End Consumers' Perceptions of Blockchain-Enabled Traceability Systems in the Food Industry

Bachelor Thesis for Obtaining the Degree

Bachelor of Science

International Management

Submitted to Dr. Horst Treiblmaier

Nikol Xheli

1821501

Vienna, Austria

31st of May 2023

Affidavit

I hereby affirm that this Bachelor's Thesis represents my own written work and that I have used no sources and aids other than those indicated. All passages quoted from publications or paraphrased from these sources are properly cited and attributed.

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Abstract

One use case in which blockchain provides considerable benefits is supply chain traceability. Due to its features, the technology has proven particularly interesting in safety-critical sectors like food. For example, a food product using a blockchain-enabled tracing system could allow customers access to information regarding all phases products go through from the origin until they reach the shelves. Hence, in this thesis, I investigate customer perceptions of the visibility, transparency, and security of such tracing systems in the food industry. The primary research question is: How do customers view the use of blockchain-enabled traceability systems in the food industry? To answer this question, data acquired via a questionnaire from a diverse group of people is used. The survey included 88 valid responses. The participants were approached online through various social media channels. The research has a quantitative design and uses regression analysis and shows the attitudes of final consumers toward the use of blockchain in the food industry.

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Abbreviations

AI	Artificial Intelligence
BETS	Blockchain-Enabled Traceability System
CPS	Cyber-Physical Systems
EU	European Union
FSCs	Food Supply Chains
FWL	Food Waste and Loss
IQ	Information Quality
IS	Information System
ISS	Information System Success Model
ML	Machine Learning
QR code	Quick Response Code
SCM	Supply Chain Management
SEQ	Service Quality
SYQ	System Quality
UTAUT	Unified Theory of Acceptance and Use of Technology
WHO	World Health Organization

1. Introduction

The first chapter of the thesis consists of the introduction chapter. My intention is that through this chapter, readers can become familiar with the motivations and objectives that persuaded me to follow this interesting research topic. In order to do so, I start by providing some background information regarding food supply chain (FSC) related issues as well as current statistics to highlight the importance of the topic.

In the following subchapter, I describe the development of the research question. This is important because the research question will guide me through conducting the study, and it will help me not lose focus. Moreover, in the development of the research question, I discuss the importance of this study and the value that it provides not only to the academic community but also to various stakeholders in the food industry. In the last chapter of the introduction, I included an outline of the rest of the thesis. My intention was to provide readers with a 'map' to easily navigate through the thesis and find what they are interested in with ease.

1.1. Background of the Study

According to the World Health Organization (WHO), around 600 million people around the world fall ill due to food safety issues, and more than 400 000 die each year.[1] In other words, almost one in ten people in the world suffer from food poisoning each year. WHO states that foodborne illnesses are caused by contaminated and unsafe food products. In the past decades, there has been a steady increase in food-related issues, which have caused significant economic losses while eroding consumers' trust in the food industry (Garaus & Treiblmaier, 2021; X. Lin et al., 2021). To name only a few, such issues include food fraud in dairy products, diseased animals, contaminated vegetables, or even bacteria-infected products in supermarkets (Garaus & Treiblmaier, 2021).

As mentioned by various authors, these issues occur mainly due to the uncertainty and lack of transparency in the origin of the products or other processes during the value chain (Galvez et al., 2018; Garaus & Treiblmaier, 2021; Rejeb et al., 2021). Galvez et al. (2018) argue that nowadays, due to the information asymmetries arising from the complexity of global supply chains, tracking and authenticating each link in the food industry is critical in ensuring food safety. Moreover, the lack of information symmetry is preventing end consumers from making

[1] https://www.who.int/news-room/fact-sheets/detail/food-safety

informed decisions when it comes to food consumption, creating a lack of trust in the industry.

Recent studies suggest that blockchain technology holds considerable potential for improving transparency and traceability in the food industry (Deng & Feng, 2020; Rejeb et al., 2020). A blockchain-enabled traceability system allows for secure, transparent, and tamper-proof tracking of products from source/farm to table. This can be a crucial development in ensuring food safety and reducing the risk of fraud and counterfeiting.

