the original seller. Especially interviewee b_1 was very enthousiastic about this. This would ensure that the user can select the people he sells to himself and as such protect himself from unsavory businesses. The technical implementation of this authorization structure might be harder to accomplish. If it should truly be impossible for someone to advertise products he is not authorized to sell on his website he should not even be able to see/read the products from the blockchain. Meaning that either products should be shared using the same strategy as ensuring the privacy of orders or products should not be shared through the blockchain at all(see section 8.1.8). Sharing products through encryption to each platform would increase the data shared on the blockchain even more and would probably be infeasible leading to the decentralised data storage appearing as an even more appealing solution.

The payment issue is a difficult problem to tackle. It is one of the most important issues as it embodies the main reason for businesses to use the application. According interviewee b_4 this would only be a problem in singlular transactions. On repeat business it would not make sense to scam the original sellers as the original seller would not accept orders from these sellers again. But to protect single orders a range of solutions were offered by interviewees.

A first seemingly logical way to ensure payment to the original sellers would be to use cryptocurrencies to pay for the products while creating the order. This method would be a very safe way to guarantee the sellers get their money but has two problems of it's own. The first problem is that it requires the platforms to keep enough currency in stock to keep paying for products. While it is a minor issue it requires platforms to invest in these cryptocurrencies which they might not be willing to do. The second reason reinforces the first reason which is the unstable nature of cryptocurrencies. The fact that these coins change value so much could be a strong deterrent to paying with them for either side. Interviewee b_1 offered an alternative by using a stable-coin[53] such as TrueUSD. These coins try to stay as stable as possible and through that they are more reliable as a payment option.

A second option offered by interviewee b_1 is using an escrow account. This would ensure that money is already allocated for the sale and will be given to the original seller when the order is shipped to the customer. Interviewee b_6 suggested this through a system called letters of credit where the banks decide when funds are released not one of the parties involved in the sale. Interviewees b_1, b_4 and b_6 also suggested a system where the blockchain is used to check whether the money has been allocated through smart contracts and again when the product has been shipped to leave payment to the blockchain in a way where neither party can trick the system. While this should theoretically be possible it is not yet known whether banking systems could be accessed from the blockchain in this fashion.

One solution offered by interviewee b_4 was not directly related at a problem in the application. He stated that using the sales records on the blockchain could be used to automate the company's administration. The orders recorded in the blockchain could be used to automatically create annual reports for the company and if the order are shown publically they could even be read by the tax agency and used to compute the amount of tax a company would have to pay without their own input.

Willingness to use

Both the online retailers and the corporate economists agreed that the application had value and that if their products could reach a larger market i.e. the products would actually get sold through the application and could resolve the threats presented above they would clearly see the benefits over the current system and would like to use this application. Whether platforms would be willing to use the application remains unclear as no employees at a large platform could be convinced to participate in the research.

All interviewees have expressed that the benefits clearly outweighed the downsides and that they would surely want to use the application if it was available.

Chapter 8

Conclusion

This research set out to see whether a theoretical solution holds up in practice. Based on the results of the interviews it can be stated that both users and developers see benefits in the use of the application. When it comes to important factors in the reliability of the system such as the security or availability of the system developers have agreed that a blockchain will be more secure than conventional implementation in computer science. In regards to factors considering the maintenance of the system, maintainability and scalability, the interviewees have found that a blockchain solution solves the maintainability problem posed by the Custom APIs model but they have also found that a centralised server model could solve this problem as well. When it comes to more social issues, privacy and transparency, the interviewees found that a blockchain can make it more clear how data is processed yet this feature of the blockchain is detrimental to the privacy of it's users. In the area of privacy the model where the least amount of people have access to the data, the Custom APIs model, is presumed the best. When it comes to performance the interviewees have rated that the blockchain model would perform best better than both the centralised and the custom APIs model. Even though the developers were very positive about a blockchain variant of the application an alternative was offered which should perform better than the blockchain model. These results reinforce the statements by Iansiti and Lakhani [12] that the blockchain model has the most significant impact on foundational elements of the application.

When it comes to the value of the system it became clear that the interviewees saw a single button as beneficial in contrast with the complex way of publishing on a platform at this time. The fact that platforms could come to sellers was seen as an improvement by both interviewees b_1 and b_2. When it came to the application's drawbacks the interviewees did find many potentially disastrous threats to the application yet most of them could be solved by making technical adaptations to the application. Making the users see that this application would in fact solve problems for the users. This reinforces the statements made by Pavlou et al. [21] that blockchain can be used to create more effective ways of dropshipping items.

The original questions stated in chapter 4 were the following:

RQ: Do potential users want to use a blockchain version of the dropshipment functionality?

- *SQ1:* Does the software architecture of the blockchain application provide any additional benefits/drawbacks over different models?
- *SQ2:* Does the blockchain variant of the application solve a problem for online retailer?
- *SQ3:* Does the blockchain variant of the application reduce efforts for online retailers?
- *SQ4:* Does the blockchain variant of the application create new threats for online vendors?

Does the software architecture of the blockchain application provide any additional benefits/drawbacks over different models?

When it comes to the software architecture the interviewees have identified that the blockchain model for drop-shipment outperforms the other suggested models. The advantages identified were in line with expectations given in section 5.4. The users identified that the maintainability and scalability would be better than in the Custom APIs model while the security would be higher than in the centralization model. At the same time the interviewees did identify that the main drawback in the model lies in the privacy of users.

