

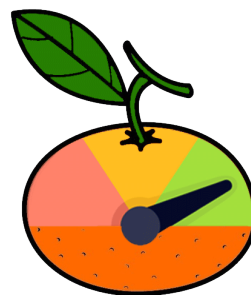
Willy Zhao

Privacy, trust and incentives in e-commerce on a Social Credit System (SCS)

Master's thesis in Communication Technology

Supervisor: Harald Øverby

June 2019



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Norwegian University of Science and Technology
Faculty of Information Technology and Electrical Engineering
Department of Information Security and Communication Technology

 **NTNU**
Norwegian University of
Science and Technology

Title: Privacy, trust and incentives in e-commerce on a Social Credit System (SCS)

Student: Willy Zhao

Problem description:

China is constructing a social credit system (SCS) to restore its economic power and social control. It will measure the trustworthiness for China's 1.4 billion inhabitants, as the government seeks to combat dishonesty in both the Chinese people and the Chinese market. Introduction of incentives in form of punishments and rewards in SCS can motivate the society to act honestly and rightful.

However, Western media have accused this system to be frightening and in violation with human rights. People will be monitored by the use of CCTV cameras and facial recognition. Data of citizens and enterprises will become controlled by the government. Due to China's political standpoint, many are criticizing the government for using this system to blacklist political opponents and to benefit from non-privacy data collection.

Although the SCS challenges the Western mindset and values, the features of such a system can be useful. In today's digitalized world, there are data everywhere and in almost every daily interaction. These data can be used to repair digital impairments such as online fraud and harassment. Even by gathering more data, it creates more opportunities for advancement in technology.

In the master's thesis, the privacy problem of SCS will be in concern. The goal is to make a proof of concept (POC) of a decentralized SCS and gather user results from a blockchain-based SCS prototype. Furthermore, the incentive mechanism to build trust will be investigated.

Responsible professor: Harald Øverby, IIK

Supervisor: Harald Øverby, IIK

Abstract

A Social Credit System defines a Chinese initiative to improve integrity in government, business and society. It aims to establish a comprehensive legal and regulatory system which provides credit information and data sharing mechanisms. The ultimate intention is to promote an honesty culture by including trustworthy incentives and disciplinary mechanisms as the motivational driving forces. The Social Credit System has attracted much attention from media, and its overall concept is chaotic, distorted and incomplete. Hence, it often results in difficulties and misunderstanding when researchers attempt for a deep understanding of this topic.

This master's thesis narrows down the problem in terms of focusing on resolving distrust in e-commerce. Today's e-commerce market is growing as a result of globalisation and digital technology capabilities. China is one of the prominent leaders in online trade, and Norway is one of the most developed democratic countries adopting an advance privacy policy in GDPR. Thus, a comparative foundation between these two different countries is present in this study.

This research paper explains how a decentralised e-commerce application can incorporate privacy and trust in a Social Credit System ecosystem. Several decentralised marketplace applications dubbed Mandarin Platforms were created to support this research. Altogether five experimentations supplementing surveys in both Norway and China were conducted to collect research data in a cross-border study. Additionally, this thesis investigates the potential of blockchain technology in incentive mechanisms in a Social Credit System.

With the application of big data and blockchain to the Mandarin Platform, the research exposes the advantages and challenges concerning privacy, trust and incentives. A total of 133 participants arranged in five independent groups participated in a simple e-commerce game as a part of the experiment. Thus, blockchain features such as immutability, decentralisation, consensus, transparency, security and availability proved to possess potentials as the results reflect. By decentralising the trading data, it achieved trust by the power of consensus. The public key cryptography provided by blockchain ensured privacy. Finally, collecting a considerable quantity of data such as reviews to store it on an immutable blockchain proved to incentivise participants' behaviour to act honestly.

China's deployment of Social Credit System requires data decentralisation to be controlled by centralised authorities with, e.g., a permissioned blockchain. A supporting remark for this requirement is the 1.4 billion population in a competitive and dynamic environment. It may repair some of the existing problems, but to approach the same level of freedom as in Norway is unlikely. Conclusively, the trade-off between privacy and convenience brought to light could indicate a paradox in ethics and technological advancement. Thus, a recommendation for future work could be to study how technology advancement shapes the future of privacy.

Sammendrag

Et sosialt kredittsystem definerer et kinesisk initiativ for å bedre integriteten i regjering, næringsliv og samfunn. Det baserer seg på et omfattende juridisk og regulatorisk system som består av kredittinformasjon- og datadelingsmekanismer. Pålitelige insentiver og disiplinære mekanismer vil fungere som motivasjonsfaktorer for å fremme en ærlig kultur. Det sosiale kredittsystemet har tiltrukket mye oppmerksomhet fra media over hele verden, og hele konseptet er rotete, forvrengt og uferdig. Derfor resulterer det ofte i vanskeligheter og misforståelser når forskere forsøker på å anskaffe oversikt i dette emnet.

Denne masteroppgaven begrenser forskningsproblemet mot et fokus på å løse mistillit i e-handel. Dagens e-handelsmarked vokser som følge av globalisering og fremskritt innenfor digital teknologi. Kina er ledende innen netthandel, og Norge er et av det mest utviklede demokratiske landene med velfungerende retningslinjer for personvern i form av GDPR. Derfor vil disse to ulike landene utgjøre et sammenlignbart grunnlag i denne studien.

Denne forskningsoppgaven forklarer hvordan en desentralisert e-handelsapplikasjon kan håndtere personvern og tillit i et økosystem for sosial kreditt. Det er opprettet flere desentraliserte markeds plassapplikasjoner kalt Mandarin Platforms for å brukes som det foreslåtte konseptet i denne forskningen. I alt ble det gjennomført fem eksperimenter med supplerende spørreundersøkelser i både Norge og Kina for å samle forskningsdata i en studie på tvers av landegrenser. I tillegg undersøker denne oppgaven om det er potensial for blokkjede-teknologi i incentivmekanismer i et sosialt kredittsystem.

Ved å bruke stordata og bane vei for blokkjede i dette konseptet, vil man i denne forskningen oppdage muligheter og utfordringer vedrørende personvern, tillit og insentiver. Med i forskningen var totalt 133 deltakere fordelt på fem uavhengige grupper som deltok i et simpelt e-handelsspill med bruk av konseptapplikasjonen. Her beviste blokkjedeteknologien store potensialer med funksjonaliteter som immutabilitet, desentralisering, konsensus, åpenhet, sikkerhet og tilgjengelighet. Ved å desentralisere dataene, kunne tillit oppnås gjennom konsensus. Den offentlige nøkkelkrypteringen anrettet i blokkjede bidro til beskyttelse av personvern. Til sist ble potensialet for blokkjede-teknologi demonstrert gjennom lagring av en stor mengde data slik som vurderinger. Disse dataene ble lagret på

en uforanderlig blokkjede og viste seg å stimulere deltakeres oppførsel til å handle ærlig.

Kinas utrulling av det sosiale kredittsystemet krever datadesentraliseringen kontrollert av sentraliserte myndigheter, for eksempel med en privat blokkjede. En støttende forklaring for dette kravet er landets 1,4 milliarder innbyggere i et konkurransepreget og dynamisk miljø. Dette kan løse noen av de eksisterende problemene, men å nærme seg tilsvarende grad av frihet som i Norge er riktignok utenkelig. Til sist, ved å kaste lys over avveiningen mellom personvern og lettvinthet fremstilles det et paradoks mellom etikk og teknologisk utvikling. Derfor kan en anbefaling for fremtidig arbeid være å studere hvordan teknologiutvikling former fremtiden for personvern.

Preface

This master's thesis is an independent study undertaken under the guidance of the Department of Information Security and Communication Technology (IIK) at the Norwegian University of Science and Technology (NTNU) during spring 2019. The thesis finalises the 5-year MSc in Communication Technology with specialisation in Digital Economics. A personal motivation for undertaking the selected topic is the ambiguity of the Social Credit System concept combining the personal eligibility of conducting research involving both Norway and China.

Following the progress of work in the research, the problem description changed a bit. After a more thorough understanding of the Social Credit System concept, the last paragraph should revise to: *In the master's thesis, the problems with privacy and trust in e-commerce embodied with the Social Credit System will be in concern. The goal is to use a proof of concept of a decentralised e-commerce application and collect results from experiments with participating users from both China and Norway. Furthermore, the study will investigate the incentive mechanism to build trust in a Social Credit System.*

Acknowledgment

It is a great pleasure for me to undertake this research entitled "Privacy, trust and incentives in e-commerce on a Social Credit System".

First of all, I am grateful to my supervisor Harald Øverby at the Department of Information Security and Communication Technology (IIK) for the support and invaluable guiding in the research.

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List of Acronyms

AFSG Ant Financial Services Group.

CPC Communist Party of China.

DApp Decentralised Application.

DLT Distributed Ledger Technology.

EU European Union.

EVM Ethereum Virtual Machine.

GDPR General Data Protection Regulation.

IPFS Interplanetary File System.

NIFA National Internet Finance Association of China.

NRIC National Resident Identity Card.

PBOC People's Bank of China.

POA Proof Of Authority.

POC Proof Of Concept.

POS Proof Of Stake.

POW Proof Of Work.

SCS Social Credit System.

US United States.

Chapter 1

Introduction

In this thesis, the potential of decentralisation contextualises in solving the privacy and trust issues in today's e-commerce. The development of the Internet empowered e-commerce to become an important way for commodity exchange. Due to the non-face-to-face nature of online transactions, trust and credit have become the critical factors for the development of e-commerce. The current global economy is a credit-based economy. China, as the influential driving force in global e-commerce, faces challenges in its credit awareness, credit system, credit technology and market dishonesty. Hence, the Chinese State Council issued the *"Outline for the Construction of Social Credit System (2014-2020)"* on 14 June 2014, in order to construct a SCS and build an honest economic and social environment. Taking the SCS and decentralisation as the starting point, this thesis collects, organises and filters related research literature. Then carry out in-depth literature analysis and experimental work on relevant ideas and methods. Based on existing and new trust models in e-commerce, the thesis analyses the three key features in focus for the research, namely privacy, trust and incentives. In light of this, this study applies a comparative study of the information asymmetry, differences and similarities between Norway and China to promote this research.

1.1 Motivation

Anonymity on the Internet is a powerful feature which shields a user's real identity. Article 19 of The Universal Declaration of Human Rights from 1948 declares that *"Everyone has the right to freedom of opinion and expression; this right includes freedom to hold opinions without interference and to seek, receive and impart information and ideas through any media and regardless of frontiers."* [Ass48]. Therefore, anonymity is useful in many situations to protect users privacy. Users can purchase and sell items anonymously on online marketplaces without revealing personal information. Unfortunately, trust in such systems is difficult. When purchasing goods from, for example, eBay or Taobao, there is a chance for fraud. The items received might

be counterfeit, or there might even be an empty package. Not all people use the perks of Internet anonymity positively. It is frustrating when a package ordered from a marketplace does not contain the described item. This critical problem deeply affects e-commerce, where retail sales worldwide in 2017 amounted to 2.3 trillion US dollars, according to Statista. Furthermore, the global e-commerce retail revenues are expected to grow to 4.88 trillion US dollars in 2021 [Sta18].

China is a leading country in e-commerce, which has a significant part of the global revenue in e-commerce. According to Statista, China reached a total market revenue of 572 billion US dollars in 2017 [Sta19]. China's economy is described to be a socialist market economy with the practice of public ownership and state-owned enterprises within a market economy. Since the introduction of this economic system, the Chinese economy has boosted and is today one of the most powerful economies in the world. Despite economic growth, China struggles with economic and social control. Problems such as creditworthiness and trustworthiness in the population are challenging for the government. The solution for controlling these problems is a SCS introduced by the Chinese state council. It is supposed to utilise the extensive spread of Big Data and digital footprints in combination with other technologies such as blockchain. However, critics often compare the SCS to Black Mirror, Big Brother and other dystopian sci-fi related works [Dau17].

Challenges such as lack of options to assess the financial creditworthiness of market participants, food security, tax evasion, and inadequate protection of intellectual property rights are critical [OAL17]. It does not exist any functioning credit system which keeps track of the 1.4 billion citizens' creditworthiness. People are acting dishonest and cynical in order to sustain themselves both economically and socially. When buying items online, sellers are sometimes acting shady and sending items not as described. Another situation is when buyers are not paying the sellers. These are very annoying problems, which in larger scale are very serious to China's economy and reputation. Many of these problems may also be valid to other countries than China. China's introduction of the SCS has drawn attention from both academic and public. Numerous people find this concept intimidating because it involves the construction of centralised data infrastructures for data collection, mining, and analysis. Additionally, incentive mechanisms will be used to reward and punish everyone.

The booming development of blockchain technology enables characteristics such as decentralisation, trust, consensus, transparency and security in many areas. Bitcoin and other cryptocurrencies are examples which demonstrate adoption of these new characteristics. The motivation in this research will be to look into the application of a blockchain-based e-commerce platform on a SCS to restore trust. Notably, the challenges with privacy and trust in e-commerce will be studied. Hopefully, it can

illustrate how the SCS relate to these challenges. The incentive mechanisms in SCS will also be investigated.

1.2 Objectives and Research Questions

The objective of this project is to gain insight into the SCS and research on how decentralisation with blockchain and SCS can solve the privacy and trust issues in e-commerce. Furthermore, a dig into the technological options will address the incentives required to drive participants in such a system. For defining the scope of this research, the formulated research questions are as follows:

RQ1: How can a decentralised e-commerce application incorporate privacy and trust in a Social Credit System (SCS) ecosystem?

RQ2: What technology can be used to implement incentive mechanisms in a SCS?

1.3 Scope and limitations

The topic to study is itself complicated, inducing many Western media describing it as controversial. Hence, this topic is interdisciplinary can engage in many fields of discussion such as politics, ethics and economics. This master's thesis will focus on the technological areas of this topic. The outlined research questions will help to constrain the scope of this research. The background will provide fundamental theories which may intersect with the other fields necessary for achieving a vital understanding of SCS.

The limitations of this thesis are time and resources constraints. An idealistic approach will be to schedule at least a year for tailoring a self-implemented and viable application. Next, the experimentations could involve more participants in more locations to collect more comprehensive data. Ideally, testing a self-implemented concept in real-world situations would be the most extensive approach. Furthermore, a larger research team consisting of experts in different fields such as politics, ethics and economics could further impact the results of the research.

Further limitations are the availability of academic work or legitimate literature in the technological field of SCS. This limitation affects the methodology of this research, which requires more time-extensive literature research. Thus, seeking the most reliable sources to gain a technological understanding of the SCS possesses a high priority. As the SCS concept is widely confusing because of its extensiveness, the research quality will improve with a thoroughly prepared background.

1.4 Research Methods

The objectives of this thesis will be reached by conducting several methods. Firstly, there will be an in-depth literature study to acquire a two-sided understanding of SCS and other topics relevant to this thesis. Therefore, this thesis will benefit from a literature study with both the Western and the Chinese perspective. Secondly, a decentralised e-commerce platform will be exercised to experiment on groups of students. Collected data from the user testings will be analysed and discussed later in this thesis. Additionally, a survey will supplement the experiments. This survey will contain simple choice questions concerning the test persons' opinions about privacy, trust, incentives and SCS.

Due to the Chinese government's political standpoint, it is reasonable to assume that some concepts from this work may not yet be a realistic proposal. In this thesis, the purpose is to prove how to achieve trust and privacy with the adoption of future technology. Moreover, a decentralised e-commerce platform could demonstrate to be a solution for solving trustworthiness issues when dealing with online shopping and trading. As the construction of SCS is yet unfinished, it currently lacks sufficient official and academic reports of the SCS. As a result of this, some media exaggerates negative news to attract readers. This misrepresentation has created some common misunderstanding about this complicated system. This thesis will, therefore, adopt cross-checked Chinese and Western information in the research on the SCS in addition to official announcements. Furthermore, the experiment with a decentralised e-commerce platform will be carried out in both China and Norway for comparative apprehension.

1.5 Contributions

First of all, the findings in this study contribute to understanding the need for a system to handle China's problems concerning its 1.4 billion population. From a democratic point of view, the SCS is a potential privacy threat opposing freedom. However, in a chaotic market and uncontrollable society, the Chinese authority needs to find a solution for harmony. By conducting a comparative experiment for the research, the results established several standpoints for proving the impact of cultural and ideological differences between the countries. Therefore, the main contribution of this thesis is the comparative study between China and Norway, which provides some valuable point of views on the development of digital technology and privacy rights.

The other contributions of this thesis are the Decentralised Application (DApp) for e-commerce and the use of it to experiment participants' behaviour and opinion towards the idea of decentralisation and SCS. Furthermore, the research was able

to observe how people reacted and addressed the trade-off between privacy and trust. Besides, the DApp used blockchain technology to organise big data. Real users experimented the concept's technological feasibility and simulated a real case of e-commerce trading. For other researchers, this study can contribute to inspire or uncover how privacy and trust can appear into context. The blockchain and big data technologies to provide administration efficiency were in operation in the suggested DApp. Thus, enforcing researchers to discover further potential areas for the usability of blockchain and big data.

1.6 Outline

Following this introductory chapter, the remaining chapters of the thesis have the following structure:

- Chapter 2: Presents the background study of SCS, privacy, trust, incentives, decentralisation, blockchain and the criticisms.
- Chapter 3: Presents the choice of methods in this study and its limitations.
- Chapter 4: Presents the implementation and execution of the experiments, including some observations and findings.
- Chapter 5: This part includes analyses and results of the experiments and survey. It also discusses and evaluates the research work and results.
- Chapter 6: Concludes the work in the study, future work and final remarks.
- Appendix A: Presents the user interfaces for buyers and sellers in Mandarin Platform.

Chapter 2

Background

This chapter provides the necessary background supporting this study. The background is in accordance with the existing literature from both English and Chinese sources. Firstly, it offers a deep insight into the SCS. Subsequently, the importance of the three properties privacy, trust and incentives will be explained consecutively. There are also dedicated sections to provide theoretical literature of decentralisation and blockchain used in this study. Finally, this chapter will surround common criticism and misunderstanding of SCS.

2.1 Social Credit System

Social Credit System(SCS) is composed of various elements such as legal, governance, moral, education, security, culture and credit score system. Rather than a system or database, the SCS is an overall policy or ideology. It includes a mechanism of punishments and rewards, that is allegedly meant to solve some problems inherited from China's development of the socialist market economy [Chi17].

Credibility is among these problems. Credit is essential in the modern economy and leads to an increase in spending, income and thus economic growth. However, the relationship between the lender and the borrower in a credit economy requires mutual trust. Credit is an ability based on trust and integrity over time, and from an economic perspective, the ability to obtain funds, materials, and services without immediate payment. The borrower makes promises to repay the funds, materials, or services received within a deadline. The lender which granted to trust the promises must also recognise this deadline. Violation of this trust can bring harm to the market order and interfere with the development of the economy [SPD11].

To be eligible for a loan, the borrower's ability to pay is crucial for the lender. Lack of a functioning unified credit system makes it difficult for lending and e-commerce companies to approve loans [Chi18]. These companies often have their independent practices to determine the risk of the borrower, but they are keeping the data for

themselves. Also, inherent conflicts of interest made previous attempts of a unified credit system a failure in China. Insufficient records of borrowers have made it difficult for students, unemployed and people with low income and worth to get into the credit market. However, people with a stable economy and wealth to display have been granted significant loans and often from several banks. The famous aphorism, "the rich get richer and the poor get poorer", is suitable for illustrating this case [Zhu17].

The credibility problem in China the recent years has extended to other aspects of people's social life. Another problem the SCS is aiming to solve, is the trust issues. Trust in society has been challenged by dishonest people trying to succeed in the socialist market economy. Fraudulent loans, embezzlement, tax evasion, counterfeiting scams and corruption are some common distrustful problems China has experienced. Ineffective regulation has led the economic system open to more significant abuse [OAL17].

One of China's most serious banking frauds in history, the Guangxi Zhongmei Tianyuan Financing Guarantee Group Co., Ltd case is an example illustrating the trust issues. Wu Dong, the head of this company and 13 others, had during 2010 to 2014 bribed and falsified documents to obtain loans from Liuzhou Bank, Beibu Gulf Bank, Everbright Bank Nanning Branch, Shanghai Pudong Development Bank Nanning Branch for totalling more than 42 billion yuan(6.1 billion US dollars). This fraud scheme was first exposed in May 2014 when the new chairman of Liuzhou Bank was the victim for attempted murder planned by a family member of Wu. The new chairman was unwilling to cooperate and grant credit to the company resulting in attempts of stabbing by a hired assassin. As a result, Wu received sentencing to 10 years and six months in prison and a fine of 200 million yuan(29 million US dollars). The remaining defendants were sentenced from six months to eight years, including four who had sentences immediately reduced to probation [Sun18].

Recalling this case, Chinese credit institutions lack a management system. The power hierarchy is dominant and plays an active role in collective decision-making. There are many loopholes in the process of review and follow-up regarding loans. The bribes did easily penetrate the system, and there was no active tracking and feedback mechanism for the loans. Besides, many of the computer systems used in banks are outdated and without effect [Luo15].

Furthermore, falsification of certificates, reports and documents issued by third-party evaluation agencies demonstrates critical loophole in the legal system. Also, the "soft" punishment for the guilty charged is arguably outrageous. The fraud of billions of banking funds did barely results in any justified consequence as one can say the Wu family in sum profited from this case. Accompanied by a vicious attempt

to murder a bank chairperson, these criminals will soon roam the streets again as the legal system is waiting for improvement [Luo15].