Some studies have examined the use of blockchain technology in the traceability of particular food products that have a rather sensitive nature when it comes to safety. For example, a study by Collart and Canales (2022) investigates the feasibility of using BETS for the traceability of fresh produce in the US FSCs. Their study argued that blockchain technology could provide a secure and efficient solution to addressing issues like food fraud, food safety, food loss, and even waste. Another study examined the use of blockchain technology in the traceability of meat products in China (Yuan et al., 2020). The study suggests that blockchain technology can improve transparency and trustworthiness in the meat supply chain while also reducing the risk of food safety incidents. In the seafood industry, Tolentino-Zondervan et al. (2023) explored not only the potential of blockchain technology for improving traceability but also its potential to reduce illegal fishing practices. Through a detailed literature review, they concluded that blockchain technology could provide a secure and efficient solution for tracking the source and journey of seafood products, helping to ensure their origin and reduce the risk of fraud and counterfeiting (Tolentino-Zondervan et al., 2023).

In conclusion, the literature indicates that the use of BETS in the food industry can significantly improve traceability, enhance food safety, and reduce fraud and counterfeiting. However, as most studies suggest, research on the topic is still in the early phases. Further investigation is needed to fully understand the impact of blockchain technology on traceability systems in food value chains and identify any potential challenges and limitations.

1.2. Research Question Development

As mentioned previously, consumer trust has suffered continuously during the past years due to more frequent food scandals across the world (Garaus & Treiblmaier, 2021). In line with these developments, many studies have stated that people are becoming more aware of what they consume in terms of their health and the environmental impact of their choices (Matzembacher et al., 2018; Yu & Qiao, 2017). The journal articles that I reviewed appear to point in the same direction regarding the cause: the majority of these issues are an effect of inadequate transparency, broken traceability, and delayed or non-delivery of data and information in the supply chains.

Hence, the improved transparency and traceability that BETS offer can prove quite beneficial to both consumers and food companies. This can be achieved through faster response times to outbreaks of foodborne illnesses, a better quality of products in general, and more informed choices in terms of sustainability and other personal values. However, I discuss the potential benefits of BETS in more detail in the Literature Review Chapter.

The current state of the literature on the topic argues that, theoretically, BETS do hold the potential to significantly reduce instances and improve the efficiency of supply chains. However, as I showed in 1.1, there are no studies that investigate end consumers' perceptions of BETS in the food industry and their thoughts on the implications that this technology brings to food products. Garaus and Treiblmaier (2021) do actually look into consumer perceptions, but their study is focused on the effect that BETS have on the trust relationship with the retailer rather than the end product itself. In another sense, my study can be viewed as a complementary addition to the findings of Garaus and Treiblmaier (2021) by investigating perceptions at the product level instead of the retailer. In this view, the research question that I am trying to answer is:

- How do end consumers view the utilization of BETS in food products that they consume?

After reviewing part of the literature selected, I developed a secondary research question:

- How does knowledge of blockchain technology affect their perception of BETS?

1.3. Thesis Outline

Chapter 2. In the second chapter, I present the theoretical foundations of my study. In doing so, I discuss several topics related to the development of the research design, including issues in the food industry, traits of BETS, and the advantages it offers to FSCs. Moreover, in this chapter, I look at real implementations of BETS in FSCs around the world. However, as the technology is considerably young, the number of cases presented in academic articles is limited.

Chapter 3. In the third chapter of this thesis, I introduce the research design developed for this study. First, I discuss the three main research approaches according to Creswell (2014). Next, I present the selection and development of the tools needed for acquiring the primary data. As my study investigates respondents' perceptions of new technology, I deemed it necessary to include an additional part dealing with the novelty of the technology.

Chapter 4. The fourth chapter of my thesis presents the results of the analysis. Here, I use several visual tools, including bar graphs and pie charts, to support the results and allow readers to understand the study with more ease. Initially, I present the results of descriptive statistic analysis in the same structure as the questionnaire, starting with demographics, then blockchain technology attributes, followed by perceptions of food quality and concluding with perceptions of adoption and usage. Moreover, the results chapter includes hypothesis testing via Kruskal-Willey and Mann-Whitney tests.