The research has however also identified that this model can still be improved upon by reducing the strain on the blockchain.

Does the blockchain variant of the application solve a problem for online retailer?

Actually solving a problem depends on exact implementations. Interviewee b_1 can't use dropshipment through platforms right now as they don't allow personalizable options, this could theoretically be implemented through a blockchain variant of the application yet this research did not dive into this specific case to make this possible. When it came to interviewee b_2 the application solves the problem of manually creating product feeds yet manually creating these files should not be the standard practice even now. For other sellers it is unlikely that a real problem the users deal with is solved through the application.

Does the blockchain variant of the application reduce efforts for online retailers?

On this point interviewees were very clear. This is considered the main benefit and reduces the work down to just a few seconds to publish a product.

Does the blockchain variant of the application create new threats for online vendors?

The interviewees have identified a range of threats and issues with the application in it's current form. Some of these issues such as the payment or privacy issue are completely disqualifying for the use of this application yet most of these issues can be resolved by adapting the application. The most important issue that can't be resolved is that the application will only hold value if platforms start using it. Without opportunities to sell the products through the blockchain there is nothing to be gained from the application.

Do potential users want to use a blockchain version of the dropshipment functionality?

Both on the technological and business side the interviewees have expressed benefits of the application and have expressed after mitigating the issues with the application they have expressed that the benefits of the application outweigh possible downsides and as such they expressed that they would like a fully worked out version of this application. As such the final conclusion of this research is that the application offers the benefits described by Pavlou et al[21] and that users are interested in a blockchain version of the application.

8.1 Limitations

The main limitation to the external validity of this study is the fact that only a small number of experts agreed to be interviewed during the research period as many of them were too busy to cooperate with the research. Due to this the research might not be generalizable or reflect the opinion of a larger body of experts in the ecosystem this is also a limitation to the conclusion validity of the study.

Another limitation to the external validity lies in the inability to interview anyone at a large platform. Attempts to contact them were but they all refused to cooperate. As such it is unknown whether they see any benefits to the developed application.

The main limitations to the internal validity are the fact that blockchain is seen as a hype might lead experts to rate the blockchain application more positively than they should. This is further enhanced by the blockchain experts interviewed for the technical evaluation as they might be more inclined give blockchain a positive rating as they specialise in building blockchain solutions, this is visible in the results where many of the minimal ratings in non-blockchain solutions were given by interviewee t_{10}.

The interviewees were also aware that the research was focussed on blockchain solutions which might lead them to give more positive results in order to give preferred results.

This limitation was mitigated these results by asking the interviewees for argumentation especially during the technical interviews. As such they were forced to think more critically about the answers they provided, however this was done only very carefully as not too influence their initial answers too much.

One instance where this is quite clear is in the technical results for performance. There is no clear reason for the blockchain application to be perform faster than the other models yet the interviewees have rated the application much higher in terms of performance.

A limit to the construct validity of the application is that the quality attributes chosen for this study might not reflect all the most important qualities of the application. For this research quality attributes that often occurred in papers surrounding eCommerce and blockchain as well as generic quality attributes in computer science were chosen. Yet there may be attributes where other implementations score better that are an important factor in the adoption of the application as well.

The same goes for the business interviews. Even if none of the interviewees could find other threats than those listed above that does not mean that the list of threats and benefits is complete and exhaustive. There could still be an unidentified issue out there which convinces all potential users not to use the system.

8.2 Future research

As there was no time for this building the same application using a decentralised data storage in combination with a blockchain to implement the dropshipment functionality could yield interesting results. This might lead to a more robust and better application that could reduce costs for the sellers.

This research could also be repeated with a larger interviewee base to ensure a stronger confirmation on the research conducted.

One or more of the improvements suggested in section 8.2.3 could be implemented to see how the application could be improved and how users would react to an improved version of the application.

The centralised server application could be built and a comparitive study between the two systems could be conducted to create more empirical data on the improvements each system offers.

As this application was not introduced into a production environment it could be productive to implement Blockshare in such an environment and study how it works with real users.

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Appendix A

Architecture assessment form

- Name:
- Company:
- Specialty:
- Send thesis: yes/no

Product publishing	Quality Attribute	Model 1	Model 2	Model 3	Priority	Comments
	Performance					
	Security					
	Privacy					
	Scalability					
	Maintainability					
	Availability					
	Transparency					
Order handling	Quality Attribute	Model 1	Model 2	Model 3	Priority	Comments
	Performance					
	Security					
	Privacy					
	Scalability					
	Maintainability					
	Availability					
	Transparency					

Additional benefits:

Model1	Model 2	Model 3

Additional threats:

Model1	Model 2	Model 3

Appendix B

Business interview protocol

1. Name:
2. Profession:
3. Would you like to receive the thesis: yes/no
4. How knowledgable are you on the topic of blockchain?
5. Do you know what the dropshipping is?
6. *Demonstrate explanation*
7. What would you express as the benefits of using this explanation as opposed to current methods of dropshipping?
8. What are your opinions on the following benefits:
    - You need only one application
    - Any store can operate as a platform
9. What would you consider drawbacks to the application?
10. What are your opinions on the following drawbacks:
    - Privacy issues

- Payment issues
- Interseller trust
- Platform adoption
- Other blockchain solutions
- Support

11. How would you mitigate these drawbacks?
12. What are your opinions on the following solutions:
13. Weighing these benefits/drawbacks would you use this application given the chance?