2.1.1 The National Social Credit System

On the surface, China appears to roam as an economic superpower. However, the growth is stagnating, and the many challenges addressed require an effective intervention [CTS⁺18]. Setting up a national system for a population as large as China's is not an easy task. On 14th June 2014, the Chinese State Council presented the "Planning Outline of Social Credit System (2014-2020)" [Cou14]. It was deployed to accelerate the construction of a system to build trust and honesty to the economic and social environment.

The SCS aims to establish a culture of integrity and promote the tradition of integrity in China. Reward and punishment mechanisms are used to incentivise the society by rewarding trustworthiness and punishing distrust. The system will play an essential part in the governance, and the economic market regulation as laws, regulations, standards and contracts which were previously ignored by many citizens [Cou14].

The distinction between a credit system and a SCS can be perceived as obscured. A credit system refers to a system with measures for collecting, processing, analysing and providing credit information services. A SCS refers to the general term for a series of promotions for the credit commitment including institutional arrangements, credit information recording, collection and disclosure mechanisms, institutions and market arrangements for collecting and publishing credit information, regulatory systems, and publicity [LDKH18]. The ultimate goal is to shape a harmonic social credit environment. The SCS is a social mechanism that, based on law and ethics, solves the contradiction of credit information asymmetry in economic and social life [Cen17]. SCS has three important functions both illustrated in the Venn diagram in Figure 2.1 and listed below:

1. **A memory function which can keep records of untrustworthy people.**
2. **A reveal function which can promote honesty, punish dishonesty and further improve economic efficiency.**
3. **A warning function which can prevent the act of dishonesty and educate morality.**

Combining the three functions will increase the trustworthiness and maintain the supposed order of economic activities and social life. Thereby, it will promote the healthy development of the economy and society.

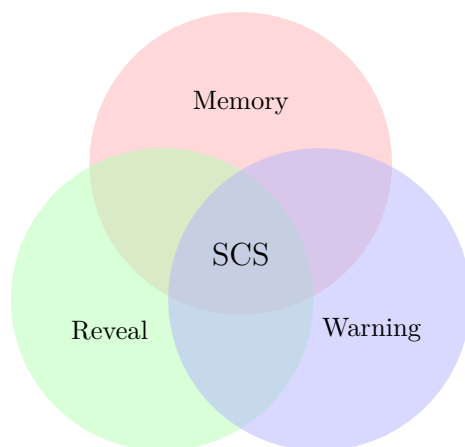


Figure 2.1: The three important functions of a SCS

Originally, the SCS was first brought up in 1999. In October 1999, the Institute of World Economics and Politics of the Chinese Academy of Social Sciences established the "Question of Establishing a National Credit Management System". It initiated a study of SCS in China. Then in 2006, the People's Bank of China (PBOC) established a Credit Reference Centre for managing both commercial and consumer credit reporting systems in financial institutions. The work related to the construction of SCS at the national level began first in 2014 [Jin18]. By the end of June 2014, the following completed tasks include:

- Promoting the deployment of a unified credit information platform, gradually incorporating credit information such as financial, industrial and commercial registration, tax payment, social security payment and traffic violation;
- Sketching plans to strengthen the construction of a governmental credit system;
- A plan to establish a unified social credit code system for citizens based on the National Resident Identity Card (NRIC);
- A plan to develop a unified social credit code system for legal and other organisations based on the code of the organisation.

In 2015, the completed tasks included the following:

- Promoting the construction of integrity in business;
- Introduction and implementation of a system for governmental honesty;

- Introduction and implementation of a unified social credit code system based on the NRIC;
- Introduction and implementation of a unified social credit code system for legal and other organisations based on the code of the organisation.

In 2017, the task was to build a unified platform for collecting and sharing credit information such as financial, industrial and commercial registration, tax payments, social security payments and traffic violations. In October 2018, the relevant social credit legislation was incorporated into the legislative planning of the National People’s Congress and prioritised. If it goes according to plan, the fundamental laws and regulations on social credit in China are expected to be declared and implemented within one to two years [CCT18].

The Chinese government is not alone in working on the SCS as private companies are also cooperating and launching initiatives. In 2015, the PBOC granted permission for personal SCS pilot licenses to eight commercial firms such as Alibaba’s Ant Financial Services Group (AFSG) and Tencent. The eight personal SCS are Sesame Credit, Tencent Credit, Koala Credit, Pengyuan Credit, Sinoway Credit, Qianhai Credit, China Chengxin Credit and Intellicredit. Three years later, due to problems such as conflict of interest, none of them obtained a license. Instead, National Internet Finance Association of China (NIFA) launched the first and only licensed personal credit agency under the supervision and guidance of the PBOC on 19th March 2018. These eight companies are now shareholders and active contributors to the new unified personal SCS named Baihang Credit. Baihang Credit will also supplement the existing information by PBOC’s Credit Reference Centre. In addition to Personal Credit System under the SCS umbrella, there are the Enterprise Credit system and the Government Credit System. The Enterprise Credit System refers to the credit system covering cooperation and trading in the financial market. The latter refers to the credit system covering all government agencies and public officials from the central government to the local government [Jin18].

Currently, there is a collection of different implementations and pilots across various regions and cities across China. Rongcheng, a north-eastern town with around 700 000 in population have an astonishing breakthrough with their pilot programme. Its citizens believe that the SCS efficiently oblige them to act more trustworthy and creditworthy after the city’s experience from the recent pilot [Mis18]. China has started to repair its social and economic problems, and the credit situation is improving in many cities. With that said, the entire population of 1.4 billion will probably face a technological advancement as well. Technologies such as big data, artificial intelligence, facial recognition and blockchain all possess some great features and will potentially play a significant role in the development of SCS.

2.1.2 Sesame Credit

AFSG launched the Sesame Credit in 2015, which functions as an independent third-party credit evaluation agency. As mentioned in the previous section, AFSG was one of the eight companies which obtained permission by PBOC to experiment with a personal SCS. Through the use of cloud computing, machine learning and other technologies, the system crunches user data into a personal credit score. Sesame Credit is voluntary, and users are benefiting from Alibaba's services if they consent to let Sesame Credit possess their data. Some may compare this system to a reward program where users receive rewards based on their social credit score ranged from 350 to 950 points. Ratings from 350 to 550 is poor, 550 to 600 is a normal score, 600 to 650 is a good score, 650 to 700 is an excellent score, and 700 to 950 is exceptional [AF19]. The third screenshot in Figure 2.2 displays these scoring levels. This measure will incentivise users to use Alibaba's suggested services for obtaining benefits. Scores are generated through logistic regressions, decision trees, random forest and other modelling algorithms, and comprehensively processing and evaluation of data [AF19]. The categories involved in the calculations, which display in the second screenshot of Figure 2.2 are:

- User credit history: History of credit repayment and credit account.
- Performance ability: Stability in income and personal assets.
- Behaviour preference: Preference and stability in activities such as shopping, payment, money transfer and financial management.
- Identity traits: Sufficiency and reliability of basic personal information provided in relevant services.
- Personal relationship: Identity of relatives and friends, and the interaction with them.

As Sesame Credit is tight related to the entire Alibaba group, all e-commerce transaction data and financial data of Ant Financial are available to use. Besides, Sesame Credit has established cooperation with public institutions such as the Public Security Network and other partners to exchange data. These data covers credit card repayment, online shopping, money transfer, wealth management, water and electricity payment, rental information, address relocation history, social relationships and others. Users' repayment willingness and ability will be analysed based on users continuous generation of online transactions and behavioural data. Thus, credit applications and cash instalment services will become faster and more efficient [DEN15].



Figure 2.2: The first screenshot from this figure illustrates the score overview page on the Sesame Credit application. The second screenshot displays the five categories used in the calculation of the score. The last screenshot shows the score levels in Sesame Credit. These images were screenshotted on 26th February 2019.

Essentially, Sesame Credit is a credit information system which collects data from government and financial systems, and further analyses the behavioural records of users on platforms such as Taobao and Alipay. Concerning user privacy, chief data scientist of Sesame Credit Yu Wujie [DEN15] stated that the use of personal data, operation and credit scores by third parties are all carried out under the premise of user permission. The automated system handles the scoring process, and the personnel is unable to reach the user's information as the user's privacy is kept confidential.

There are abundant choices of benefits to high-scoring Sesame credit users. The benefits range from free bike rentals to easy application of a Singapore tourist visa. For a score over 700, one can order items from the e-commerce platform Tmall to try first and pay later. However, there are punishments for untrusted persons too. Primarily, a low social credit score will miss the benefits provided to people with good credit scores [AF19].

The Supreme People's Court is providing official information of untrusted persons called "Lao Lai" to Sesame Credit through blacklists. The judicial online blacklist

was created in 2013 and is today publicly accessible on a public website¹. Millions of untrustworthy executors are for example restricted to book flight tickets and high-speed train tickets as they are visibly blacklisted. One will enter the blacklists if they fail to perform required obligation such as a court order or administrative decision. In principle, the "Lao Lai" will remain on that list until the obligation is fulfilled, except in specific circumstances which may cause an extension [Cre18].

2.2 Credit System in Norway

In Norway, companies and institutions can engage credit check companies to evaluate if a person or a company is eligible for a credit loan. However, a credit check is not allowed if the operation carried out does not involve credit, such as in advance payment. Today, Bisnode, Creditsafe, Experian and Evry are the only companies working credit information. When they perform credit checks, they are obliged to send a notification letter to the targeting person. The notification letter has to contain notification of who makes the inquiry and what the distributed data includes. After the introduction of General Data Protection Regulation (GDPR) in 2018, the four companies will today need to comply with GDPR in terms of processing of personal data. They were previously working with a license from the Norwegian Data Inspectorate to operate credit checks on private persons. However, after GDPR, the license obligation to all companies working with credit information was revoked. The Norwegian Data Inspectorate will instead supervise and ensure GDPR compliance rather than approve licenses. Additionally, they have confirmed a new credit information act on the way [kre18].

A credit score is calculated from available data for collection such as information of income, tax assessment based on information from the Norwegian Tax Directorate, payment remarks, businesses registered with the Brønnøysund Register Centre, age, and registered home address. The credit score generally ranges on a scale from 0 to 100. Furthermore, the credit score advances into a scale for risk assessment, which banks use as part of their credit assessment. A low credit score makes it difficult to obtain credit. This score is not permanent as it changes dynamically based on a person's finance. For example, a payment remark will negatively affect the score. However, as soon as this remark settles, it will be removed [kre18].

2.3 Trust fraud in e-commerce

One might argue that Norway has one of the world's most harmonious society where trustworthiness is not an issue. However, with technology advancement and a globally increasing use online services such as e-commerce trading platforms, the trust issues

¹Chinese court blacklist - <http://zxgk.court.gov.cn/>

arise. FINN.no is Norway's largest marketplace with an average of 6.3 million unique visitors each week and more than 8 million listings in 2016 [FIN19]. The Norwegian consumer site Dinside reported 16 incidents of fraud by using the platform in 2017. Buyers are paying without receiving the described item and sellers are not receiving payment for sending the specified item. According to Statistics Norway, four per cent of the e-commerce users did experience fraud in 2016 [SSB16]. Furthermore, ten per cent is experiencing problems such as a higher final price than expected, faulty or damaged goods, or problems with product warranty and legal rights.

Many online services are solving the trust issues by integrating reputation scoring into their platforms. *"Reputation has the power to define who will interact with you and what people will do for you and with you"* [FT15]. For instance, Airbnb, the largest peer-to-peer exchange service for hospitality around the world, utilises a reputation system with personal and commercial consequences. Renters can submit ratings on the accuracy, communication, cleanliness, location, arrival, and value, which will accumulate a score of the host. Likewise, the host can evaluate how clean, tidy, respectful and friendly the guests were during their stay. With poor ratings, people may not be able to use the service. Reputation as a parameter to define someone's worthiness to access a particular service is not a brand new concept [FT15].

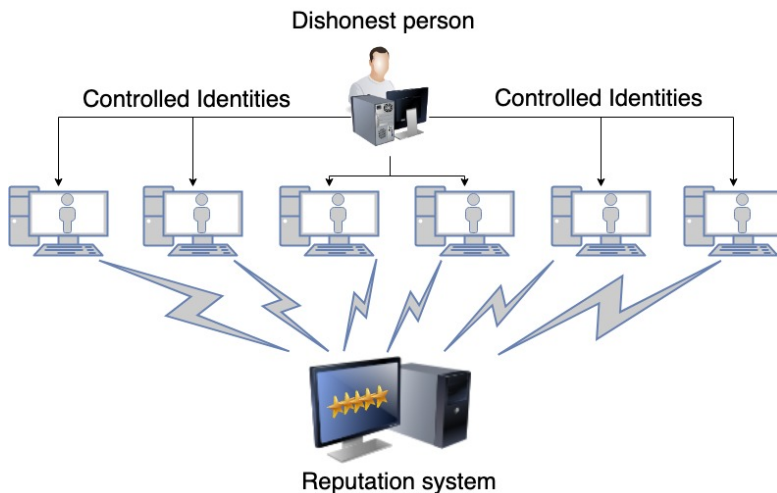


Figure 2.3: Sybil attack - a dishonest person is controlling many false or stolen identities to manipulate ratings.

Many online marketplaces today have a built-in reputation system which consists of a review and rating mechanisms. As these systems are trying to solve the online trust issue, they lack a robust verification mechanism. Users can unrealistically

manipulate and duplicate scores from many accounts (Sybil attacks) as illustrated in Figure 2.3. A unified system of verification data gathered from different platforms may reinforce the reliability in reputation scores. Additionally, linking each account to a user's real identity may achieve the authenticity of the user. Gradually, users will have a better knowledge of other users of the system. However, GDPR allows users to delete and create new accounts if the associated ratings are low. Corresponding data is also erasable, which means that the GDPR paradox obstructs this idea. Put aside GDPR, a decentralised reputation system with application of blockchain could be the solution to restore immutability, trust and transparency to online marketplaces. Indeed, this solution sounds familiar [LF18].

2.4 Privacy

In China, it is not possible to sign up anonymously on most online platforms. To use e-commerce platforms such as Taobao and Tmall, the users have to confirm their identity with the NRIC. The security of the NRIC is inadequate. Leakages from databases containing images and information of the NRIC and loss of cards have caused NRIC vulnerable to identity theft. Stolen NRIC are overwhelmingly common in China. Stolen cards can sell for above 350 yuan (50 US dollars) each on the black market. The current NRIC are not applying biometrics, which makes it exposed to authentication fraud. The SCS is also planning to use NRIC to validate users. However, Chinese media has reported a new upgrade to third-generation NRIC. Official government has indicated that the new NRIC are in a design phase. These cards are rumoured to include features such as biometrics, location tracker and compatibility with the SCS [Hao19].

Adding up all the outlined features, the introduction of SCS may sound like an invasion of privacy. After the Facebook/Cambridge Analytica scandals in the United States (US), big data research took an ethical turn and shivered the confidence people once had in their democratic governments and companies [JF18]. Since the scandal, the European Union (EU) introduced the GDPR while other democratic countries such as the US are still actively considering updating privacy legislation. However, the GDPR would have restrained the idea of a SCS in Europe [Sac18]. Mainly, it becomes compulsory for citizens to contribute personal data to the government. Furthermore, these data remain in the government's full control as citizens have no rights to require removal of these data from the government's database. Therefore, a SCS appears unthinkable for countries in Europe.

On the other hand, the Chinese government is aiming to exploit the massive spread of Big Data and digital footprints to combat some of its most prominent issues in the economy and social development. Every Chinese citizen, governmental official, and corporate actors will have to join the system with their corresponding data of

actions and omissions [Aus18]. Some Chinese are positive about the initiation of the system as it will bring extra perks to their life. The CEO of the Chinese search giant Baidu, Li Yanhong, claimed: "the Chinese people are willing to trade privacy for convenience, safety and efficiency." This statement heated debate about privacy in China last year [Dai18]. During the years under the Communist Party of China (CPC), people's privacy is unprotectable if it conflicts with the CPC's interests. In case of conflict with companies, the Chinese Cyber Security Law will protect the collected data from being misused [Sac18].

Advancements in digital technology lead to escalating privacy concerns. With the increasing amounts of smartphone users and the flourishing mobile application market, the data generation is limitless. To use a specific digital service, one has to sign up and provide personal data. Furthermore, an ever-increasing number of connected devices amplifies the volume of such information. Both software and hardware of these devices are becoming smarter for each day. Development of artificial intelligence, facial recognition algorithms and physical video components have inspired Western media to ignite a debate about China's future surveillance state [CTS⁺18].

The construction of SCS will depend on digital technology. Simultaneously, some believe that digital technology will still advance during China's implementation. Scientists believe that the availability of data will enhance the technological development. Many Chinese internet users are happy for everyday convenience by sharing data to enable this convenience. If no data exists in digital services, these services would have been worthless. Opting out of this data-intensive world would mean going back to live in the stone age. The internet has become vital for people living in the modern world [CTS⁺18].

2.5 Trust

Trust is the reliability and dependability to expect or believe in someone or something [CD03]. With the advancement of science, technology, economy and social development, the trust model of human society has gone through different stages. In the agricultural period, trust was interpersonal and based on the customary relationship between acquaintances. Its characteristics were moral constraints, supplemented by township rules and regulations. Later, in the industrial period, trust became contractual between the two strangers. The new characteristics were institutional constraints, supplemented by moral constraints and third-party credit constraints. In the digital era, trust is mainly systematic among anonymous people. It can be protected by technology, augmented by institutional and moral constraints. The latest shift pushes more responsibilities to individuals. The number of internet service

users are increasing drastically. Thus, advancement in digital technology will become more crucial to be able to supervise mutual trust relationships [CD03].

A primary concern in today's e-commerce is the trust issue. Online transactions complete without buyer and seller being physically present. Instead, a growing number of online consumers in e-commerce platforms are trusting the seller's legitimacy and authenticity of the items or services. Rousseau et al. [RSBC98] suggest that trust is a *"psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behaviour of another under conditions of risk and interdependence"*. This definition is widely accepted and can easily describe the situation when using an e-commerce platform. The convenience of online shopping has attracted many buyers and sellers to grow these platforms. However, to use this service, one has to sacrifice a risk in trusting the system security and privacy. *"There ain't no such thing as a free lunch"*. In exchange for using an e-commerce service which provides a buyer's and seller's marketplace, the customer needs to trust the service and share their data. Hence, it means that the customer has to trust both the platform and the seller.

2.6 Incentives

Incentives are an easy and often cost-effective way to encourage trust. It is a way to motivate human behaviour by rewarding or punitive measures. Rewards are positive incentives that are effective to reinforce the desired action. Contrary, punishments are negative incentives that are effective to prevent undesired behaviour [FL04]. Through the human life cycle, people are developing their desires and wishes. For example, some parents may use monetary reward incentives to encourage their kids to behave nicely. Other parents may ground their children to discipline them. For a student, grades work as an incentive mechanism to motivate students to work hard. In society, prison functions as a punitive measure to hinder people from not obeying the laws. At workplaces, employees are often provided monetary bonuses to increase their productivity and performance. Businesses are very good at widely equipping incentive mechanisms to gather large groups of people. Many corporations are using loyalty programs to attract customers and collect data on their behaviour.

An essential economic assumption is that rational maximising persons will respond to incentives [FL04]. In a market economy, prices act as incentives to buyers and sellers. The fluctuation of prices is causing people to balance the amount they are willing to purchase or sell. A governmental approach by applying tax to a good or service leads to an increase in price. From an economic perspective, this means that the number of sales will reduce. Pigouvian tax is a tax on negative externalities [TP10]. For example, the government can apply such tax on cigarettes as a measure to reduce the occurrences of lung cancer in society. Hence, the Pigouvian tax is

monetising the social cost of negative externalities. This strategy to prevent by applying a subsidy can change a rational maximising person’s behaviour. Otherwise, the collected subsidy could be used to cover the damage. For instance, many companies today have an allocated carbon quota. If they exhaust their quota, they have to buy extra allowance or subsidise.

In today’s digital world, privacy regulations are pushing companies to offer incentives to hold onto data. To receive user consent to collect user data, companies will need to provide something in exchange for customer’s data. Companies paying a data fee, lowering service prices and offering loyalty bonuses are among the incentives they are hoping to work. Online services and social platforms are allowing users to delete their account with chunks of data if they feel for it. However, by deleting accounts and data, the users will miss out on using the services. For the majority of people, this is not an option as many of the online services and applications are essential in everyday life. The trade-off between privacy and convenience is often followed through by economic incentives, immediate satisfaction, and general ease of interaction. For instance, to sell an item online through an online marketplace, one has to provide with personal details to publish the listing. The online marketplace is providing convenience in return for user’s data [Dai18].

2.7 A Decentralised Social Credit System

Although the SCS provides a prospective solution to address problems of trust and credibility, it still poses challenges. Currently, the government and companies are the ones which provide the data in the system. Individuals have no opportunity to participate in providing direct data as the data collection is currently centralised. If someone wants to report an action, the information has to go through an intermediary. The data collected by the intermediary is then processed, but the processing is not transparent. Behind the curtains, it is difficult to know if the data processors are misusing the user’s private data. Furthermore, this kind of centralised architecture is vulnerable to problems such as a single point of failure and performance bottleneck. A decentralisation of SCS opens the opportunity for individuals to provide tamper-proof, censorship-resistant, and permissionless data in a secure, but trustless network [Lee18].