Chapter 5. In the fifth chapter of my study, I summarize the main findings and present them in a structured way. After discussing the most significant results, I include a chapter with stakeholder implications. In this section, I talk about the steps that policymakers and various FSC participants have to take in order to ease and facilitate the adoption of BETS in the food industry. To conclude, I look at the limitations of my study and provide suggestions on future research.

2. Literature Review

This chapter serves as the theoretical foundation for my study and presents the definitions and descriptions of the ideas and concepts discussed in the paper. Initially, I present the most current supply chain-related issues in the global food industry. In particular, I discuss food fraud, contaminations, and waste & loss. Then, I focus on traceability and its role in FSCs.

After, I introduce the idea of blockchain-enabled traceability systems (BETS) as the answer to the challenges in regaining consumer trust. In doing so, I briefly explain how the blockchain works, followed by the ability of this technology to address many of the concerns in the food industry. Next, with the intent to provide more evidence to the claims about BETS potential, I include a description of real word cases of the implementation of the technology.

2.1. Food Industry Issues

One of the most discussed topics in the food industry which attracts the most public attention is food safety. Food safety is defined as the degree of trustworthiness that a food product will not result in any form of illness or injury, either during production, serving, or consumption (Matzembacher et al., 2018). Hence contamination and fraud can happen at any point in the FSC, and foodborne disease outbreaks can inflict severe losses on the food industry. These losses can be the results of removing products from shelves, notifying customers, customer demand loss, market share loss, company closures, or litigation and lawsuit expenses (Collart & Canales, 2022). In addition, in cases of contamination, it can take several days in order to track the products back to the retailer or farm from which the contamination originated. Such delays can further increase the cost of these events as without the proper information, product recalls can extend to other categories, distributors, or producers that are not linked to the specific event.

2.1.1. Food Fraud

Spink et al. (2017) define food fraud as the set of actions that have a deceptive nature done by fraudsters with the aim of greater economic gains. These actions can be in the form of stolen goods, smuggling, product adulteration, substitution, tampering, dilution, diverting sales toward gray markets, unauthorized modifications, or intellectual property rights counterfeiting (Collart & Canales, 2022). It is important to note that food fraud events do not always have health repercussions but always and undoubtedly have economic ones. Such is the horse meat scandal which eroded consumer trust across Europe (Kamath, 2018; Spink et al., 2017).

Before detection, no one apart from the fraudsters knew or could tell that a cheaper substitute was used extensively in various beef products. Even though this event clearly constituted an illegal case of product adulteration, no health hazards were identified. Nevertheless, Spink et al. (2017) explain that the fraudulent activity led to massive economic consequences in the form of authenticity testing, product recalls, as well as the effective halt on the sale of almost all ground beef products across Europe and the UK. Kamath (2018) explains that this event caused considerable public concern and affected more than 4.5 million products equaling more than 1 thousand tons of meat goods.

A similar case has also happened in China, caused by an enormous mislabeling scandal in 2011, where pork products were falsely labeled as organic. The same company involved in the mislabeling scandal was also charged with fraud and had to recall many of its donkey meat products as tests found traces of other animals' DNA (Kamath, 2018). There are several more food fraud cases in the Chinese market, and many involve cross-border supply chains (Cao et al., 2021; Kamath, 2018).

Another considerable food fraud problem is the misuse of labels and certificates over credence attributes. Collart and Canales (2022) describe credence attributes as factors the buyer can not verify even after purchase and consumption, for example, 'bio,' 'sustainable,' 'fair trade,' or 'locally grown.' Due to the many cases of fraud when it comes to labels, more so with issues of fraudulent 'organic' certificates, public credibility has suffered considerably, and the authenticity assurance that such labels provide is only limited (X. Lin et al., 2021; Spink et al., 2017).

Another case of food fraud that affected the whole global food industry was the sale of illegal expired meat (Spink et al., 2017). This happened when one or more of the links in the global FSC decided to tamper with the expiration dates of products in order to be able to make a profit. Even though the meat proved to have no health hazard, the consequences of this event were felt by multiple food corporations (Spink et al., 2017). For example, McDonald's Corporation had a drop in stock value of almost 500 million US dollars when the event was announced, and the monthly global sales fell by more than 40 million (Forbes, 2014, Jargon, 2014, as mentioned in Spink et al., 2017).

2.1.2. Food Contamination

Food mismanagement and contamination have been the sources of serious health hazards not only in underdeveloped countries but also in advanced economies. In 2006, a nationwide E.coli outbreak in green vegetables in the US caused harsh economic losses and shattered public trust in the food industry (Kamath, 2018). Moreover, identifying and isolating the source of the contamination led to a waste of more time, energy, and resources in the whole FSC. Additionally, after the scandal, most American consumers refused to consume spinach altogether, which later resulted in grocery stores and restaurants completely removing the item from their shelves and menus (Kamath, 2018). Kamath (2018) states that it took health officials around two weeks to find the origin of the problem, which was one single lot number from one single supplier, responsible for one day's production. Hence, if officials were quicker to track the source of the contaminated spinach, they would have been able to prevent most of the lasting economic harm done to farmers and food retailers, and limit the loss of customer trust in the industry.

Similar cases continued to happen in the US, like the multi-state outbreak of Salmonella disease in 2017. The outbreak was caused by contaminated papayas flooding the US market from the border with Mexico (Kamath, 2018). This time, it took more than two months to track the source of contamination (Pal & Kant, 2019). Nevertheless, such issues in the food industry do not happen only across borders. For example, Astill et al. (2019) conclude that almost four million Canadians suffer from food-related diseases or illnesses as a result of domestically acquired contaminated food.

Food contamination events happen in our daily lives. Almost everyone, personally or through a family member, has suffered from the consumption of unsafe food products, which can have consequences varying from a simple stomach ache to even death in cases of severe food poisoning. Even cases of light poisoning can prove fatal for older generations or individuals with health complications.

2.1.3. Food Waste & Loss

Although there is no widely accepted definition or measurement practice for food waste and loss (FWL), they have been recognized as global issues due to their economic, social, and environmental impact, which have significant consequences worldwide (Teigiserova et al., 2020). According to the research conducted by the United Nations Environment Programme (UNEP) in 2021, the amount of food wasted each year globally is more than 1 billion tons, equivalent to one-third of all the food produced.[2] Teigiserova et al. (2020) state that FWL is responsible for almost 8% of global greenhouse gas emissions, 25% of the water used in agriculture, and 23% of global croplands, comparable to the whole croplands in Africa.

Even though this topic is of high importance in the food industry and BETS could prove to be an efficient solution, I will not get into more details because my study does not investigate FWL. I took this decision as my study is based on primary data acquired from end customers with a focus on food safety and security. Hence, in a sense, my study concerns customer perceptions of food products that are still on shelves.

2.2. Role of Traceability in Food Supply Chains

All the issues presented above come mainly as a result of inadequate transparency in food products (Collart & Canales, 2022; Santeramo & Lamonaca, 2021; Teigiserova et al., 2020). Globalization has led to the emergence of complex global supply chains (Garaus & Treiblmaier, 2021). In search of lower costs and better margins, large companies look for partners and suppliers all over the world. However, different countries have different standards regarding food, and the level of control varies considerably between developed and developing economies. Garaus and Treiblmaier (2021) mention that there are different regulations and guidelines that state the required information that traceability systems should provide for different destinations, like the EU Regulation 178/2002, the ISO 9000, FDA Food Safety Modernization Act, and many more. Moreover, there are many companies that provide additional information on a voluntary basis in order to improve consumer confidence and improve trust in food products.

Food traceability is defined as the ability to track the end product, feed, food-making animals, or substances used for consumption, through each stage of production, handling, and distribution (Garaus & Treiblmaier, 2021). Due to the increasing number of food safety incidents, consumer concern has increased drastically in terms of quality and safety (Yu & Qiao, 2017). The information asymmetries exist not only between the links of the FSC, but also between customers and food retailers, which prevent them from making informed choices regarding the food they consume. Hence, ensuring the integrity of food traceability systems is vital in boosting consumer trust and confidence in food products.