In the currently available commercial SCS, user data is stored on the cloud or in centralised databases. The data infrastructures for collection, mining, and analysis in the upcoming national SCS are according to some sources supposed to be centralised [LDKH18]. Consider China’s history of controlling and censoring the Chinese internet with the Great Firewall [Rey17], the CPC will unsurprisingly continue with this approach. However, following this approach can emerge into one of the most attractive and vulnerable targets for hackers. Considering all the

information of China’s citizens stored in one single place, it is mutable and highly sensitive to security breaches.

The outlined weaknesses in a centralised SCS could potentially be solved by decentralisation [XLDC18]. Despite some sources claiming that the SCS will be about centralisation, the state media has reported about some projects involving Distributed Ledger Technology (DLT) in the recent construction works of the SCS. Even though decentralisation associates to freedom, a private DLT controlled by central authorities is also an option. Many are familiar with blockchain as a public DLT which applies in the Bitcoin cryptocurrency. Another possibility is utilising a private blockchain which uses the core idea of blockchain by creating a permissioned blockchain. Figure 2.4 depicts the concept of a permissioned blockchain. Thus, the responsibility of validation belongs to the private entities, which is desirable for the Chinese government [XLDC18].

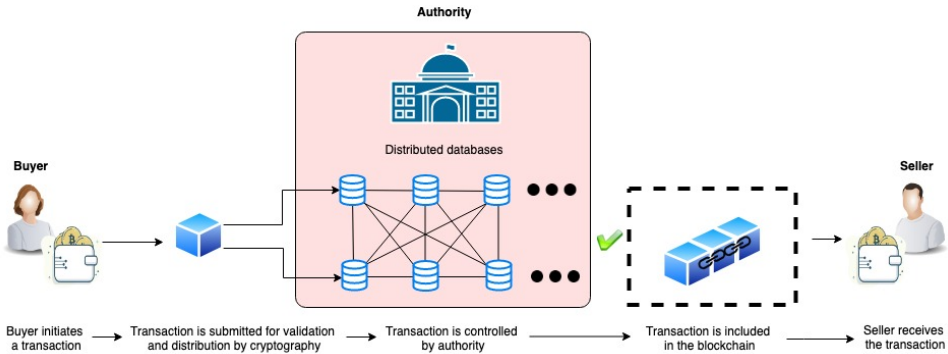


Figure 2.4: Permissioned blockchain - The transaction between buyer and seller is controlled and validated by an authority.

2.8 Blockchain

In 2008, the US subprime mortgage crisis broke out and spread continuously around the world, resulting in a worldwide financial crisis. It carried out a massive shock wave through people who used to trust their banks and financial institutions. The modern financial system proved to be vulnerable through the practice of fractional-reserve banking. When a bank receives customer’s deposit, they generally keep just a small percentage of the deposit, liquid. The rest of the deposit is on risky investments such as mortgages. This crisis gained some mistrust in fiat currencies and opened the door for a decentralised financial system [N+08].

On 1. November 2008, Satoshi Nakamoto sent an email attached with a paper entitled "Bitcoin: A Peer-to-Peer Electronic Cash System" [N⁺08]. The paper proposes an implemented electronic cash system through peer-to-peer technology, later named blockchain. It enables digital payments to be sent from one party and received at the other party without passing through any financial institution. Bitcoin was proposed to be a workaround for e-commerce relying on financial institutions as trusted third parties to process electronic payments. Nakamoto believes that the most fundamental problem of the modern financial system is trust.

"The root problem with conventional currency is all the trust that's required to make it work. The central bank must be trusted not to debase the currency, but the history of fiat currencies is full of breaches of that trust. Banks must be trusted to hold our money and transfer it electronically, but they lend it out in waves of credit bubbles with barely a fraction in reserve. We have to trust them with our privacy, trust them not to let identity thieves drain our accounts. Their massive overhead costs make micropayments impossible."

- Satoshi Nakamoto, Inventor of Bitcoin

In a certain sense, the US subprime mortgage crisis has triggered Bitcoin and blockchain as its underlying technology. Blockchain combines ideas from cryptography, mathematics, economics, network science, politics and other fields, and builds Bitcoin into digital currency and online payment system. It uses digital signatures to achieve mediation and removes the reliability of central banks and financial institutions. A blockchain is essentially a distributed database system in which different nodes participate together. Data is stored in blocks by cryptography with the hash of the previous block and a time stamp. The hash of the previous block links the originating block to the current block, forming an immutable blockchain. Bitcoin uses a public key as the address to send and receive Bitcoins and handling transactions, thereby realising pseudo-anonymity. In short, the blockchain technology brings some unique and distinctive features [Anw18]:

1. Immutability: Every participant on the network has a copy of the digital ledger. To add a transaction to the blockchain, one needs consent from the majority of participants. Otherwise, no one can add any transaction blocks to the ledger. If a transaction block succeeds to attach on the ledger, no one can go back to edit, delete or update it.
2. Decentralisation: Transactions in the network do not require validation by any trusted authority or a single intermediary. Instead, a group of participants maintain the network, making it resistant to single point of failure.

3. Consensus: Every blockchain employs a version of a consensus algorithm to ensure that validators act accordingly. Participants are provided incentives by consensus mechanisms such as Proof Of Work (POW) and Proof Of Stake (POS).
4. Transparency: Transactions stored on a blockchain is open for the public, and anyone can query the public blockchain data and develop related applications through the public interface. Changes on the blockchain are detectable and make it corruption-proof.
5. Security: Asymmetric cryptographic encryption of data adds a layer of security to the blockchain. Additionally, blockchains eliminate the need for a trusted third-party. Thus, no one with less than 51% control of the network can change any characteristics of the network for their benefit.
6. Availability: Distributed ledgers among millions of computers ensure the reliability of the network. The blockchain uptime is theoretically 100%. It is important to note that private blockchains can be shut down any time by the administrators, while public blockchains cannot be controlled even by the creators.

Nakamoto uses the blockchain technology to combine the innovation of an incentive mechanism and a trust model in Bitcoin. On the one hand, the blockchain enables a tamper-proof distributed ledger which is available for the public. This mechanism accomplishes trustworthiness. Concurrently, to encourage all participants to maintain the blockchain, Bitcoin utilises POW mining as an incentive mechanism. This mechanism encourages miners to participate in the block creation and connecting the new block to the previous block. Miners will automatically receive a block reward if they successfully solve the block puzzle. Therefore, the blockchain technology can be helpful to prevent occurrences of dishonesty as participants have incentives. Thus, achieve a balance of transparency and security through the entire blockchain network [N⁺08].

2.8.1 Legislation on the blockchain technology

The emergence of blockchain technology and Bitcoin has laid the foundation for innovation in more fields. Authorities have been unable to ignore the development in Bitcoin and blockchain technology, and have adopted corresponding regulatory policies [Ble17].

The US does not acknowledge digital currencies such as Bitcoin as legal tender, rather a commodity that should be added tax at the time of the transaction. Policy

for use and possession for crypto assets depend on the state. Some states require a licence to engage in digital currency transactions [Ble17].

Due to slow legislation process in the EU, the individual member countries have developed their cryptocurrency stances. However, a 2015 decision of the European Court of Justice (ECJ), claimed that cryptocurrency investments should be exempt from VAT in EU countries. The Norwegian Directorate of Taxes is regarding Bitcoin and other cryptocurrencies as a taxable asset, where profits must be added tax as capital income with a 23% tax rate [Ble17].

Currently, China has a ban on Bitcoin and other crypto assets. All banks and financial institutions have prohibition from transacting or dealing with cryptocurrencies. The government is also restraining cryptocurrency exchanges and miners. They seemed to see Bitcoin and cryptocurrencies as a severe threat to its economy and has in response initiated plans to start a state-controlled digital currency [Ble17].

2.8.2 The development in blockchain

Although the attitude towards cryptocurrencies such as Bitcoin is different, the potential development and research of the blockchain technology have been highly valued by government, companies and academic. From a macro perspective, the blockchain technology can support government regulation, social governance and financial market activities in reduced search costs, resources, transaction costs, externalities and network effects. Blockchain can help the government provide transparent management of the society, which is conducive to the implementation of economic and social supervision.

In 2016, development and research of blockchain technology were in China's 13th Five-Year Plan - the plan for national development over 2016–2020. Thus, China became one of the first countries in the world to include blockchain in its official policy. All in all, China attaches great importance to the development and innovation of potential benefits in the blockchain. A report by the UK Government Chief Scientific Adviser in 2016 highlights the potential benefits of the blockchain technology in the following quote [Wal16]:

"In summary, distributed ledger technology provides the framework for the government to reduce fraud, corruption, error and the cost of paper-intensive processes. It has the potential to redefine the relationship between government and the citizen in terms of data sharing, transparency and trust."

- Mark Walport, Chief Scientific Adviser to HM Government

From the perspective of development, the blockchain evolution has gone through several stages [Swa15]:

1. Blockchain 1.0: The implementation of DLT led to the application of cryptocurrencies. Bitcoin is the most prominent example in this stage with its transformation of currency transfer, exchange and payment system applications in the financial sector.
2. Blockchain 2.0: Introduction of smart contracts, which extended the potential application opportunities much broader than simple cash transfers. Simple instructions are written in the blockchain and executed automatically according to specified conditions. For example, smart contracts can include agreements on stocks, bonds, futures, loans, mortgages, property rights and assets.
3. Blockchain 3.0: Emergence of DAG-based blockchains improved efficiency, scalability, interoperability and user experience. This development enabled blockchain application in other areas such as social governance, government regulation, environmental protection, health, science, culture and arts.
4. Blockchain 4.0: Adjoining foundations laid by the previous stages, blockchain 4.0 will satisfy industries to execute real-world use cases and applications.

2.8.3 Blockchain as a trust machine

The tamper-proof ability in blockchain has made people describing it as a potential trust machine. Since the introduction of Bitcoin in 2008, the excitement in blockchain has only increased. Every problem can seem to be solvable with blockchain. As blockchain seems like a powerful tool, it is crucial to learn if it adds any value to the solution. Blockchain provides a trustless trust mechanism. It also offers innovative space and practical possibilities to improve supply chain transparency, performance management and stakeholder engagement. Eventually, this can reduce procurement risks and management costs. Currently, projects involving the application of blockchain technology are in an early stage. Many areas are still exploring security, cost and impact, in addition to the connection of blockchain and physical components, technical complexity and consensus [TT16].

2.8.4 Ethereum

Ethereum is a public blockchain platform which allows anyone to build and use decentralised applications. At the end of 2013, founder Vitalik Buterin released the first Ethereum white paper and launched the project. Ethereum extends the Bitcoin features and tries to provide a solution to Bitcoin's scalability problem. Like other public blockchains, Ethereum requires participants to run software on their computers

to maintain the entire network. Every node (computer) in the network runs an Ethereum Virtual Machine (EVM). The EVM is Turing-complete and works as an operating system for interpreting and executing code written in a smart contract. Once the smart contract executes, the blockchain maintains its consistency [B⁺14].

The features such as immutability, decentralisation, consensus, transparency, security and availability also apply for Ethereum. Moreover, users must pay a small transaction fee called gas to the network on every transaction with the blockchain. This fee is paid at a predefined gas price and protect the Ethereum blockchain from malicious attacks or infinite loops. This gas value will further be calculated into the Ethereum cryptocurrency (ETC) and paid to the node which consumes memory, electricity, storage and calculation [Dan17].

Both Bitcoin and Ethereum are currently using POW as a consensus system. It works as an incentive mechanism for participants to confirm transactions and add new blocks to the blockchain. In this way, miners will compete against each other to complete blocks by processing power and be rewarded. Once the blocks are confirmed and added to the blockchain, it will be stored permanently. Unless more than 51% of the nodes in the system control at the same time, the blockchain data will remain stable and tamper-proof, thus eliminating the possibility of fraud. A drawback with this system is the processing power required and therefore provides a setback in scalability. Another concept which is planned to replace the current POW system in Ethereum is POS. This system chooses the block creator in a deterministic way depending on participants stake. The validators will only receive transaction fees as a reward due to the removal of the block reward competition. Hence, energy efficiency increases [Dan17].

2.8.5 Smart Contracts

A smart contract is simply a piece of code that is running on EVM. It works as an agreement between parties. The code which executes on the Ethereum blockchain can control valuable properties such as ETH or other digital assets. The code can contain predefined rules and terms which will be automatically executed in the EVM when published onto the tamper-proof blockchain. In this way, trust in people and institution is switched to trust in the machine [Dan17].

When trading in e-commerce, there are typically three conventional methods of trust. These methods are mutual trust, legal agreement, and engaging a third-party escrow. Each method of these methods has its shortcomings. Firstly, it is difficult for strangers to trust each other. Secondly, legal agreements are costly and time-consuming. Lastly, engaging a third-party may initiate additional risk [Dan17].

A smart contract is equivalent to a mutual friend of both parties and represents

in code, which is not prone to trust issues. Once written a smart contract, it cannot be altered or tampered. Therefore, no matter what the contract contains, it will execute at some point. When a smart contract executes, the blockchain records the execution information as a transaction on the block. Just like other blockchains, all transactions broadcast to the entire network. Moreover, each node performs the indicated smart contract, keeping its EVM state in sync with the network. Each node executes a piece of code, making the entire blockchain a large and slow distributed computer [Dan17].

2.9 Criticism

The research in SCS has increasingly become a prominent topic of foreign media. In an increasing number of different reports, most of these sources are portraying the SCS negatively. Some comments mention this system analogues to an Orwellian system of social control [Orw49] [CTS⁺18]. In other words, this means that the government tries to control every part of the citizens' lives. The Economist wrote an article titled "China invents the digital totalitarian state" in 2016[Eco16] discussing the absence of privacy and the power in the government. Some popular critiques against the SCS is its non-transparent potential to induce governmental abuse, public fear of association, limited personal freedom, political victimisation and gamification.

Many comments sound extreme, but Chinese experts agree that it is reasons for this confusion of concepts. First, the theoretical research foundation is weak. So far, the construction of SCS still lacks official academic support. On the other hand, the lack of transparency in the development of the national SCS has caused many misunderstandings. Since the publishing of "Planning Outline of Social Credit System (2014-2020)" in 2014, the Western media and tabloids already began to criticise the construction of China's SCS. However, Chinese officials have rarely responded [Dau17].

A fundamental misunderstanding is to view SCS as a single and coherent entity, while it is a massive mixture of elements to combat China's social and economic problems. It is also common to understand Sesame Credit as a representative of the SCS. However, Sesame Credit should be distinguishable from the SCS because the government is unlikely to use the data collected by Sesame Credit for any form of large-scale data analysis. Nevertheless, some Chinese researcher considers that there are potential defects in this private SCS, such as neutrality, objectivity, and the fact that they may invade consumer privacy and security. For the blacklist system, blacklists are designed based on existing regulations and used to identify specific people who violate existing laws and regulations. These blacklists provide a real name and carry out related joint punishment, which contradicts to the Western standards [Dau17].

Although the Chinese view of SCS is not as terrible as described in many Western media, the purpose is to solve the practical problems in China. The primary concerns are about whether to link personal data, abuse of credit information and calculate all into one rating as in the commonly compared Nosedive episode in *Black Mirror*. Fear produced by the SCS could further stifle intellectual and political freedom, as political dissenters who fear consequences would keep quiet. Despite criticism, most Chinese citizens seem to approve both the commercial and national SCS based on public reports [Kos19].

Chapter 3

Methodology

This chapter provides the research methods, approaches and designs to use in this study. It presents the plan and its tools to solve the research goal in this thesis. The research topic is complex and relatively fresh in academics. Hence, it will require various methods to untangle research problems. The research questions formulated for guiding this research are:

RQ1: How can a decentralised e-commerce application incorporate privacy and trust in a Social Credit System (SCS) ecosystem?

RQ2: What technology can be used to implement incentive mechanisms in a SCS?

The following sections will contain a systematic and theoretical analysis and presentation of the methods applied in this study.

3.1 Mixed Methods Research

This research uses a mixed method comprising of qualitative and quantitative research methods for working with the scope. A mixed method is preferable to use due to its ability to provide a more thorough understanding of the research problems. It enables examination and research from multiple forms of information and answers complex research questions which cannot be addressed by the use of quantitative or qualitative methods alone [DWZS13]. Johnsen et al. [JOT07] define mixed methods research with the following generalisation:

"Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration."

Conducting this research requires combinations of several methods to answer the research questions to the fullest. Limiting method will not provide comprehensiveness or a genuine understanding from the research problems. By using mixed methods, research problems can resolve with both the benefits of quantitative research such as survey investigation and qualitative research such as Proof Of Concept (POC) study. For example, results gathered from surveys might only help to identify a people-centric view, but it may not be adequate to understand the technical feasibility and challenges. Thus, conducting a mixed methods research by including extensive literature research, POC, experimentation and survey increase the potential of a holistic understanding of the research.

It is favourable to make a systematic and strategical plan when designing this research. Initially, the information collected is vast and segmented, which makes it hard to know precisely how to process the information further. Figure 3.1 illustrates a process model, including the steps to follow in pursuing a finalisation when using mixed methods research. The mixed methods research process model comprises eight distinct steps suggested by Johnson et al. [JO04]. Determination of the potential research questions and whether a mixed methods research approach is appropriate took place in the pre-project work [Zha18].

Furthermore, selecting the mixed methods research design and collecting the data initialised in the pre-project work and continued at the beginning of the work

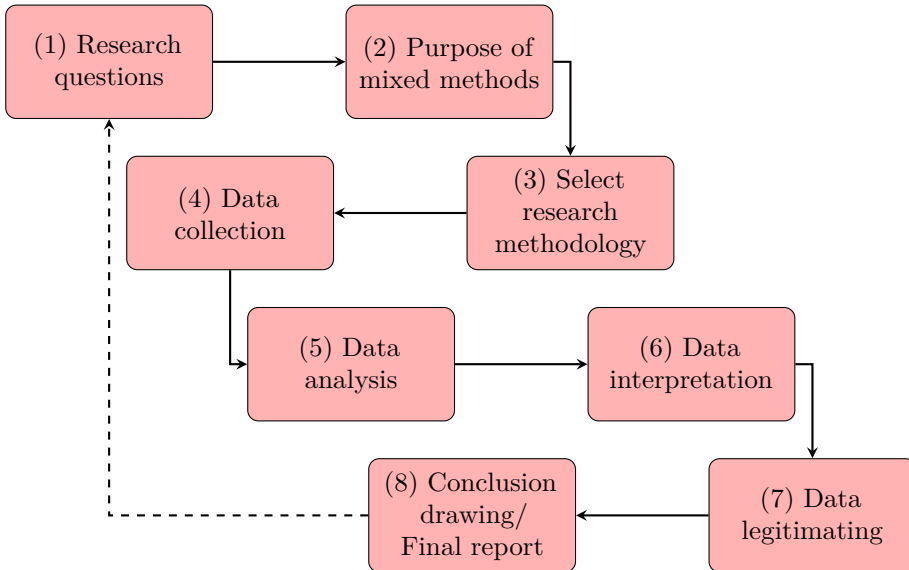


Figure 3.1: Mixed research process model

with the master's thesis. The remaining steps, such as analysing, interpreting and legitimate the data, draw conclusions and write the final report, was approached in work with the master's thesis. After writing the final report, a revising process of going through the steps again can potentially uncover errors or information to refine. The following sections present the methods utilised in this work with the thesis.

3.2 Literature Review

The literature study in this thesis is comprehensive with the main goal to gain an in-depth understanding of SCS. One of the prominent challenges is the scarcity in official and academic resources related to the topic. The SCS is still in a development stage, and the Western perception of it as a single unified system is not present in the Chinese news. On the contrary, the published papers and reports in China consider the featured concept as multiple ongoing projects. Understanding the Chinese aspects of the SCS will ease the resource filtering process in grasping the accurate information provided from English-written resources. By studying the several components of SCS separately, leads to a comprehensive understanding of this complicated scope. It was made an extraordinary finding when conducting a cross-referenced check of Chinese and English resources. The English-written authors who previously lived in China for a more extended period had a more comparable paper to the Chinese official and academic references.

The literature reviewing process lays a theoretical foundation when working with research problems. It can help to identify research topics by recognising the status quo and past of the problem. Being able to form a preliminary impression of the research object will help to observe further and more profound details. Furthermore, it provides evidence, discussion and further questions to extend the research. The review type in this thesis is a theoretical review, in which attempts to *"draw on existing conceptual and empirical studies to provide a context for identifying, describing, and transforming into a higher order of theoretical structure and various concepts, constructs or relationships"* [PTJK15]. As the topic of this thesis lacks appropriate theories and is in a research state, a theoretical review will patch the gaps between the known and unknown theories.

Templier and Paré [TP15] explained six generic steps when conducting a literature review process:

1. Formulating the problem: This is the first step before collecting the data. It is essential to define what the research should investigate. The research question will guide the entire study as it states the problem.

2. Searching the literature: This step initiates the data collection phase and includes the relevant search around the formulated problem in the previous step. It is also essential to retain an overview of the search objects and further explore the studies linking the problem.
3. Screening for inclusion: This step involves a filtering process by identifying, analyse and determine the relevance. It requires enhanced objectivity to constrain the relevant literature around the formulated problem further.
4. Assessing quality: This step involves assessing the methodological quality to refine inclusion. The inclusion will reflect on possible biases and validity during the review process.
5. Extracting data: This step involves extracting applicable information relevant to answer the problem.
6. Analysing and synthesising data: This final step wraps up by organise, compare, collate, summarise, aggregate or interpret the extracted data. The ultimate goal is to achieve a new contribution to knowledge.