[2] https://www.unep.org/news-and-stories/story/why-global-fight-tackle-food-waste-has-only-just-begun

2.3. Digitalization of Supply Chains

As Rejeb et al. (2021) mention, managers and business leaders all over the world, across many industries, have chosen digitalization as the answer to addressing the issues arising from globalization and complex value chains. In this sphere, digitalization refers to the process of implementing inter-organizational information systems (IS) across the different links (suppliers & trading partners) of the respective value chains. Due to digitalization, the supply chain management (SCM) industry reached approximately 19 million US dollars in 2021 (Rejeb et al., 2021). This increased interconnectivity has had enormous benefits for organizations in terms of agility and velocity in identifying and addressing potential threats and opportunities in supply chains. Additionally, digitalization has significantly improved the trust between different links in the network and increased the level of security (Bigliardi et al., 2022).

The main contributor to this development was the creation of Cyber-Physical Systems (CPS), which Bigliardi et al. (2022) define as e set of enabling technologies that form an autonomous, intelligent, and interconnected system capable of facilitating cooperation between different actors. Such systems allow for better and more efficient collaboration between firms, mainly in three areas:

- Data generation and acquisition (sensors, GPS devices, cameras, etc.)
- Aggregation and computation of previously acquired data (ML & AI, advanced databases, etc.)
- Decision-making support (deep analytics, ML & AI, etc.)

Bigliardi et al. (2022) state that apart from blockchain, there are a number of CPS technologies that have innovated and brought global supply chains to their current state. The ones that are more worth mentioning include Internet of Things (IoT), Advanced analytics – including Machine Learning (ML) and Artificial Intelligence (AI), Virtual Reality and Augmented Reality, robots, 3D printing, and drones.

2.4. Blockchain Enabled Traceability Systems

A blockchain enabled traceability system (BETS) is a CPS that relies on blockchain technology in order to create, transfer, and manage information and data. Blockchain technology can be defined in simple words as "a digital, decentralized, and distributed ledger in which transactions are logged and added in chronological order with the goal of creating permanent and tamperproof records" (Treiblmaier, 2018, p. 574). However, there is no generally accepted definition of blockchain on which scholars agree, and the definition can depend on the usage intention and discipline. Rejeb et al. (2021) describe blockchain as a combination of several technologies, methods, and tools that address a specific issue or particular business circumstances.

Apart from its enormous use and potential in the financial world, with cryptocurrencies and DeFi solutions, the technology has also shown incredible potential in the supply chain field. Multiple studies argue that blockchain can benefit logistics and supply chains based on four distinct qualities that it provides: immutability, decentralization, openness, and anonymity (Cao et al., 2021; Deng & Feng, 2020; Kamath, 2018; X. Lin et al., 2021; Tolentino-Zondervan et al., 2023; Yuan et al., 2020). More information on each of the characteristics follows in Sub-Chapter 2.4.2.

Lin et al. (2021) explain that a BETS is a very promising solution when it comes to FSCs. Together with IoT, ML & AI, big data analysis, and more technologies, blockchain has the potential to provide vital advantages to information-sharing platforms. Being transparent and unchangeable, a BETS can prove to be a fast, secure, and trusted solution in the food industry. In other words, it can solve all the major issues present in the food industry.

2.4.1. Blockchain Technology

Tolentino-Zondervan et al. (2023) argue that the increased interest in blockchain in global supply chains is due to five unique attributes of blockchain "– (1) transparent transactions, (2) immutable data, (3) no central authority, (4) peer-to-peer value transfer, and (5) conditional transactions" (p.2). To better understand these properties, I will briefly explain how blockchain works, using a Proof of Work blockchain as an example. First, as I mentioned before, for a transaction to be stored in the system, all the participation nodes have to approve its validity. Hence, in the case of BETS, each transaction made by an FSC participant has to theoretically be approved by each other 'node' before being storing it in the ledger. At the same time, a crucial criterion of the success of BETS is the need to include any party involved in the value chain (Creydt & Fischer, 2019). Creydt and Fischer (2019) add that the long-term establishment of BETS in FSC requires an industry-wide adoption of the technology.

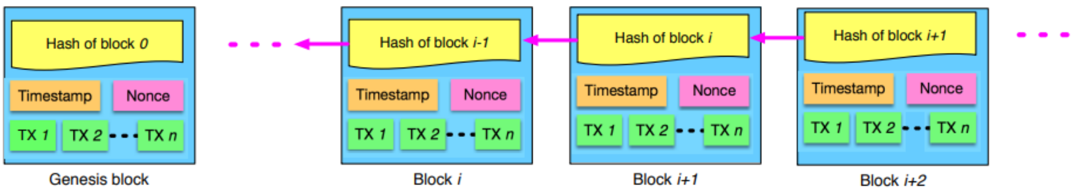


Figure 1. Blockchain Architecture (source: Zheng et al., 2018, p.355)

As seen in Figure 1, each block containing new transaction data generates a unique hash value (hexadecimal value of fixed length) that can be used to reify the validity of the block. Hash values can be generated only after difficult computations that require considerable computing power are done. It is through this difficulty that blockchain ensures the security and immutability of its transactions (Zheng et al., 2018).

Once a block is added to the public ledger, it is immediately visible to all nodes in the network. As each block is linked to a previous one, creating a chain of blocks, from where the name 'blockchain' comes. Due to these characteristics, tampering with previous transactions becomes harder and unrealistic with each addition to the chain, as it would be almost impossible to recalculate the hash values of each block (Tolentino-Zondervan et al., 2023).

2.4.2. Blockchain Potential in Fixing Broken FSCs

The four characteristics identified in 2.4 have the potential to reduce the issues of FSCs significantly. Due to the first characteristic, immutableness, that blockchain elements like hash functions and cryptography provide, BETS can offer a safe digital environment for all participants of the supply chain, including end customers (Garaus & Treiblmaier, 2021). Lin et al. (2021) explain that an IS database that relies on blockchain technology allows for information only to be added and not changed or removed. Such features can provide value to end consumers in FSCs.

H1: End Consumers with knowledge of blockchain understand that a BETS offers an immutable record of information regarding food products and their production.

At the same time, the database is not stored by a single entity but distributed through every node of the system (Garaus & Treiblmaier, 2021), in our case, in each link of the FSC. Moreover, each node is involved equally in the validation, storage, and preservation of each piece of information added to the system. Hence, the second quality, as Garaus and Treiblmaier (2021) state, can help improve end consumers' trust by improving traceability and verifiability.

H2: End Consumers with knowledge of blockchain understand the added benefits of a decentralized system in FSC.

The third quality, openness, also constitutes a valuable benefit to all supply chain participants, and in particular, end consumers. Due to the characteristics of BETS technology, all the necessary information on the chain is open and available to anyone at all times (X. Lin et al., 2021). Hence, consumers, as well as all trading partners, can access the system to trace the whole value chain of a good, starting from material selection, production, packaging, and all other processes until it reaches retailer shelves. Apart from the increased trust, the system's openness could also help governmental agencies and other bodies better monitor and prevent epidemics and other contamination-related outbreaks in the food industry.

H3: End Consumers with knowledge of blockchain understand the added benefits of the openness characteristic of BETS.

The last quality, anonymity, means that participants in the system can hide their real names. The privacy that blockchain technology provides enables users to protect their personal information through cryptography. Hence, in a supply chain, blockchain allows users to track and trace the product and information regarding its manufacturing while protecting the identity and privacy of customers (X. Lin et al., 2021).

H4: End Consumers with knowledge of blockchain understand the added value of anonymity in BETS compared to traditional traceability systems.

2.4.3. BETS Applications in FSCs: Walmart and IBM

Even though BETS is still in its early development stage, there are several pilot cases that have tested the technology in the real world. The first one that I choose to describe in terms of significance is Walmart’s collaboration with IBM which resulted in the development and implementation of a BETS focused on the provenance attribute of pork and mango products in their FSC (Kamath, 2018). The pilot project regarding pork was conducted in China. The one about mangos was conducted between South, Central, and North America (Kamath, 2018; Yiannas, 2018).

As Kamath (2018) explains, this choice was not random as China is not only a leading importer of pork but is also responsible for almost half of the global pork production. The enormous size has pushed the industry towards large, industrialized production systems, and displaced small-scale producers. Hence, also concern has been rising regarding the origin and safety of the products, regarding all phases of production and distribution, from farm to table.

While consumers' focus is shifted to quality and safety, trust becomes even more critical. Based on these developing circumstances, Walmart was presented with ideal conditions to explore the new technology (Kamath, 2018; Tan et al., 2018). In other words, Walmart had a strong incentive to examine the ability of BETS to create trust in the provenance of pork products in China.