The first step in this study was to gain a comprehensive overview of SCS. After that, the research goals and problems were formulated to guide this research. Multiple sources and approaches have ensured the comprehensiveness in the searches. The two search engines, Google and Baidu, have extensively contributed to targeting information. However, the majority of the search results could consider as sources with a media perspective. Hence, part of the work in this thesis was to conduct a careful review. For a more academic approach, Google Scholar¹ and CNKI² provide literature from a more thorough perspective. Google Scholar is a bibliographic database providing scholarly literature. CNKI provides Chinese academic literature, foreign literature, dissertations, newspapers, conferences, yearbooks, reference books and other resources.

Additionally, posts on social channels such as Weibo³, Wechat⁴ and online forums have supported the literature review. The final screened, assessed, extracted, and analysed information are available in Chapter 2 — background with related references at the end of this thesis.

¹Google Scholar - <https://scholar.google.com/>

²CNKI - <https://www.cnki.net/>

³Weibo - <https://www.weibo.com/>

⁴Wechat - <https://www.wechat.com/>

3.3 A Decentralised E-commerce Application

In order to work out the problem regarding fraud in online e-commerce, a POC approach will test the feasibility using blockchain and SCS to handle the privacy and trust issues. The POC in this thesis is a decentralised e-commerce application using blockchain and ideas from a SCS. Origin⁵ provides a protocol for building decentralised marketplaces online. Therefore, the POC will include a decentralised application built on the Origin Platform. There will not be direct implementations of SCS to this application, but rather the ideas of creating trustworthiness from SCS will complement indirectly. For instance, there is a rating mechanism which can express a seller's credibility.

3.3.1 Proof Of Concept (POC)

A POC project is focused on determining if a concept can turn into a reality [Rou18]. Its purpose is to verify whether a concept is successful or needs further review. The participants involved in the project can also use the POC as a guideline of principles to explore or build the concept. POC widely adopts in many fields such as manufacturing, engineering sectors, software development and science. The success of this work requires the investment of valuable resources such as time, material composition, talent coordination and technology. The value from developing a POC is the feedback as evidence of whether the concept is worth pursuing with further resources.

3.3.2 Origin Protocol

The fundamental building blocks in Origin Protocol's work are Ethereum and Interplanetary File System (IPFS) which enable decentralised e-commerce. The Origin Platform contains the DApp, developer libraries and protocols. The DApp allows buyers and sellers to transact without involvement from intermediaries. Sellers can manage, validate and publish listings, while buyers can make an offer and leave reviews. The developer libraries are open-source and designed to reduce Ethereum programming complexity. The protocols realise by Solidity-written smart contracts and IPFS. They define standards for functionalities such as user identity and reputation. Data such as price and availability are stored directly on the blockchain, while other metadata such as reputation and description can found stored on the IPFS and linked to smart contracts. Smart contracts are used to publish and manage listings, make offers, leave reviews and perform blockchain interactions. Altogether, the application from Origin Protocol will provide all the necessary features for the POC.

⁵Origin - <https://www.originprotocol.com/>

3.3.3 InterPlanetary File System (IPFS)

IPFS is a peer-to-peer distributed file system for content-addressable storing and sharing of content [Ben15]. Data stored on IPFS are given a unique cryptographic hash to reference the data. Each peer on the network stores arbitrary content with indexing information to navigate. As this protocol works as a distributed web protocol, it can increase the trust in the integrity of the data. The DApp uses js-ipfs⁶ for connecting to the IPFS network and running on browser.

3.3.4 Ethereum (ETH)

Ethereum is the most adopted blockchain for building a decentralised application. Its smart contracts realise the possibility of creating a complete application such as the Origin marketplace application. Besides, the second most popular cryptocurrency, Ether (ETH), runs on the Ethereum blockchain. Origin accepts Ether as the payment currency. It is important to note that the volatility of this cryptocurrency makes Ether unsuitable for payments. Ideally, a more stable currency should be of service in a marketplace. However, as Origin Platform is using the Ethereum blockchain, using Ether is currently a simpler approach than choosing another currency.

3.3.5 Rinkeby Test Network

Running the application on the Main Ethereum Network means using real Ether (ETH). Another option is to run on the Rinkeby Test Network. Hence, test Ethers are obtainable from several Rinkeby faucets for free. Rinkeby Test Network is using another consensus mechanism than the Main Ethereum Network which runs by centralised nodes. The consensus it uses is Proof of Authority which engages explicitly "authorities" to maintain the blockchain. This mechanism means that the validators are putting their reputation in stake as the incentive to preserve the network. Running the application on Rinkeby Test Network is adequate for the POC, and testing the application with the intended amount of users in the experiment.

3.3.6 MetaMask

MetaMask⁷ is a browser extension which enables access to DApps without running a full Ethereum node. It uses web3.js to connect with the browser and makes it possible for DApps to read from the blockchain. MetaMask is also an Ethereum wallet in the browser, which allows users to create and manage their accounts securely. In order to perform and write transaction to the blockchain, the user will be able to review, approve and reject the transaction.

⁶Js-ipfs - <https://github.com/ipfs/js-ipfs/>

⁷MetaMask - <https://metamask.io/>

3.4 Experimentation of the Application

Experimenting the application is the next approach which supports the testing and data generation of the concept. There are carried out two experimenting events to demonstrate and verify the feasibility of concepts and their potential in real-world use cases. These experiments will pull off in two different countries and test groups. With the assumption of varying privacy practices in different countries, there will be two events targeting Norwegians and Chinese citizens, respectively. This approach can be beneficial to strengthen the understanding of the results in a broader perspective. The contrast between similarities and differences can demonstrate different angles to the study. Thus, comparing these two cases may result in new findings impacting a global understanding of the dynamics present in different settings [CJTC11]. The research data from the experiment are to obtain by using modified focus group testings, observations and questionnaires. These are the methods which will physically obtain both qualitative and quantitative data.

The participants were university students in both China and Norway with a technological background. Hence, this demographic characteristic divided the focus groups. For simplicity, the accompanying Chinese professor invited some students to join a mandatory class exercise. Each group consisted of approximately 14-16 participants. Besides, the Chinese professor's involvement in both planning and experimenting was helpful. Figure 3.2 depicts in-game action of the experiment which took place in a computer laboratory at their university. In Norway, the participants were fellow technology students invited to a classroom following the same procedure. All the participants' data remain anonymous through the entire research, and no personal information is retrieved. Providing incentives to the participants were also a needed measure for collecting the appropriate quantity of qualitative data.

3.4.1 Modified Focus Group Testings

The experiment conducted various modified focus group testings. It is a modified method to describe focus groups testing the application. The primary purpose with modified focus group testings was to draw upon participants' attitudes, feelings, beliefs, experiences and reactions on the concepts in the application [CJTC11]. A moderator will collect the in-depth verbal feedback from the participants' view on the concept, and provides a flowing interaction with the participants to discuss issues. Finally, the collected feedback will be analysed and processed into relevant results.

3.4.2 On-Site Observations

On-site observations were an additional method to analyse the e-commerce application in function. This method gathers data on participants' interaction with the e-commerce application in a controlled environment. The observation procedures were



Figure 3.2: Displays the experiment setting at the University in China.

exploratory and open-ended, with an observer as participant approach, meaning some time spending inside the situation [CJTC11]. The observer controls and runs through a game allowing participants to test the functionalities. Participants were delivered clarified goals for intervening with other participants in the marketplace. It was an excellent way to discover what was occurring in a setting and helped in understanding the importance of contextual factors [CJTC11].

3.4.3 Questionnaire Survey

Questionnaire survey supplements data collection in the experiment with participants self-reporting. This method measures participants' subjective opinions toward specified questions, which can further support categorisation, validation, and structuring the all results [CJTC11]. The survey for this experiment includes closed-ended questions served on an online survey software tool named Questback. Questback is suitable for conducting academic research and is widely used by students to earn their diplomas [Que]. They also provide built-in tools to ease the generation of evaluations

and graphics. Closed-ended questions provide specifically targeted information and simplify data analysis.

A questionnaire can deliver a thorough and systematic understanding of the research objects and collects a large amount of data for comparison, analysis and induction to summarise the regularity. Results collected through surveys are practical as they can be compiled and statistically studied. The design of the questionnaire followed guidance from chapter 7 in Johnson et al. [JC08], "*How to construct a questionnaire*". It provides some essential principles to follow for constructing a successful questionnaire.

3.5 Limitations in the choice of method

This section describes several limitations in the chosen methods, including some approaches to mitigate and deal with these limitations.

First of all, mixed methods research is intricate and time-consuming, which requires time and resources to plan and implement. Despite being able to equip every tool available, it requires a deliberate strategy to connect the methods and results. Therefore, learning the research methods and how to use them together is essential as working with both quantitative and qualitative research can be challenging. A step to mitigate this challenge is to design a systematic progress plan with precise tasks.

Secondly, some of the common challenges in the literature reviewing process are where to find literature, literature credibility, understand the meaning, defining its value and structure the findings. This process is also time-consuming, where a clear pathway for conducting a literature review can be beneficial. The previously mentioned framework by Templier and Paré [TP15] provides helpful steps while conducting a literature review process. Following these steps can lead to organised data which can mitigate errors and easily comprehend to this research.

There are also some limitations to consider by conducting POC. Essentially, a POC realisation provides a clearer picture of the concept and should not be too complicated. The complexity should remain minimal with only viable functions to demonstrate the technical feasibility and potential. Thus, the final POC will limit to work for small group testings on its concepts. A full-scale product will, on the other hand, cost both time and resources, which is not necessary for this research. Choosing Origin Platform for creating the decentralised marketplace concept mitigate the expenses of time and resources. However, using third-party software to provide the concept will spawn new limitations in availability and reliability. The dependability on Origin to be online and provide operating functionalities when using the platform

requires another mitigating approach. Therefore, it was established a dialogue with an Origin developer and one of the heads as a measure to speedily fix potential issues.

Modified focus group testings are used in combination with on-site observations and questionnaires to complement the POC in data collection. The open-ended environment in modified focus group testings can result in a large amount of unnecessary or fuzzy information. Thus, the researcher will have the responsibility to assemble the relevant information collected with this method and the information from the other combinational methods. The on-site observations also have limitations in the sampling of observed people, application and settings. Furthermore, a shortcoming of the questionnaire is that the participant makes a false or wrong answer to the question. A mitigation for this problem is to make the respondents answer twice. Finally, a combination of these three methods can potentially provide more validity of the answers and feedback given by the participants. Hence, the data analysis of these collected data will contain comprehensiveness and surrounding both subjectivity and objectivity in both a quantitative and qualitative manner.

Chapter 4

Experiments

This chapter will present a detailed overview of the experiment. The first section outlines the functions in the DApp used for the trading game experiment. Afterwards, it presents the planning and implementation of the experiment. Also, this chapter includes the activities from the experiment and the collected findings.

4.1 Mandarin Platform

This thesis proposed creations of decentralised e-commerce marketplaces termed Mandarin Platform. Thus, the naming of Mandarin Platforms intends to describe a marketplace DApp created on Origin Platform promoting a SCS theme. It is profiled with a symbolic mandarin orange colour with a matching logo of a gauge meter on a mandarin, as shown in figure 4.1. As this application plays a significant part in the experiment, including appealing graphics in the application may signify a more severe application which can stimulate the users' attitude to use this DApp. For each modified focus group testings, a new independent marketplace will be created to initiate an empty marketplace with no listings.

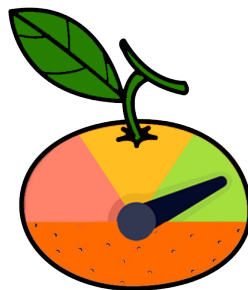


Figure 4.1: The logo of Mandarin Platform

The application provides a set of functionalities which are useful for the experiment. Figure 4.2 displays a flowchart embodying the essential activity flow in the marketplace application. Users start by entering the homepage in a browser which also detects whether MetaMask is set up on the computer. If the authentication with MetaMask is successful, all the listings in the marketplace will appear. From this point, a user can either buy or sell an item. Following are the steps to complete a transaction.

- **Seller** list an item on the marketplace by first choosing a category and then types a listing title, description(at least ten characters), quantity, price and a photo of the item. The seller can then review the listing before confirming to publish the listing onto the blockchain. Also, it is possible for the seller to edit published listings.
- **Buyer** can make an offer on an item by clicking on the targeting item and the purchase button. After confirming the offer, the buyer must wait for the seller to accept or reject the offer.
- **Seller** accept or decline the purchasing request from the buyer with its respective confirmation. After accepting the offer, the item ships to the buyer.
- **Buyer** receive and inspect the item, and write a review to reflect the satisfaction and experience of the transaction. Usually, giving a max rating if the item received is as described, and lowest rating if the item is not as described. However, the buyer is free to decide the rating to give and additional comments. After confirming the publishing of review, the transaction finalises, and the seller obtains a new review to the profile.

The appendix A includes screenshots of the various activity steps described above, captured from a demonstration marketplace¹. Furthermore, it was created several other marketplaces for the respective testings^{2 3 4 5 6}. A marketplace’s primary function is to establish a favourable environment for buyers and sellers to interact and transact items. Notably, every interaction and transaction between the users are direct without any intermediary in between. Therefore, all data are decentralised and open for the public to inspect. Ethereum’s smart contract is a breakthrough in establishing trust and ensuring transactions to take place. Hence, the application also provides data authenticity and escrow to settle non-functional requirements, such as integrity and reliability.

¹Mandarin Platform demo - <https://mandarinmarketplace.staging.origindapp.com/>

²Mandarin Platform test 1 - <https://mandarin.staging.origindapp.com/>

³Mandarin Platform test 2 - <https://mandarin0.staging.origindapp.com/>

⁴Mandarin Platform test 3 - <https://mandarin1.staging.origindapp.com/>

⁵Mandarin Platform test 4 - <https://mandarin2.staging.origindapp.com/>

⁶Mandarin Platform test 5 - <https://mandarinmarket.staging.origindapp.com/>

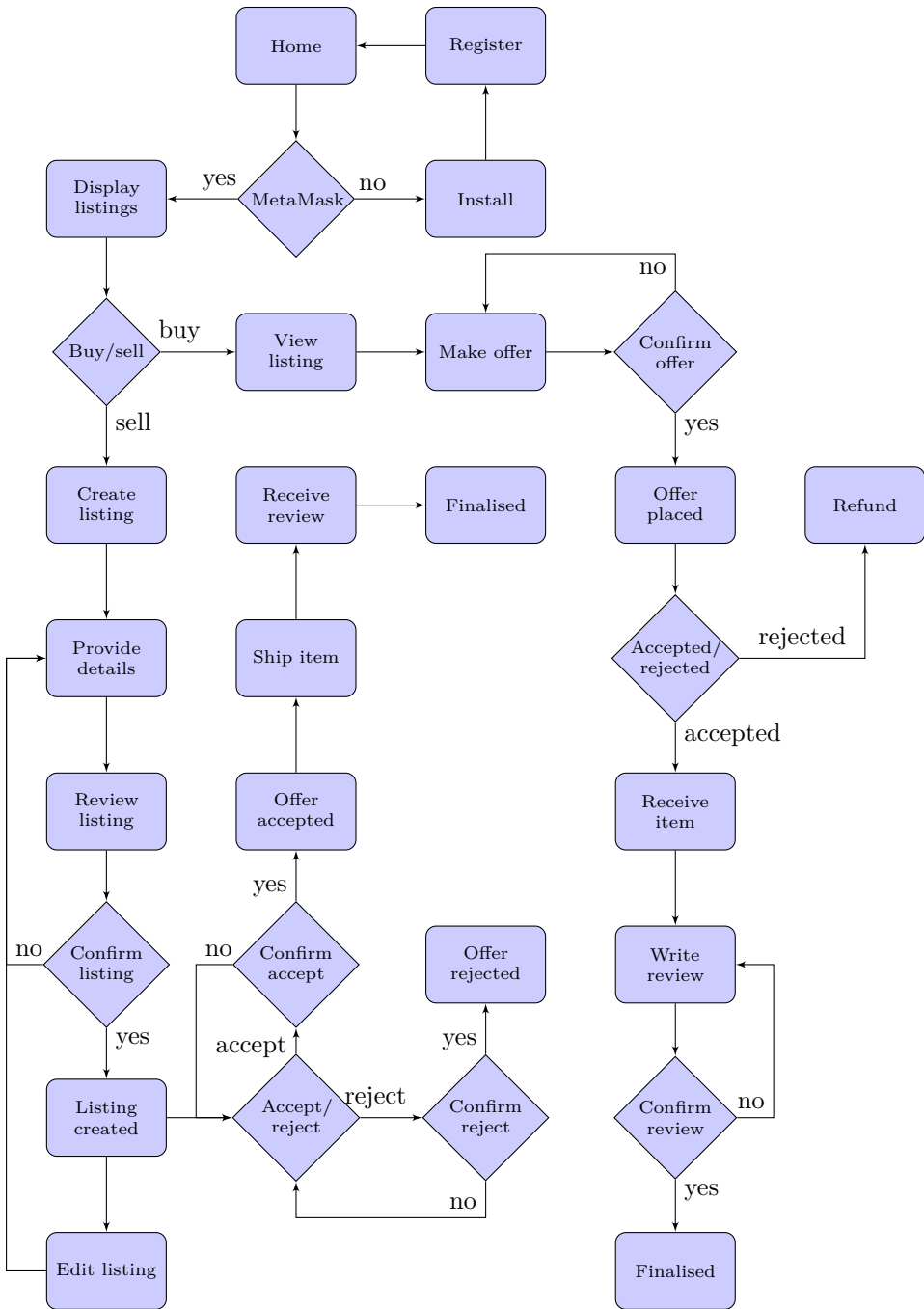


Figure 4.2: Flowchart of the decentralised e-commerce marketplace

4.2 Experiment Planning

Planning the experiment is an important event to keep control, foresee and prevent pitfalls when experimenting. Also, a well-designed plan helps to achieve the objectives. The following subsections provide details of the experiment planning.

4.2.1 Objectives for the experiment

This subsection lists the objectives for this experiment. The objectives guide the research tracks and ensure that the goal of the research is apprehensible. The following objectives for the experiment are:

- Investigate decentralisation as a solution for ensuring trust in comparison to centralisation.
- Study the trade-off between privacy and convenience.
- Examine how the application of blockchain and big data can work as the tools to incentivise users to act honestly.

4.2.2 Equipment and Materials

This subsection lists the equipment and materials required for the experiment. The following equipment and materials are:

- Computers with an installation of Mozilla Firefox and MetaMask
- A projector with screen to provide instructions
- Printed single letters from the 26 characters in the alphabet on small paper sheets

4.2.3 Procedure

This subsection describes the procedure of the chronological tasks the participants will follow. The steps are essential and designed for smoothly conducting the trials. The following steps are:

1. Each student installs Mozilla Firefox and the MetaMask browser extension.
2. Each student creates a MetaMask Account on their computers by following the on-screen instructions after installation. After successful creation, an

amount of 0.5 ETH allocates to each user and adds to their MetaMask wallet. Alternatively, it is also possible to claim 0.5 ETH from a faucet⁷.

3. After the setup is ready, everyone enters the Mandarin marketplace platform effective for the respective testings. Also, a projector will display instructions on how to use the platform.
4. All participants will draw five paper sheets, each containing a single letter from a pile. These papers sheets represent the items for trading and have an unknown value during the market's trading hours. However, the value of the items is pre-determined before the game for the sake of fairness.
5. When everyone is ready, the game starts, and the students will then use the marketplace platform to trade. There are in total four general steps required to complete a transaction, and each of these steps needs confirmation to write to the blockchain. The previous section and Figure 4.2 are describing these steps. A participant has the following choices:
 - Sell their item(s).
 - Buy other's item(s).
 - Do nothing.
6. The students will either risk buying item(s) or risk selling item(s) or do nothing. However, some hints concerning the value of particular letters will be throughout certain stages in the game, announced so that some students may have more or fewer incentives to trade. These hints were:
 - Vowels(A, E, I, O, U) are valuable.
 - Some letters might deduct a certain amount of the total value.
 - Sequential letters are the most valuable.
 - Duplicated letters are unfavourable and will deduct a certain amount of the total value for each duplicate.
7. The rating score is used to describe the seller's reputation. A low rating score may result in few or no sales. One can neglect the buyer's reputation in this case because of the escrow feature provided by Ethereum's smart contract controls the payment.
8. Soon after closing the trading market, there will be revealing of the letter values. All participants will sum up their total value along with the announcement. The letters or combination of letters will have a varied range of both positive and negative values. Negative values indicate a deduction of the total ETH

⁷Ethereum Rinkeby Faucet Testnet - <https://testnet.help/en/ethfaucet/rinkeby>

value applying to the participant. Positive values indicate an addition of value to the total ETH value belonging to the participant.

9. There will be announced winners who receive prizes as an incentive in participation to win the game. During and after the ongoing experiment, participants are advised to comment and discuss any matter regarding the concept.
10. In the end, the participants will also answer a questionnaire survey containing multiple-choice questions, which will further supplement the experiment data collection.

4.2.4 Risk assessment

By starting early to identify and plan potential risks which might impact the experiment is important. A risk assessment prepares an understanding to contain and mitigate possible risks. Table 4.1 provides an overview of potential risks and suggested tactics to prevent or deal with the risks.

4.3 First experiment implementation - Tianjin

Altogether, four different groups attended the experiment in China. The first trial took place on the 9th of April 2019 with a group consisting of 78 participants. Several hours before the scheduled time of implementation, Origin Protocol released an update which left the *"Discovery Server"* field blank. Thus, the marketplace was displaying every item stored on the Rinkeby Test Network blockchain with connection to Origin Protocol. With an urgent conversation with the Origin Protocol team, they quickly proposed a solution for this issue. By entering an URL⁸ to the *"Discovery Server"* field, Mandarin marketplace immediately filtered the listings only to include its own.