As mentioned previously, Walmart worked with IBM on the project. IBM personnel recognized that they could ease blockchain adoption and avoid any proliferation of their data formats and other components of their internal systems by using already established open standards such as the Core Business Vocabulary (CBV) and the Electronic Product Code Information Services (EPCIS) of Global Specifications 1 (Kamath, 2018). The two standards mentioned are global guidelines aimed at improving information sharing in global supply chains. The EPICS is a data-sharing standard targeting visibility by providing the “what, when, where, why, and how” of products, allowing the capture and sharing of production and treating information like status, movement, location, and chain of custody. The CBV is a complementary standard that specifies the data values and their definitions that can be used to populate the required structures defined in the EPCIS (Q. Lin et al., 2019).

Another critical factor for the success of Walmart’s pilot projects was the cooperation of governmental bodies. Kamath (2018) explains that regulators and policymakers were enthusiastic about blockchain and its potential to transform supply chains. Hence, with IBM’s technology and the green light from regulators, Walmart was ready to test the features of blockchain on supply chain management and food safety. After all the planning and preparation, the pilot was started in 2017 (Kamath, 2018).

2.4.3.1. BETS of Pork Products in China

As shown in Figure 2, the process began at pig farms, where every animal was smart-tagged with a bar code that followed the product until it reached supermarket shelves. With the use of many cameras and radio frequency identification systems (also in the slaughterhouses), all the pig movements and the entire production process was monitored and recorded (Yuan et al., 2020). These efforts provided multiple additional benefits to farmers as they could better tend to the needs of the animals regarding the conditions like temperature, humidity, feed, and many more (Tan et al., 2018).

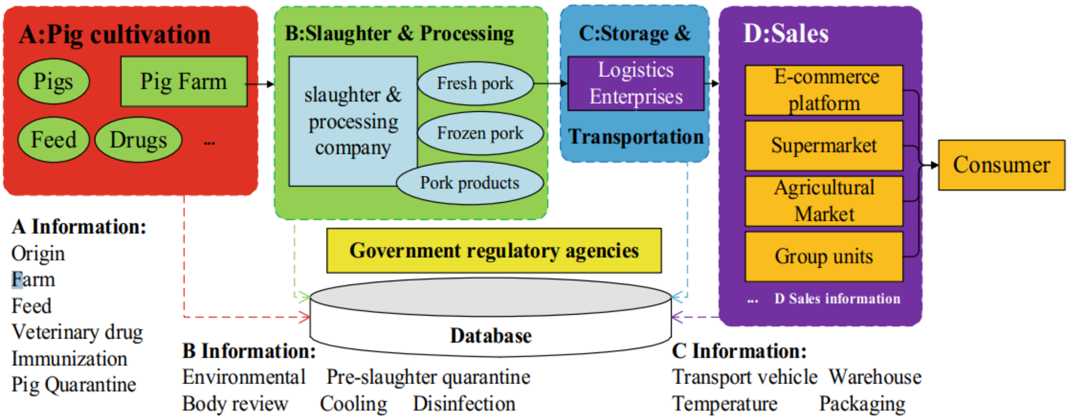


Figure 2. BETS Pilot of Pig Products (source: Yuan et al., 2020, p. 346)

The same monitoring technology was also used in shipping trucks. Hence, during this phase of the supply chain, Walmart and other stakeholders could also track valuable information like temperature and humidity in real time. Along with location sensors, the BETS was able to ensure that each delivery reached the retailer at top conditions (Tan et al., 2018). The accuracy and timely delivery of information enabled Walmart to prompt adequate corrective action in case any of the monitored conditions exceeded thresholds.

The tracking did not end there but went along distribution centers and stores. As Kamath (2018) explains, BETS allows procurement managers to access remotely all kinds of information regarding the products, including origination, transportation, fertilizers & additives, temperatures during storage, and much more. All this information can be accessed simply by scanning a quick response (QR) code found on the product package (Tan et al., 2018).

This pilot program integrated new systems of data capture and significantly improved the speed, accuracy, and availability of data regarding the pork products from the farm to the store (Kamath, 2018). Kamath (2018) and Tan et al. (2018) argue that the increased traceability notably improved public confidence in food safety. Even if a contaminated food product reaches a consumer, the BETS can better identify which products should be retrieved without jeopardizing the whole product line.