The first trial could then start after an hour delay. Following the plan, all 78 students were able to install and register a MetaMask wallet. Following the test ETH allocation to their wallet, the trading game could then start. Only some few students were able to complete a transaction. In total, 35 transactions completed, and 16 transactions were still in progress out of 116 successful listings. These numbers are not very convincing because 78 participants proved to be too many. First of all, the website providing the DApp for use with Rinkeby Test Network was not able to handle the load. Another Origin Protocol developer told that its original intention was to be a test environment for the development of Origin Protocol. A further recommendation was to experiment with a smaller group. After all, controlling a group of 78 is also challenging.

⁸Discovery Server - <https://discovery.originprotocol.com>

Table 4.1: Risk assessment of the experiment implementation

Risk	Control measures
Mandarin Marketplace not working	Establish a continuous dialogue with the Origin Protocol team and schedule time of implementation.
One of the services are blocked	The Internet censorship policy blocks many domains in China. An Internet censorship policy blocks many domains in China. Thus, all the services requiring an Internet address are on beforehand carefully chosen and tested.
MetaMask problems	By testing many use cases combining MetaMask and Mandarin Marketplace on different browsers, Mozilla Firefox seems to be the most stable browser. Moreover, Google Chrome is not possible to install in China.
Problem with ETH fund allocation	The researcher has prepared more than 100 ETHs on Rinkeby Test Network to allocate manually. Alternatively, a Rinkeby Test Network ETH faucet was also a solution for users to claim funds.
Slow or bad Internet connection	Slow or lousy Internet connection is prone to application performance. Therefore, the experiment takes part in a university with a pre-test of the application in a similar environment as the intended experiment.
Computers not compatible	Test several types of computers in both Norway and the Chinese computer labs. Then, only choose to include compatible software.
Low activity level of trading	Hints provided underway the experiment are a measure to persuade participants to trade.
Uncooperative participants	Include real prizes and rewards as incentives to increase the participants' participation.
Questback servers down	The questionnaire survey is also available as a word document which can be printed out.

The second trial was live the next day on the 10th of April 2019, now including a new group of 16 participants. This time, 47 transactions completed, and only two transactions left in progress out of 73 total listings. On average, each participant completed three sales. Many participants commented that the confirmation process required too much time, which is impractical when trading with lower value items. A completed cycle from listing an item to the finalised transaction had a best-effort

measured time of approximately five minutes. It is indeed time-consuming when the four steps require four independent writes to the blockchain. Figure 4.3 displays the experiment setting for this second trial.

The third and fourth trial was conducted simultaneously six days later on the 16th of April 2019. There were a total of 25 PhD students participating and divided into two groups of 13 and 12 each. These two groups were using two separate marketplaces, and the performance was similar to the second trial, which is good. For the first marketplace, it was a total of 32 completed transactions and two pending transactions out of 65 listings in total. The other marketplace ended up with 30 completed transactions and two pending transactions out of 54 total listings.



Figure 4.3: Second trial with 16 participants

4.4 Second experiment implementation - Trondheim

Back in Norway and Trondheim, a group of 14 participants were invited to complete the last experiment. It took place on the 6th of May 2019 in a similar classroom environment as in China, as illustrated in Figure 4.4. This final trial was planned accordingly to the previous successive trials in China. As a result, 37 completed transactions and two pending transactions out of 93 listings were the final numbers. Like in China, the participants also mentioned about the time-consuming steps to complete a transaction which is quite impractical for trading cheap items. However, it was a general acceptance that a decentralised marketplace is beneficial for trading with items more prone to fraud, such as event tickets and mobile phones.



Figure 4.4: Last trial in Norway with 14 participants

4.5 Observations and findings

Each experiment had a duration of around 2 hours, where approximately 30 minutes were for installation and experiment setup. This duration means that the effective trading hours were less than one and a half hours. To compare the experiments, Table 4.2 clarifies the previously mentioned numbers and observations. Furthermore, this section also offers findings from the experiments.

Table 4.2: A table comparing the several trials

	1. trial	2. trial	3. trial	4. trial	5. trial
Participants	78	16	13	12	14
Total listings	116	73	65	54	93
Complete transactions	35	47	32	30	37
Pending transactions	16	2	2	2	2
Average listings per participant	1.49	4.56	5.00	4.50	6.64
Average completed transactions per participant	0.45	2.94	2.46	2.50	2.64
Sales per listing	30.17%	64.38%	49.23%	55.56%	39.78%

During the experiment, each participant had an identifiable name attached to their profile. This concept is to portray that every user links to their real identity, and the blockchain protects their real identity and personal data from the rest of the users. The data is either stored on a blockchain or IPFS so that it is decentralised. No

user had to provide personal data to use the marketplace. Based on the observations from the experiments, the participants seem to act more careful because of their attachment to the DApp. The participants were asking questions such as "*can the other users find out who I am if I scam them*", which addresses their concern of identity exposure. Notably, the Chinese were more confident about the other participant's trustworthiness, which also reflects in sales per listing in table 4.2. However, the experiment consisted of students who knew each other and thus potentially exposed to friendship bias. It means that friends can comfortably serve each other, and favouritism will conflict with fairness. This factor could likely affect these numbers.

From table 4.2, it is expedient to disregard the 1. trial as these results strongly deviated from the other trials. Furthermore, the row describing pending transactions is to indicate transactions which did not complete due to time limitations.

An interesting finding from the results is that there were more listings in Norway per participant, but less completed transactions per listings in comparison to China. It can indicate that Norwegians prefer to sell items more than buying items. In Norway, it was sold less than 40% of the listed items while the Chinese on average sold more than 55% of the listed items. During the experimentation, an observation to endorse these numbers was that the majority of the Chinese seemed to buy items without concerns about potential fraud. The demand was higher on particular items as a consequence of the hints provided. Thus, these hints engaged in higher sales completions per listing in China rather than in Norway, where the majority of users only wanted to sell. Another trend was that buyers in Norway were more careful in purchasing items by using the reputation mechanism and consider a purchase more thoroughly.

The escrow feature in Mandarin Platform made it convenient for the users to control and track their payments. It also shifts the trust burden from the buyer and third-parties to smart contracts. This shift ensures that the payment is guaranteed to go from source to destination. The sellers found this feature very convenient. However, a scam could arise from the seller who provided the items as blockchain does not provide an escrow for items.

In the experiment, the participants were encouraged to scam each other if they wished to. Mandarin Platform used a review mechanism to rate sellers' trustworthiness. Majority of the sellers expressed that they did care about their trustworthiness and wanted to create a reliable market order. When sharing the hint that some letters may have negative value, the fraud activities started immediately to infest the marketplace. An observation is that the Norwegian buyers became more cautious, and the fraud attempts were less successful compared to the Chinese. The numbers from Table 4.2 can also support this observation.

The next hint provided information about valuable letters. This information resulted in a high activity of making offers. Despite this high activity, the majority of the sellers rejected these offers. It was because the sellers started to include the sellers' rating into consideration for approving or declining the offers. This approach is a new observation which supports the idea of a unified system to determine trustworthiness as proposed in the SCS.

The last hint of unfavourable duplicated letters evolved in a higher trade volume. All sellers were mostly honest as they had to get rid of their duplicated letters, and many buyers were willing to buy. Many of the sellers who previously received bad reviews were able to sell their duplicated letter if the buyers needed it for their sequence. This round demonstrated that demand wins over reputation as buyers were now trusting sellers with bad reviews.

4.6 Target audience

All the participants in the experiments are students, which limits to a small group of society. This group of people are known to be an elusive group to target. High educated university students often have above average knowledge in digital technology. Thus, conducting this experiment by inviting student as the target audience is both valuable and straightforward. Educated targets can demonstrate objectiveness and well-reasoned subjectiveness. Therefore, students make an ideal target audience for technology-concerning experiments.

4.7 Ethical issues

Each participant had to name their account on Mandarin Platform with an identifiable name to be recognised. Also, it represented each user's address of receipt. When buyers had their bids accepted, sellers went personally to deliver the items. This simplification was an approach to link the account to a user's real identity. It is a simplification which supposedly will demonstrate an essential part of SCS. It is important to note that the participants' personal data was never after the experiment kept. Anything which could be traced back to any specific individual was discarded. By participating in the experiment, only the data relevant to the experiment itself was available for further analysis. The immutability characteristic in blockchain was also informed so that everyone was self-responsible of what they posted to the blockchain. The surveys following the experiments were made available through a shared link on Questback, and do not link to names or e-mail addresses.

Chapter 5

Results and Discussion

This chapter brings in the discovered results, observation and findings from the previous chapter and the results from the questionnaire survey. The discussions of these results will be together with the results which are in line to answer the research questions for this master's thesis. Firstly, a dive in the results from the questionnaire survey will further extend the observations and findings from the previous chapter. Secondly, the literature reviewed background will possibly explain and support the results. Finally, the significant findings are either valuable for answering the research questions or worthy of being explored in future work.

5.1 Results from the questionnaire survey

Following the questionnaire survey as a part of the data collection methods, the next subsections dedicate a look into these collected results. The questionnaire was active at the end of each experiment, and all participants have completed it. There was a total of 133 respondents and the results partition into 14 Norwegian respondents and 119 Chinese respondents. The results from China are combined, as the responses were considered equivalent from all experiments. However, the results from Norway have a smaller confidence level because of fewer respondents. Regardless, the results from this survey still provide a satisfactory overview of the matters as the participants have tried a concept and possess adequate knowledge in the e-commerce field.

First of all, more than 42% of the Chinese students were buying items online more than one time during a week. Contrary, all the Norwegian students were purchasing items online either one time in a month or only a few times in a year. These numbers indicate a more frequent online shopping habit among Chinese participants. A similarity was that approximately half of the participants had been frauded before. However, while more than 95% of the Chinese were not scared of buying items online, almost 30% of the Norwegians were. Again, it is important to note that these data is not adequate to generalise, but they will provide an excellent sense to the statements

and for further discussion.

5.1.1 Trust

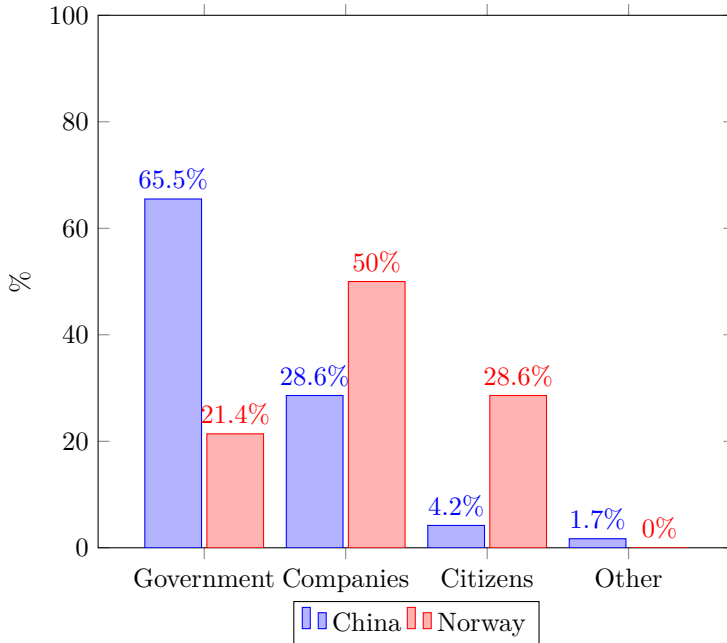


Figure 5.1: Who should have the responsibility of providing trust in commerce in your country?

Figure 5.1 shows the percentage distribution of who should have the responsibility of providing trust in commerce. It is clear to see that the Chinese rely on the government, while half of the Norwegians think companies are responsible. The results also reflect the type of market economy the respective countries have. When there are state-owned companies, the state has the authority to intervene with high flexibility. For the Norwegian companies, there are some companies which are partly state-owned and regulated, but the majority of companies are governed privately in a free market economy. Thus, it seems taken for granted that the government in China are responsible for ensuring a system of trust in e-commerce. Likewise, the companies have that same responsibility in Norway.

In order to restore trust to its people, the Chinese government's SCS is an upcoming solution to provide improved integrity for the entire nation. The final technical specifications are still not revealed for the public. However, this research experimented some potential technologies which have high potentials in a SCS ecosystem with storing, revealing and warning functions. The technologies used in

the POC were further tested in the experiments and demonstrated its feasibility. Decentralisation of data and the DLT showed to be concepts which have the potential to promote trust. Storing people's reputation on an immutable blockchain is a powerful mechanism. Almost all of the respondents also agreed that they care about their reputation.

Since e-commerce buyers are not able to see or touch an item in person before buying, buyers decision of purchase focuses on trusting the seller. For overcoming payment fraud in the experiment, the escrow function ensured a 100% secure payment operation. The remaining weak point of inherent distrust in this system is the seller's item and its delivery process to the buyer. Storing the records from this process enables supervision of the entire action. Moreover, the experiment revealed that fraud could easily succeed if it did not result in any consequences. So, by introducing a legal system which can punish distrust and promote trust is immediately an efficient solution. All these mechanisms should be precise for all users and should also include a warning mechanism to educate the users. Otherwise, potential violators will not learn how to act legally. Lastly, this system is useless without quality-assured input data, which leads to the discussion of who should control and store all these valuable data.

Indeed, the Chinese government in charge will control this data for themselves as part of their ideology. Today, many of the governmental decisions are made based on the state's ideology, philosophy and interest. For instance, the existence of the Great Firewall of China divides in social, political and economic reasons. Firstly, it protects citizens from being exposed to dangerous websites. Secondly, the unpopular opinion is that it exists as a tool for government control and spread the Chinese culture. Lastly is the economic reason with concern to boost the Chinese economy and therefore excluding large foreign companies such as Facebook to enter the Chinese market. This idea remains fundamental for the Chinese government in the work of constructing storage and control of valuable data. Similar to today's e-commerce model with middleman between buyers and sellers to handle payment escrow and dispute settlement, users generally have very little control over their own data.

The original decentralisation concept where data is distributed freely and open for everyone will not work for China. China will probably move towards a private DLT and permissioned blockchain to remain data into its control. This way, the government has its private blockchain inaccessible by everyone else without authorisation. They are then able to read, write and audit all data communicating with the blockchain. With its centralised and exclusive traits, it is certainly questionable to put this new proposal on the same page as decentralisation. However, it still offers essential decentralisation values such as cryptographic auditing and known identities, which makes the system difficult to tamper but easier to validate transactions with Proof

Of Authority (POA) consensus.

Additionally, the system will be faster and more cost-effective than, e.g., the Ethereum blockchain. In the experiment, the duration of confirming and adding transactions to the blockchain was lengthy and time-consuming. A permissioned blockchain could also be the solution to undertake this problem. However, over 80% of the participants indicated in the survey that the public blockchain in the experiment made them more confident trading than having an intermediary controlling the trade. This result may fortify that the younger Chinese generation holds stronger trust in today's digital technology.

5.1.2 Privacy

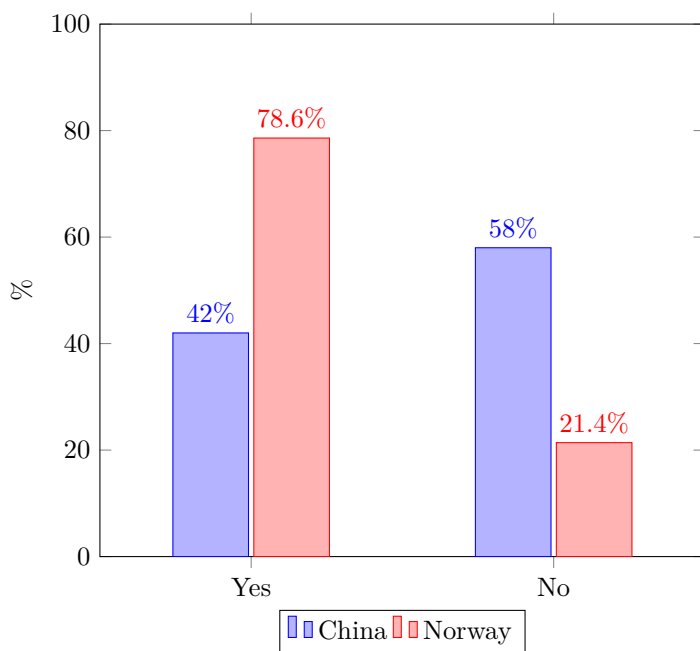


Figure 5.2: Would you share your private personal data in order to be provided with social safety and security?

Figure 5.2 reports a higher willingness to share private personal data in exchange with social safety and security for the Norwegian students. Interestingly, 58% of Chinese students are not willing to undertake this type of exchange. An impotent legal system could be the reason concerning this result. As identity theft and black market sales of NRIC are quite common in China, the Chinese people do not believe that exchanging such critical information can really provide social safety and security. Many companies and government systems have security weaknesses, which often leads

to leaks of personal data. The legal system retains the shortcoming of a competent system to detect abuse of personal data. Information and identity falsification is, therefore, an easy way to bypass the current system. Thus, many abusers are not afraid of using other's identity and data to do harm in society and earn themselves some benefits from it. As a consequence, the majority of Chinese people are generally afraid of sharing any personal data.

In Norway, the high percentage speaks for itself. Norway has one of the world's most advanced and comprehensive legal system. Besides, citizens' privacy is well-protected by laws. Thus, the Norwegians have more control of their personal data with fewer cases of identity fraud. The Norwegian participants could, therefore, share a higher willingness to exchanging their personal data with social safety and security.

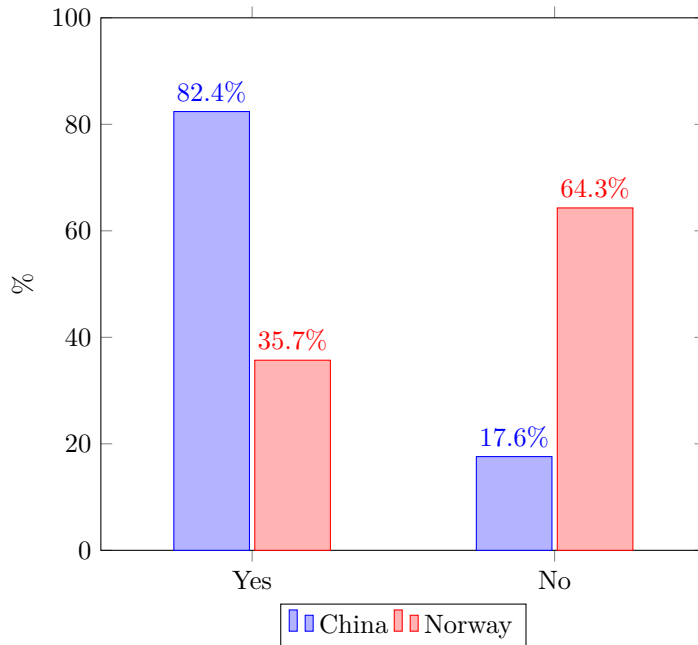


Figure 5.3: Would you share all transaction data to the governmental institutions in order to influence your creditworthiness? This can ease your loan and credit applications.

Figure 5.3 compares the willingness to share all transaction data to the governmental institutions to impact the participants' creditworthiness. As displayed, 82.4% of the Chinese participants would agree to share this information to improve their creditworthiness. Contrary, 64.3% of the Norwegian participants disagree in sharing such information. An explanation could be that it is tough to obtain a loan and receive approval on credit applications for Chinese students. Thus, the lack of a

functioning credit information system is a valid explanation for this cause. On the other hand, Norway has an advanced welfare system with ease for students to apply for student loans and credit. Hence, it does not sound necessary for the respondents to agree to share transaction data with governmental institutions to easily apply for loan and credit.

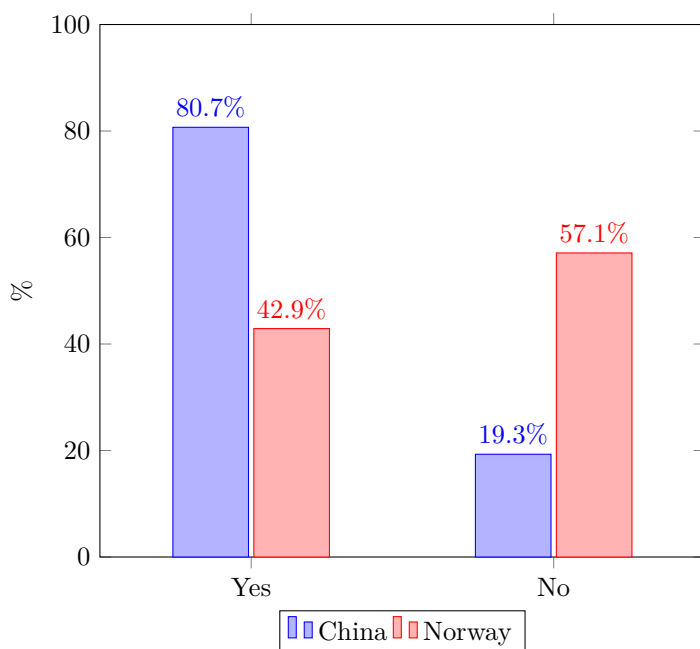


Figure 5.4: Would you share all transaction data to the governmental institutions in order to influence your trustworthiness? This can ease people’s confidence in your business.

Figure 5.4 compares the willingness to share all transaction data to the governmental institutions to impact sharers’ trustworthiness. These results are somewhat related to the results obtained about creditworthiness in Figure 5.3. 80.7% of the Chinese participants and 42.9% of the Norwegian participants would agree to share all transaction data to improve their trustworthiness. Comparable to the previous explanation, the reasons behind these numbers could arise from the lack of a functioning trust system in market situations. Hence, the more significant proportion of the Chinese students could agree to share their transaction data for a more trustworthy market. These questions also ask to share data to the governmental institutions, which from Figure 5.1 favours a greater recognition amongst the Chinese. Nevertheless, 42.9% in Norway is a substantial portion which also reveals some level of expectations to the governmental institutions’ influence of trust.

Figure 5.2, 5.3 and 5.4 all describe different motives to exchange the willingness of sharing data. No matter if it is personal data or transaction data, they are valuable and useful for companies and the government. By comparing Norway to China in the sense of data privacy, it is clear to distinguish a fundamental difference in the practice of collecting, storing and sharing data. Chinese internet companies have in the past years built business models around Chinese people's lack of awareness about privacy. It is also statutory to share these data with the government to not have their business license revoked. Besides, numerous data leaks incidents as the consequence of security malpractice are simple targets for fraudsters and criminals. The China Consumer Association [Ass18] reported that 85.2% of their 5458 survey respondents had experienced personal information disclosure such as leaked phone numbers and NRIC information. These series of privacy breaches were the needed wake-up call for the privacy unawareness in the population.

Today, many of the Chinese have higher privacy awareness as a result of facing the consequences of data abuse. Especially the younger generation who carries a more profound knowledge in digital technologies. From the questionnaire in the experiment, more than 80% of the participants would not sell their privacy for a monetary value. Despite the massive amount of mobile applications and data collecting devices in the Chinese market, most people do not coincide with the statement by the CEO of Baidu as mentioned in the background, *"the Chinese people are willing to trade privacy for convenience, safety and efficiency"*. As also observed from the experiments and survey, the students were cautious of every keystroke and did not enter any sensitive information. All in all, the importance of privacy in people's life has indulged in a government intervention of building a data protection framework with GDPR as the model.

Similar to what is happening in China, the importance of privacy is fundamental in Norway. The level of privacy awareness rises accordingly with the expansion of digital services and devices. With the recent introduction of GDPR and a previously steady legal system in protecting privacy, it seems like the Norwegian students are comfortable in sharing their data and trust different services. Comparing to the Chinese students, the Norwegian students had a more lax attitude when entering data. Despite the high concern on privacy, this attitude reflects good faith in society and the ease of information sharing in a well-protected system.

An online e-commerce marketplace is a convenient place for buyers and sellers to do business. As these platforms often operate by a company, the users require to provide personal data to confirm identity. Then, data generated from activities in the marketplace churned in some algorithms before recommending buyers different items to buy. Indeed, it provides a convenience which is time-saving, cost-effective and straightforward. However, a critical vulnerability in a such described system regarding

privacy is single-point of failure. Data leakages are often a result of lousy security practice in centralised control, and chunks of data are together compromised. In this research, decentralisation is in the analysis of being an alternative to this problem. Recalling the survey, over 80% of the participants agreed that decentralisation in this experiment made them more confident trading than having an intermediary controlling the trade. Thus, the POC in this research seems to be compliant with people's privacy expectations.

5.1.3 Incentives

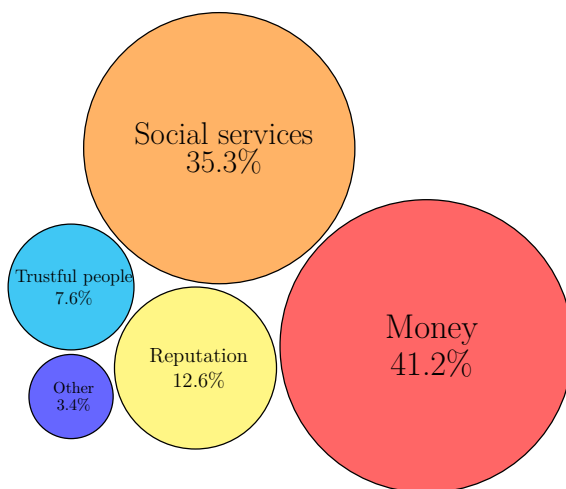


Figure 5.5: What do you consider most important? (China)

Figure 5.5 displays the most important values for the average Chinese participant, which are money(41.2%) and social services(35.3%). Money stands as the most compelling option in comparison to other choices such as social services, reputation, trustful people and others. This high cherishing for money is an important motivation factor for an average Chinese citizen. Money is necessary for paying vital needs such as food, shelter, health service and also a person's dignity. In China, the competition of making money is high, and there is traditional importance in making enough to take care of oneself, one's family and future. In such a competitive market, the value of money becomes a favoured incentive which reflects in the survey answers. On the other hand, money becomes a motivation for criminals to proceed with fraud, which is initially the main problem. Secondly comes social services which provide vital services to enhance living such as health and public services.

For the SCS, several proposals of incentive mechanisms exist. First of all, the monetary incentives proposed are in the forms of tax cuts or cheaper costs of social services. Thus, there are not any direct money incentives to reward social

and economic harmony. The incentive mechanisms are not necessarily positively rewarding people to encourage good acts. Some incentive mechanisms are punishing the violators and lecturing their harmful acts. Both the punitive and rewarding incentives mechanisms are efficient measures to direct the citizens into a configured path. However, its system to decide, condemn, praise and execute resumes a critical discussion in establishing a SCS as China the past years have strived for a competent legal system.

One proposed way to establish a competent system to distribute rewards and punishments are through decentralisation of data. Hence, collecting the data and place it onto the blockchain, which also immediately sounds like a familiar solution for every challenge today. Undoubtedly, this solution provides many advantages and suits the requirements for traceability and immutability. As one of the few countries in the world with this mighty authoritarian power, the Chinese government has a tremendous opportunity to exploit big data and to structure data with a traceable and immutable feature. The Chinese government has the resources and technological capability to invent a new technological system based on big data and blockchain, which has not yet reached its intended potential.

In a successful SCS, citizens must not carry everlasting tension in the society as the result of fear of punishments or addiction of rewards. The incentive mechanisms intend to assist in the stimulation of trustful behaviours. If the system ends up with the kind of fear described in George Orwell's 1984 [Orw49], the rest of the world would most certainly respond firmly. The questionnaire registered 95.8% of the Chinese participants would act more honest with an extra social benefit incentive such as lower taxes. 88.2% also accepted punishment, such as limiting rights for social services if they frauded other people. These numbers could explain the need for consequences or motivations to reduce dishonesty in China.

Figure 5.6 displays the most important values for the Norwegian participants. Similar to China, social services are important by 35.7% support. In contrast to China, money is as much crucial as trustful people and reputation. The welfare system in Norway is an excellent explanation for the less importance in money comparing to the results from China. The Norwegian citizens have the right of free support in health, education and even work. The conditions are not the same in China, inherently disclosed in the survey where money was more important than trustful people and reputation. Norway is a much smaller country in comparison, and the Norwegian citizens' reputation(21.4%) is advantageous to reach a successful business or career. It is besides necessary to trust other people(21.4%) in a much smaller market than in China. Eventually, the fundament in doing business is to earn money, which in the survey displayed importance to 21.4% of the participants.

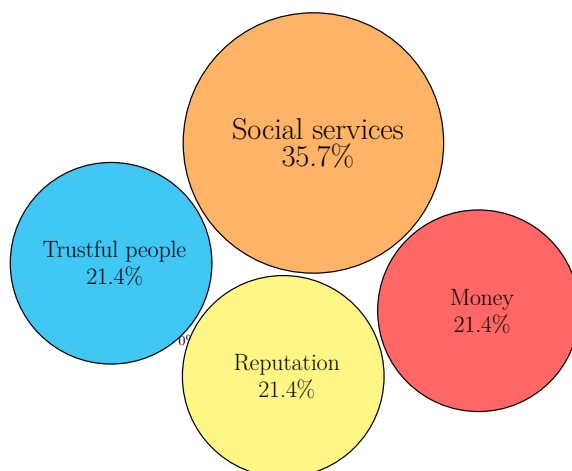


Figure 5.6: What do you consider most important? (Norway)

In the experimentation, approximately 85% of the participants looked up the user ratings before purchasing an item. This trend also exists among the younger generation of Internet users when conducting online shopping today. Many online marketplaces provide a user review system to determine one's trustworthiness. However, there are some biases with these systems. Firstly, when someone receives multiple poor ratings, they can delete their accounts and create a new account with reset reviews. Secondly, these systems are prone to Sybil attacks as users and friends usually can create many accounts to rate themselves. Thirdly, the total review score is generally not sufficient to indicate someone's trustworthiness as it lacks other parameters such as historic misconducts.

The Mandarin Platforms in the experiments decentralised the reviews to a IPFS and connected the IPFS hashes to the blockchain smart contracts. This method ensured the reliability in the user-provided reviews. 90% of the survey respondents also felt more confident in trading with other users by using the review system and preferred that all reviews were available. Besides, the same percentage was concerned about the rating they receive. Based on these results, the majority of the participants were satisfied with the review functions to incentivise honesty.

5.2 An in-depth discussion based on all collected results

Principally, information and data can be kept private without being shared entitling to privacy regulations such as GDPR. However, with the emergence of digital technology, one may be locked out from the convenient services by not contributing data. Most people now realise that convenience comes by a cost. Inevitably, companies must

launch new business models to obtain the consent of user-sacrificed data due to new upcoming privacy regulations. With these new privacy principles emerging, companies are also responsible for educating their customers on the costs of the offered convenience.

Results from the research regarding privacy demonstrate high attention to privacy among the participants in both China and Norway. During the e-commerce scenario, the participants simulated an unalterable identity linking to their real identity. Connecting user accounts to a real identity is an essential approach for providing trust. The privacy criteria fulfil if the users have the absolute rights to control their data. It means they can manage what they want to share and also remove information they do not wish to share. The latter creates a paradox with decentralisation as the purpose is immutability to provide trust. The POC demonstrates the difficulty of ensuring trust and not requiring user identification and authentication at the same time. Providing trust systems in e-commerce is a convenience for users. The users can select whether to use this convenience or not. Hence, the inevitable trade-off between privacy and convenience creates a difficult decision for users.

Storing data on the blockchain makes it readable for all nodes on the entire blockchain. A fully decentralised and permissionless blockchain will store the unalterable data for eternity. Hence, essential and personal data must go through an encryption process before storing on the blockchain. Currently, blockchain's public key cryptography is the most widespread approach. It ensures that the transaction source is legitimate by using a secretly kept private key to sign transactions. In the experiment, all users created their unique MetaMask wallet, which uses a representation of hashed public address to receive and send transactions. Besides, they used their secret private key to sign transactions and thus ensured legitimacy. No personal data which could trace back to the users were readable for the other participants without authorisation to read. Therefore, cryptographically encryption was able to preserve user privacy.

In a decentralised marketplace, the terms are determined by buyers and sellers with no middlemen to intervene. All transactions are open, transparent and immutable, which enables a tamper-proof trading environment. The direct payments between buyers and sellers disrupt international payments by removing third-party intervening and facilitating instantaneous, secure and low transaction fee. The participants in the experiments profoundly embraced these features to provide a trustworthy trading environment. More than half of the participants have previously experienced fraud. Hence, the DApp demonstrated a potentiality in which the specified system possesses technological feasibility in solving trust issues.

In a world of globalisation, the trust issues expand to a cross-border problem as

a result of uniting all of the world's markets. Motivations for buying across borders vary from item price to item uniqueness. Foreign credibility is even harder since foreign buyers and sellers lack information to prove universal credibility. Fraud is even easier across borders as it will be resource consuming to supervise each transaction. Therefore, decentralised marketplaces become an obvious solution which has the potential for assuring international trust. However, the compatibility with China's SCS remains a challenge. Additionally, globalisation leads to a more significant market size than China. Bringing the Chinese problems of trust and credit issues into focus, one can imagine these same problems could conceivably arise in a global market as well.

In a SCS ecosystem, the government or a control institution will be in charge of maintaining user privacy. Companies will require to comply with an upcoming privacy regulation which has inspirations from the GDPR according to Chinese media. The experiment in this research pointed out the importance of privacy for both participants from China and Norway. The Chinese participants expressed their trust in governmental decisions, and more than 80% would share data to the government to influence trustworthiness and creditworthiness. Norwegians, on the other hand, would share data for social safety and security. The participants were not unwilling to share data in exchange for something in return. Inevitably, this trend of data exchange will become more customised soon. As the rapid development of digital technologies causes some ethical challenges, technologies have become important tools for creating convenience in human life.

Trust in both the market and society will depend on the successful implementation of SCS. China's systematisation process of legal and moral is an optimistic process which requires thorough planning. The acceleration of SCS started first in 2014 with a six years schedule. Some cities in China have already implemented a pilot system. Rongcheng is one of the cities which has successfully initialised processes of cleaning trustworthiness and creditworthiness. Also, commercial SCS such as Sesame Credit is a system which can remind of a loyalty program for its users. Users trade on e-commerce platforms such as Taobao or Tmall and will receive rewards for their honesty. On the other hand, dishonest companies or violators will become blacklisted and punished for their recorded crimes.

From a democratic perspective, the SCS does not adequately provide freedom and privacy for a user in an e-commerce society. From China's perspective, privacy is sound as it is the government's role to ensure privacy. However, SCS seems capable of providing trust from both aspects. Similarly, a decentralised marketplace will further ensure trustworthiness in economic situations. The smart contracts have the potential to be extended to real agreements between buyers and sellers. The SCS initiative receives many criticisms for being government-centric and scary. Notably,

the privacy part violates the anonymity feature, which defines the original Internet.

After years of technological development, the Internet today is vital. Two of the most exciting technologies are blockchain and big data. Blockchain's capability of storing big data in a structured manner proves to be useful. In a SCS ecosystem, participants must provide data to create usefulness. The Chinese government have still not revealed what kind of data a finalised SCS would include. To incentivise citizens to act honest, a unified system to keep records is needed. Considering using a centralised database to store all incoming data could potentially result in the same chaos as it is today. The government collects a massive amount of data, but the current systems have weak security and are impracticable to handle the load of 1.4 billion citizens.

Applying blockchain to store and display user data in the SCS is a possible alternative. Similar to the use of blockchain in e-commerce, it provides some basic features to handle loads of data. Firstly, the immutability feature ensures unalterable data. It makes the data reliable to trust, and rich people with power cannot modify or remove negative records. Secondly, to decentralise will make the system resistance to single point of failure. However, China will presumably use a permissioned blockchain where the authority is in the charge, but other nodes will still participate in submitting suggested data. Thirdly, POA as the consensus algorithm provides time-efficient and cost-effective validation of data. Fourthly, SCS will probably aim for a semi-transparent blockchain. It means anyone can read some authorised part of the blockchain while the rest is only visible for the authority. Fifthly, an improvement in the security mechanisms by adding public key cryptography provides an additional layer of data encryption. The authority will have private keys and thus retain control on the privacy. Lastly, data will always be available with neglectable downtime in service. Hence, blockchain handling big data emerges as a capable solution of incentivising 1.4 billion citizens.

Chapter 6

Conclusions and Future Work

This final chapter provides the conclusion and future work for the master's thesis. In this research, the POC demonstrated the potential of decentralisation. A comprehensive study of SCS displayed the key concepts and its intention to solve the economic and social problems in China. Finally, the experimentations of e-commerce trading scenario brought to light the challenges of privacy, trust and incentives.

In a nutshell, the wide gap in the population size between Norway and China emphasise a perception into China's challenges. Today, Norway's 5.3 million population lives in one of the happiest countries in the world. In contrast, China's 1.4 billion citizens live in fast-paced and challenging conditions where people equip all possible strategies to succeed and pursue pride. Consequently, social and economic problems arise and require an urgent response. With the emerging technological advancement in technologies such as big data and blockchain, the Chinese authority seizes its potential and aims for a system to promote trustworthiness and creditworthiness. A combination of the population size and lack of a functioning system for controlling the masses leads to the introduction of the SCS, including its incentive mechanisms as the qualified solution.

China often portrays as the big bad wolf from a Western perspective because of their practices of privacy infringe human rights. Nevertheless, the introduction of the SCS implements surveillance on every citizen and violates the right to freedom. However, the reality is uncertain, but it may not resemble to match the clickbait stories by media trying to generate profit. The Chinese government is facing enormous responsibility in a nation lacking a fulfilling financial and social system. Consequences for the rapid growth in the economy has developed a high level of fraud and dishonesty in the Chinese society and market. Fraud and dishonesty are also visible in democratic countries such as Norway, but the advanced legal systems establish an effective barrier to most of these problems. However, people's right to privacy will again appear to be a trade-off to trust.

As an answer to **RQ1**, decentralisation by embracing blockchain technology can grow a scalable marketplace system which is fully transparent and possesses useful features to support trust and privacy. The Mandarin Platform used in this study was a conceptual marketplace which displayed secure data sharing processes, elimination of intermediaries, immutable reviews and transaction history. By collecting data and store on blockchain, users were not able to tamper the provided information. Hence, the data was secure and reliable, which protected other users against fraudulent sellers or buyers. In the study, the SCS ecosystem reflected its concept of storing, revealing and warning as incentives to control, promote and prevent dishonest users. Thus, the answer to **RQ1** is that a decentralised e-commerce application has the potential to incorporate privacy and trust in a Social Credit System (SCS) ecosystem.

Nevertheless, shopping on a decentralised e-commerce application not only saves transaction costs but also provides better protection to both seller and buyer. With support from digital technologies such as blockchain and big data, the incentive mechanisms in a Social Credit System (SCS) is also described to be feasible to enhance trust towards a potential implementation. As the answer to **RQ2**, this thesis demonstrated the potentials of big data and blockchain to implement incentive mechanisms in a SCS. The experiments proved that immutable reviews of users stored on blockchain resisted, e.g., Sybil attacks. Thus, the participants felt pressured to act honestly to receive positive reviews in order to be a part of the trading ecosystem.

The next step for this kind of research is to grow a precise knowledge of the intended national deployment of SCS, which is approaching. Similarly, the work in decentralisation is still in an early phase. It is an ongoing study in the field of decentralisation and related concepts such as DLT and blockchain. Despite its potentials, it still lacks completed projects which have demonstrated the acclaimed capabilities of these technologies. An inevitable bottleneck to these concepts is the ethical issue regarding privacy. The trade-off between privacy and convenience is hard, which will require further regulations depending on each country. Privacy issues arise from the continuous big data expansion. Most definitely, the future will grow more challenging as increasingly new technologies will be part of people's every day. A recommendation for future work could be to study how technology advancement shapes the future of privacy. Moreover, a study on how to implement a permissioned blockchain in SCS is also a needful task.

The research accompanied Mandarin Platform is based on the third-party Origin Protocol for research simplification in this master's thesis. A further step is to customise a trading platform to satisfy both China under the regulation of SCS and democratic countries with a developed controlling system. After the implementation of a more general concept, real-world experimentation will provide new significant results for possibly impact e-commerce in privacy, trust and incentives globally.

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Appendix

Screenshots of Mandarin Platform

The following appendix includes the screenshots of the marketplaces Decentralised Application (DApp). All screenshots are also captioned with some information describing the functions.

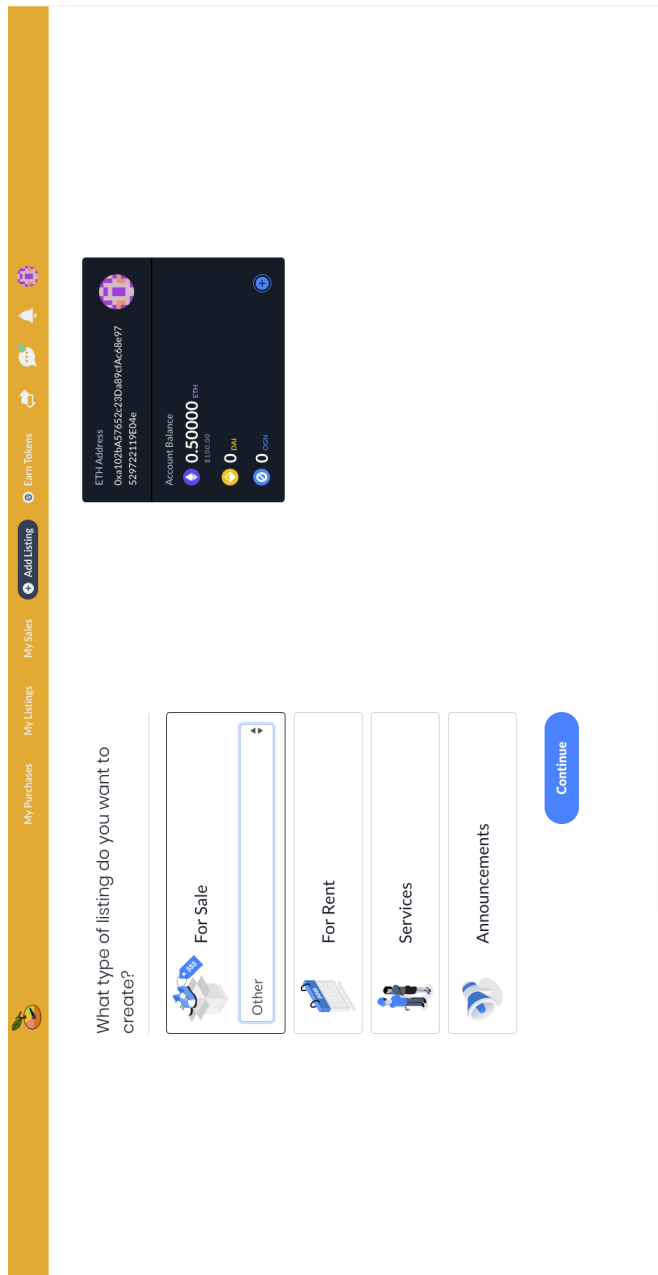


Figure A.1: Create listing

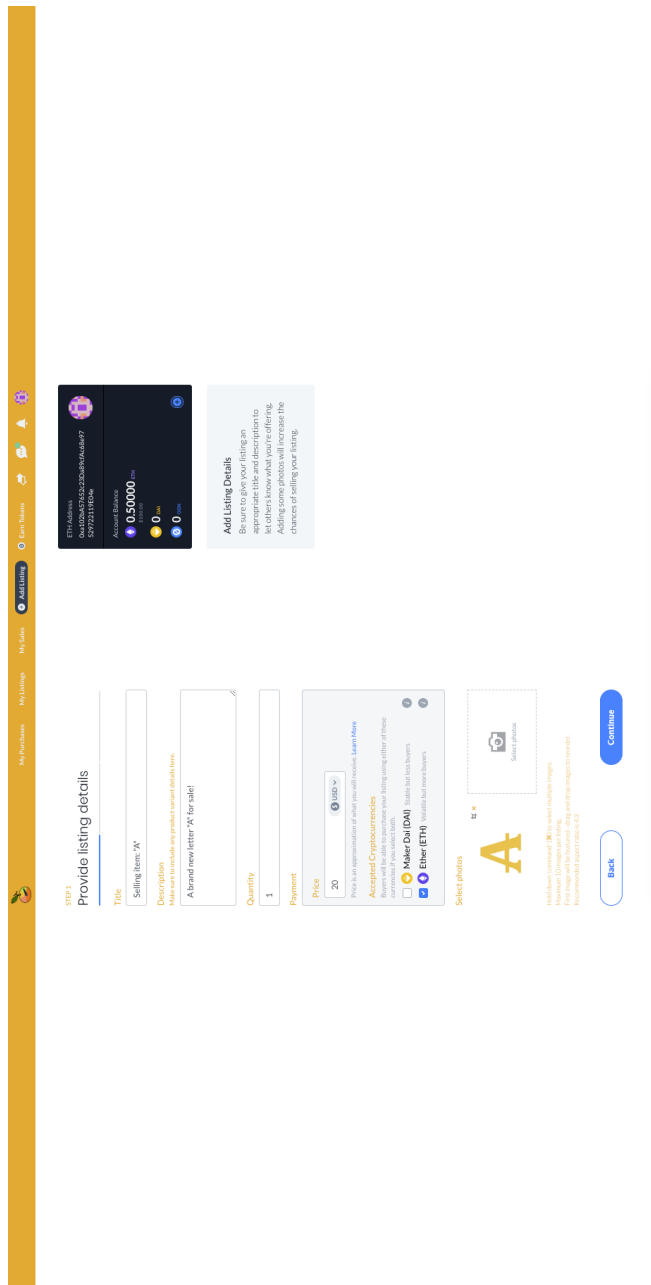


Figure A.2: Providing listing details

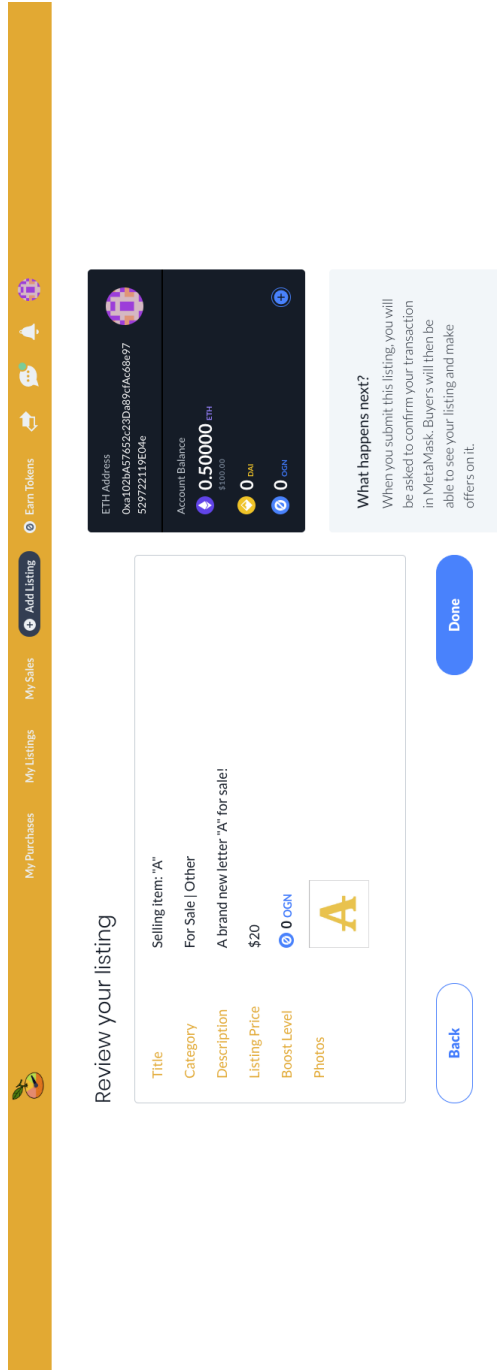


Figure A.3: Review the listing

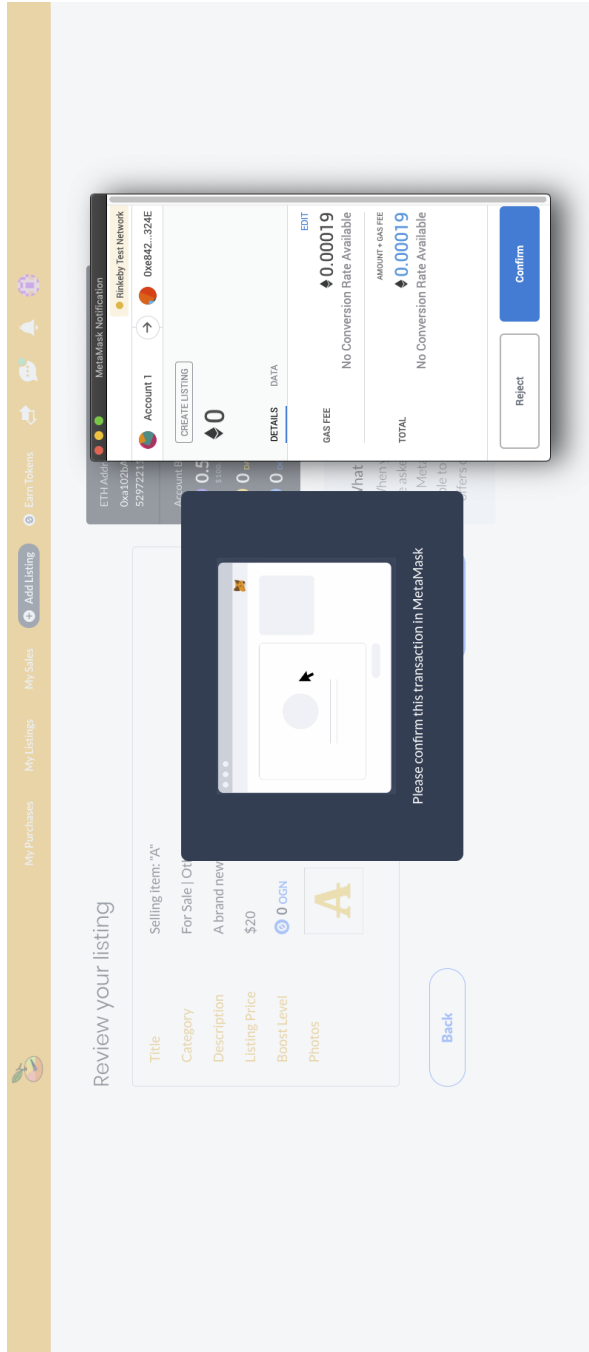


Figure A.4: Confirm the listing

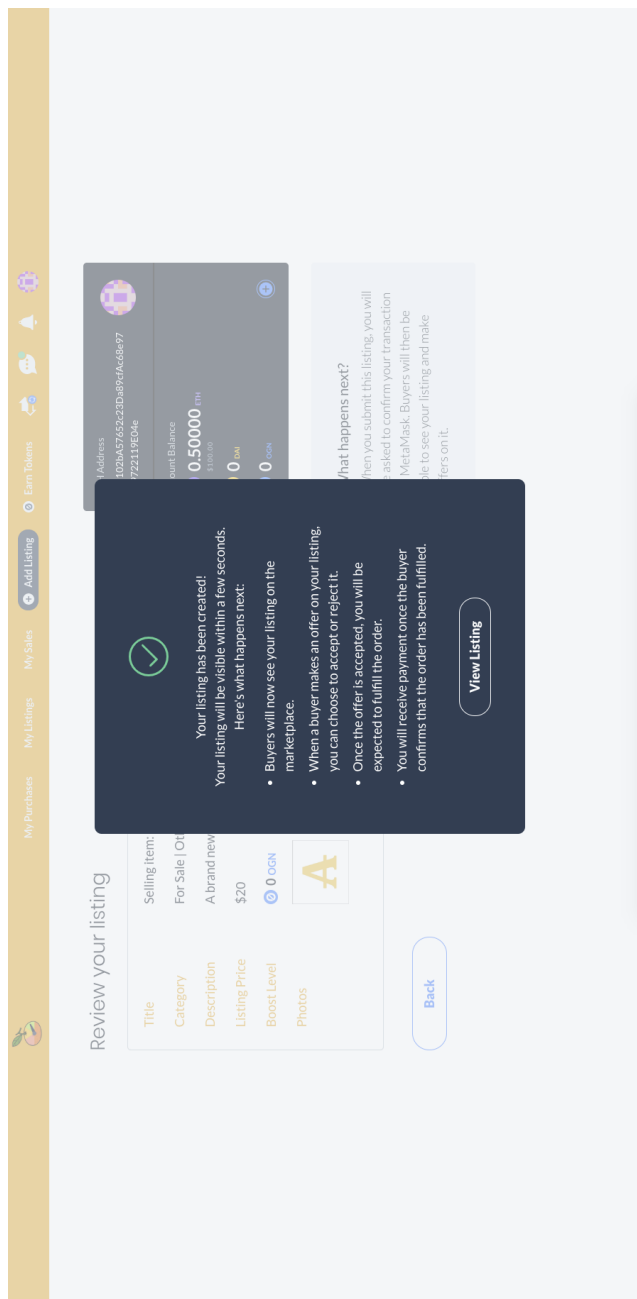


Figure A.5: Listing created

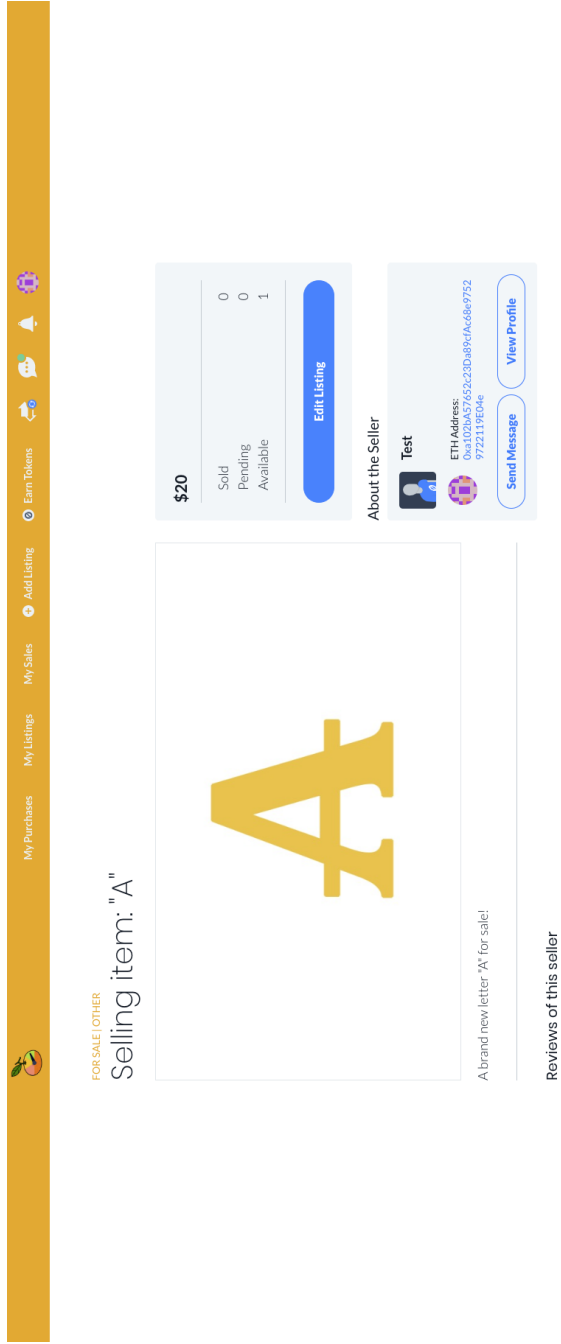


Figure A.6: Edit listing

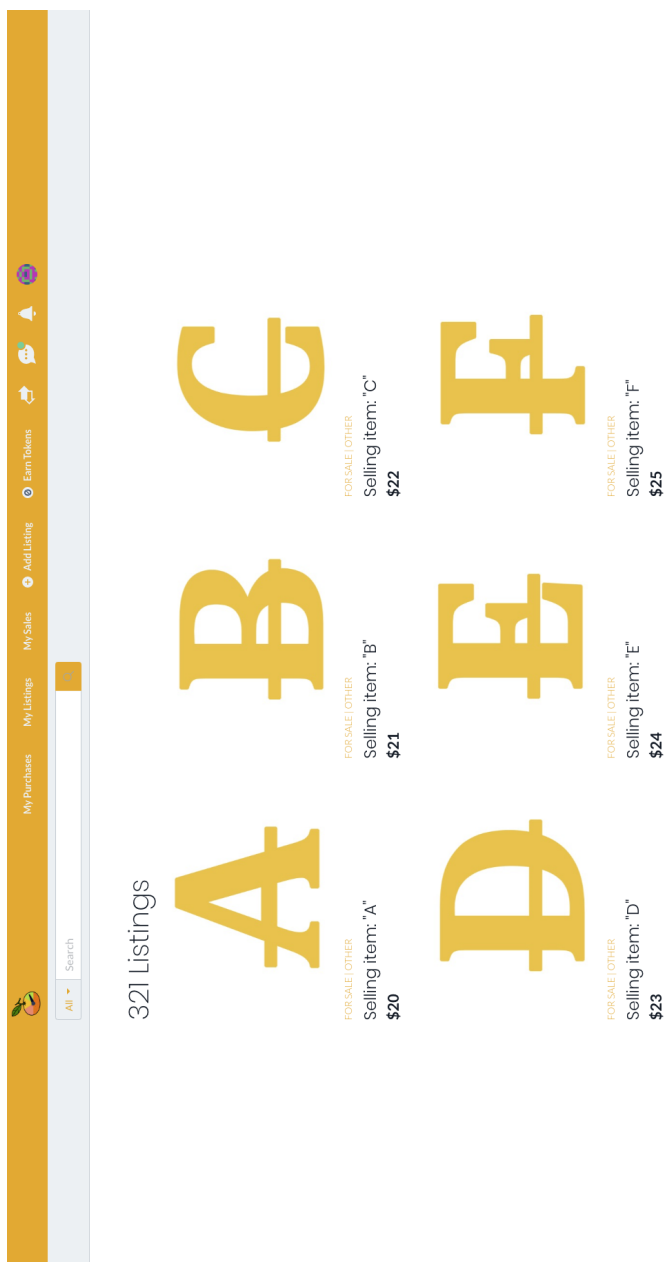


Figure A.7: Showing all listings in the marketplace

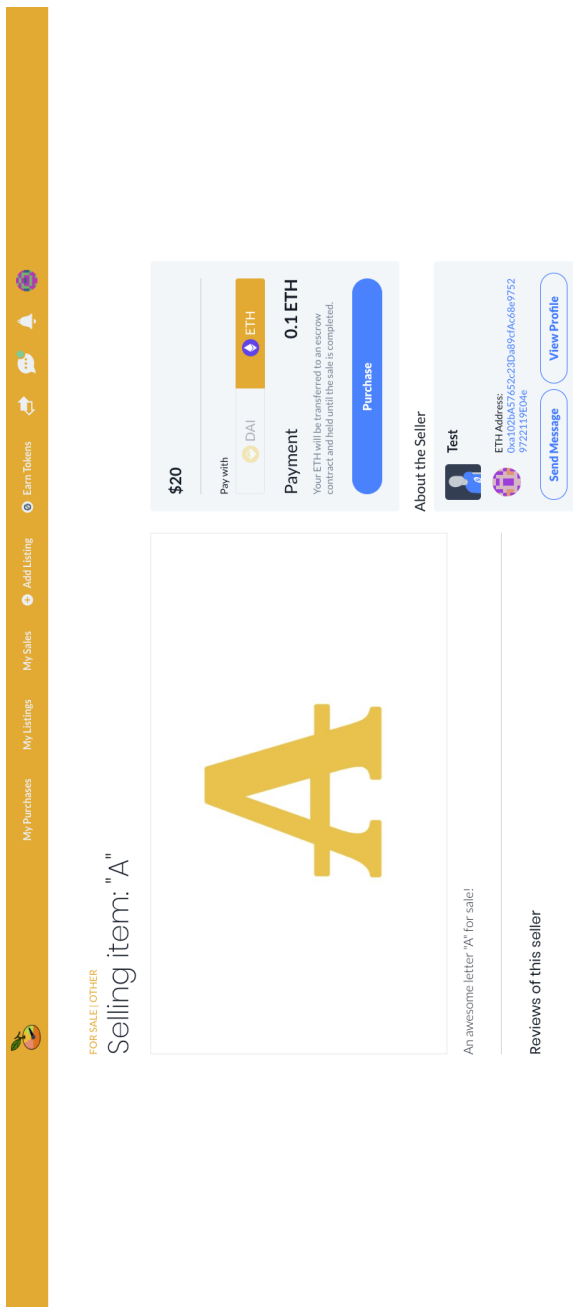


Figure A.8: Viewing a listing

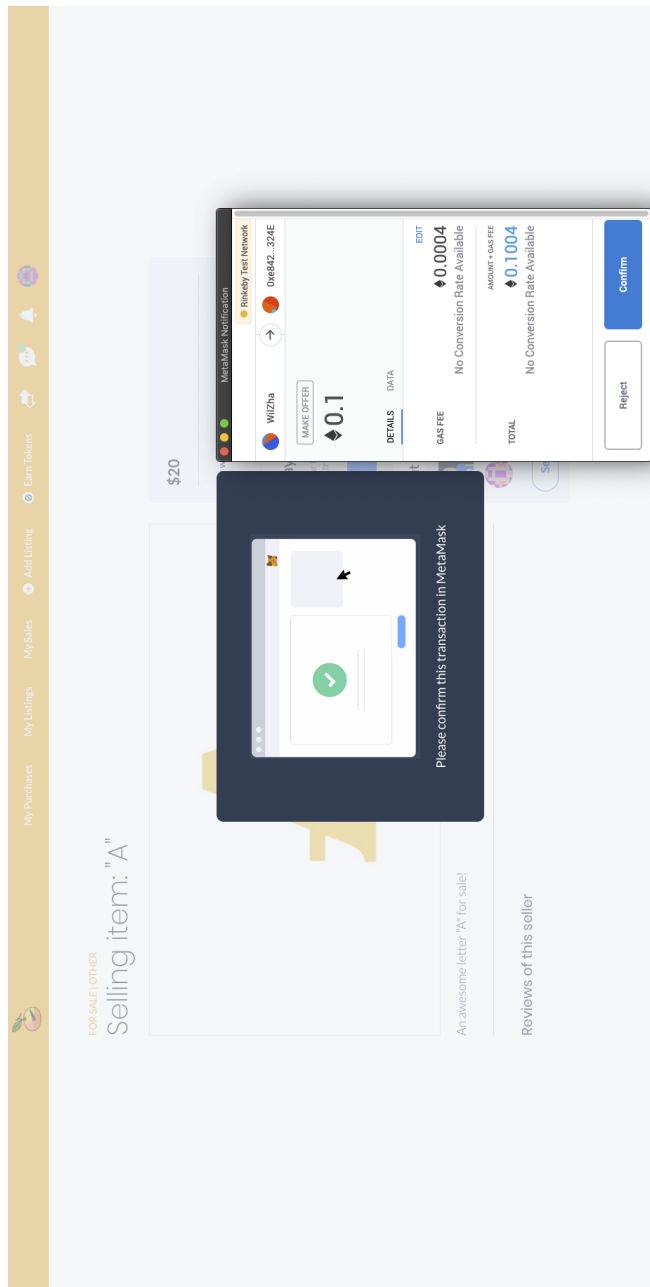


Figure A.9: Make an offer

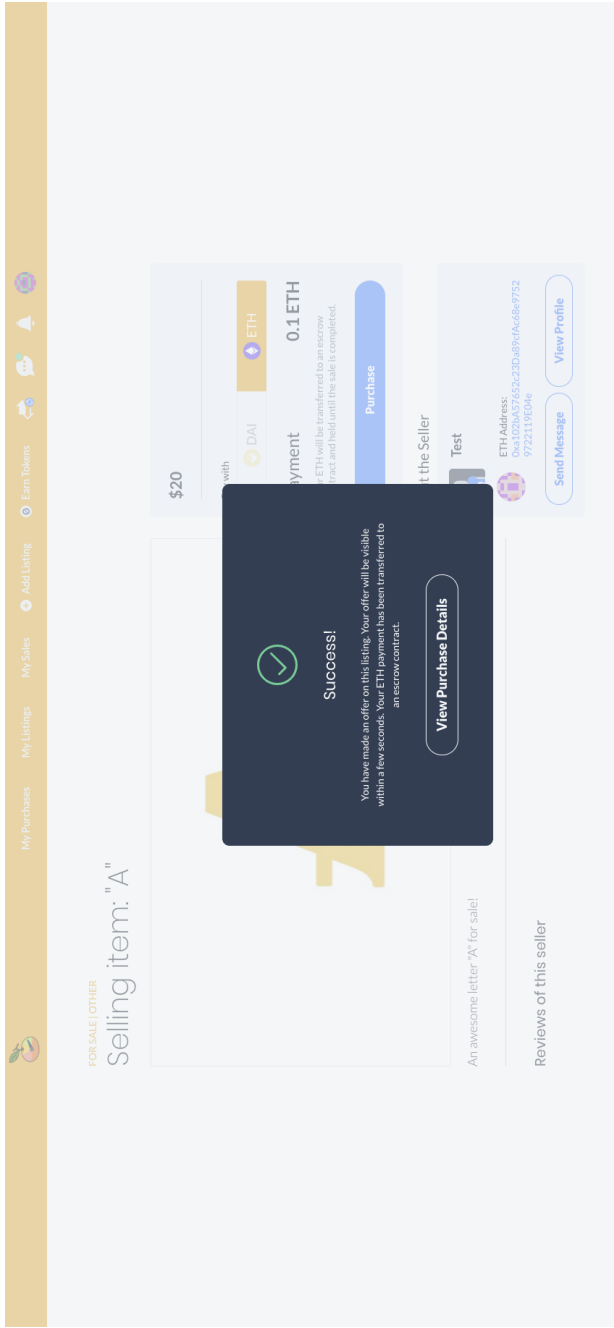


Figure A.10: Offer successfully placed

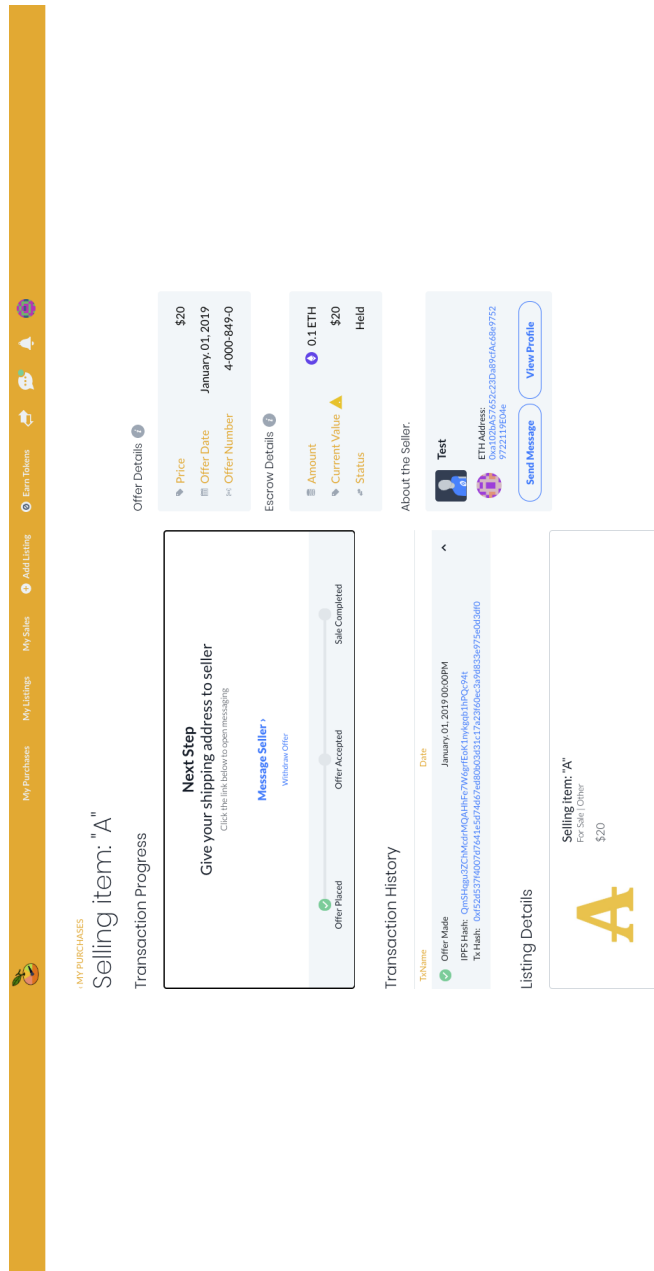


Figure A.11: Give address for shipping

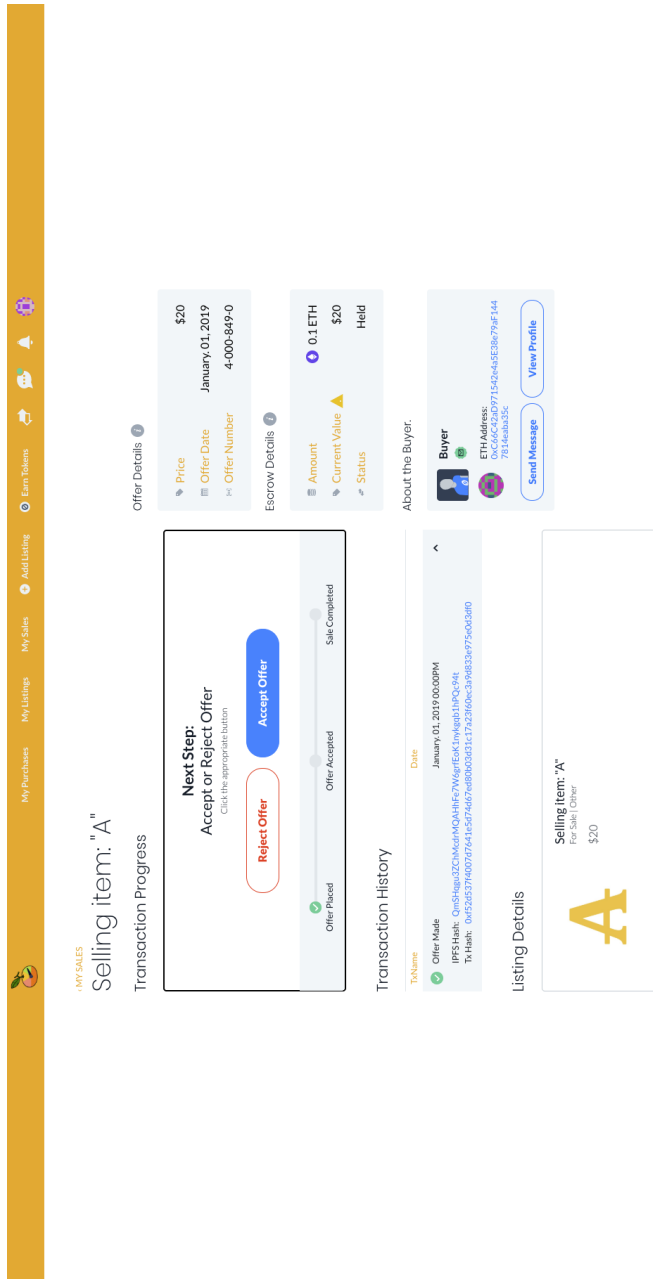


Figure A.12: Seller to accept or reject offer

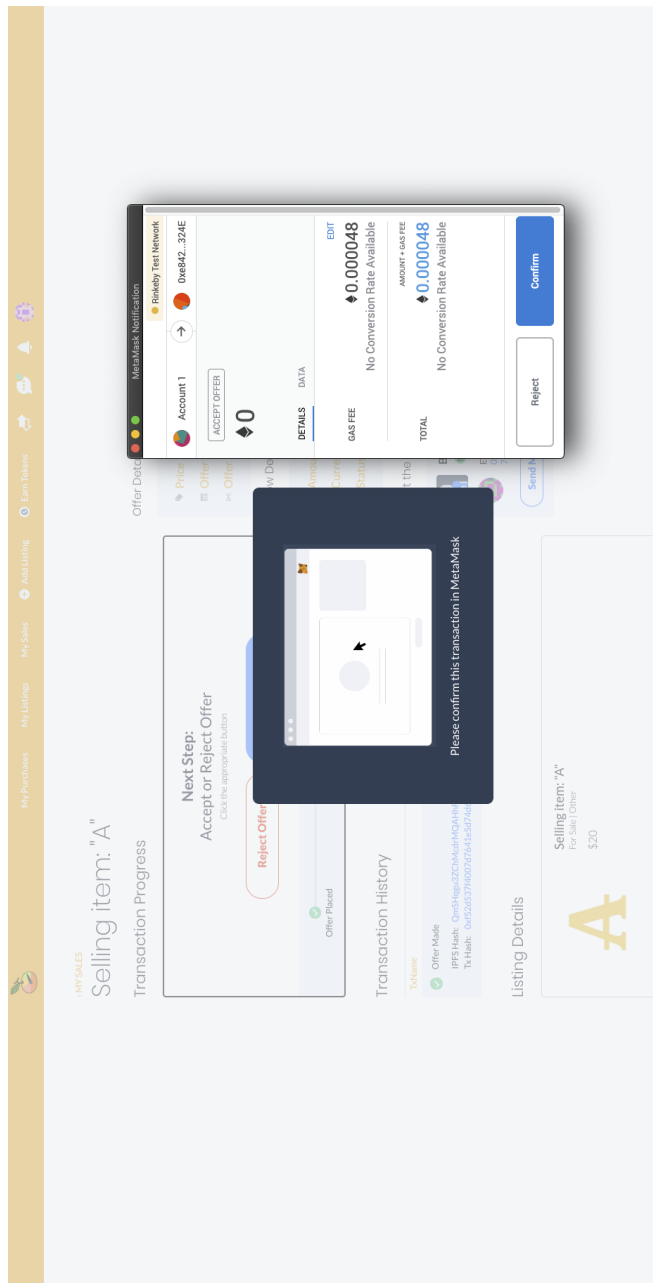


Figure A.13: Confirm accept offer

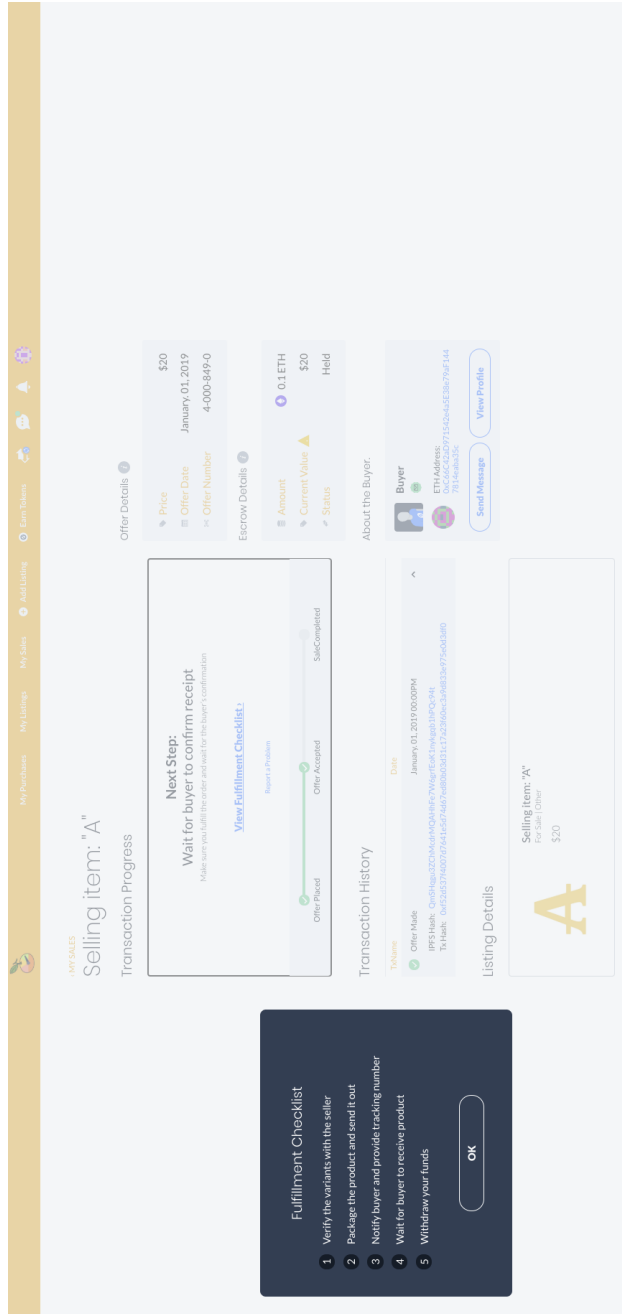


Figure A.14: Wait for buyer to confirm receipt

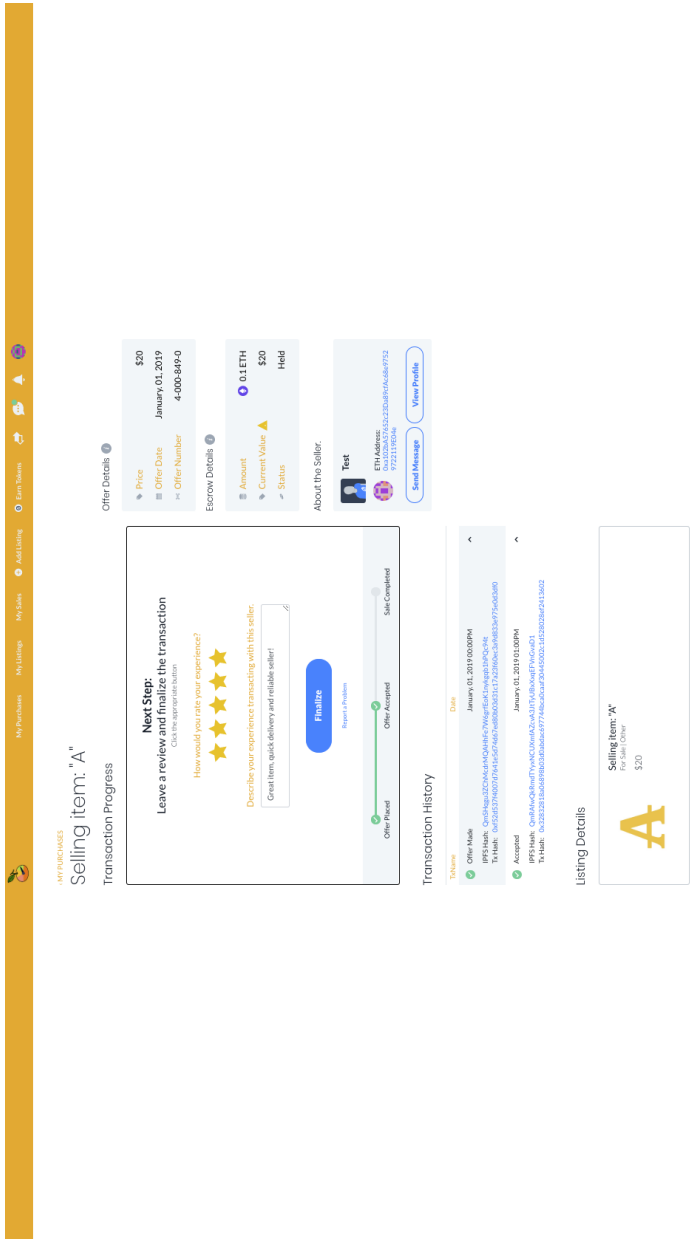


Figure A.15: Review the seller

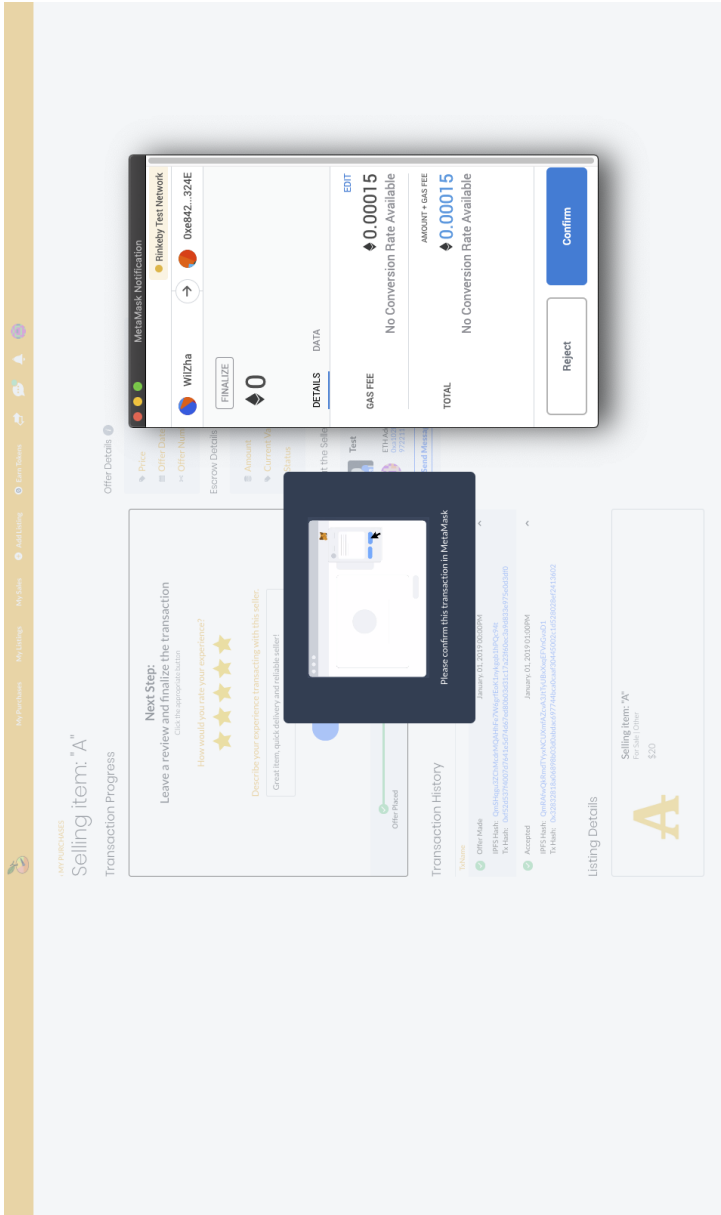


Figure A.16: Confirm reviewing the seller

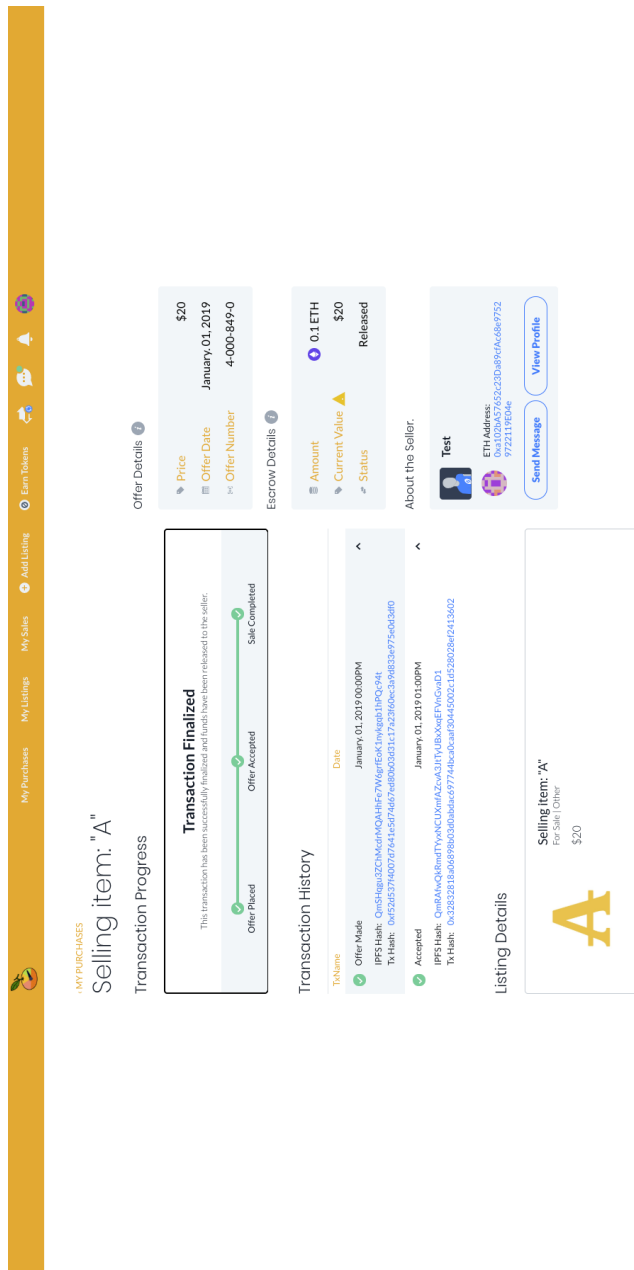


Figure A.17: Finalised transaction

My Purchases My Listings My Sales Add Listing Earn Tokens

Test Seller

Reviews of this user

Buyer Purchased Selling Item: X

Great item, quick delivery and reliable seller!

6 Listings

FOR SALE | OTHER Selling Item: "B" \$21

FOR SALE | OTHER Selling Item: "C" \$22

FOR SALE | OTHER Selling Item: "D" \$23

FOR SALE | OTHER Selling Item: "E" \$24

FOR SALE | OTHER Selling Item: "F" \$25

SOLD

Figure A.18: Seller's profile