2.4.3.2. BETS of Mango Products in the Americas

Simultaneously with its pork traceability pilot in China, Walmart conducted a second pilot using IBM's blockchain technology solutions to track sliced mangos from the origin (South and

Central America) to stores (North America) (Kamath, 2018). Mango, as well as different mango products that are shipped all over the world, have often been shown to be susceptible to contaminations like Salmonella and Listeria (Yiannas, 2018). Yiannas (2018), a Walmart executive at the time, explains that this pilot intended to investigate the ability of BETS to manage traceability and accountability across borders to improve public trust in the information of the origin of the supply.

Kamath (2018) explains that the mango FSC faces many challenges and threats starting from the pre-seeding stage. Mangos can suffer from rotting, shape defects, irregularities during ripening, and heating or chilling damages. In addition, the production of mangos requires considerable labor and care. Farmers may try to cut corners by using inadequate fertilizers, poverty wages for extremely long working hours, or even employing children (Kamath, 2018). Another issue is that most farmers that grow mango have unstable access to quality fertilizers, almost no bargaining power with traders, and very limited information regarding market prices. Blockchain technology could prove an efficient solution to the issues above by raising many red flags along the FSC.

Using IBM’s blockchain technology, the pilot BETS was involved in the full FSC, starting from when the fruit was on the tree, to harvest, packaging, warehousing, distribution, and finally, stores (Yiannas, 2018). This system enabled Walmart to analyze and verify the quality and marketability of the products during each link in the FSC. Kamath (2018) explains that also the other participants of the FSC could profit from the BETS by utilizing the collected data to benchmark performance across a global market.

A BETS's enhanced traceability enables supply chain participants to acquire new competitive advantages (Kamath, 2018; Yiannas, 2018). For example, stores and supermarkets could integrate their enterprise resource planning as well as their point-of-sale system into the BETS, in order to trace every individual item sold. Yiannas (2018) explains that such a system would allow for more strategic removals and other precise strategies which would make both customers and companies more confident.

In case a customer fell ill, the BETS allowed Walmart to acquire critical information from a single receipt. The data available on the BETS could provide detailed information on the supplier, where and how the food was grown, and who managed and inspected the distribution, from large batches to individual packages. In addition, customers could provide feedback regarding the quality of the products, which could be attributed to single growers and sources. Kamath (2018) further adds that the implementation of the BETS could result in higher quality with reduced prices for end consumers. On the other hand, restaurants, schools, and other institutional cafeterias could benefit greatly from the instant quality assurance enabled by BETS.

Whether pork or mangos, the BETS pilots that Walmart developed in cooperation with IBM, proved to have the capacity to track and effectively make available all relevant information within an FSC. The digital tracking system could positively impact many aspects of the industry, like quality assurance and issue management. Each process and movement that the product goes through generates an immutable proof of record, from the farm to the consumer’s table.

2.4.3.3. Closing Remarks on Two Pilots and Future Use

With these two pilot projects, blockchain demonstrated an enormous potential for benefiting FSC by providing greater traceability, transparency, accuracy, and trust in the information shared along the supply chain. This allows supply chain participants to act immediately in case issues arise. Traceability is very important in FSC, and BETS could prove essential in responding to or preventing contaminations, drugs, harmful pesticides, and diseases in food products effectively. However, as Yiannas (2018) explains, to achieve wider adoption of the technology, all participants have to understand the benefits that BETSs enable. With the great amount of information available and by utilizing deep learning and data analytics, FSC participants can achieve better control over their brand and business. Kamath (2018) suggests that BETSs could even go a step further from traditional FSC participants and include development and research facilities, trading partners, grading institutions, policymakers, and other food industry stakeholders.

Another important factor that contributed to the success of Walmart’s BETS pilots is that instead of creating new supply chains, the project leveraged blockchain and other existing technologies to enhance traceability in existing FSC (Yiannas, 2018). This could not be achieved without increased cooperation and knowledge sharing within FSCs. Yiannas (2018) states that Walmart will continue to work and learn from its BETS pilots, while expanding collaboration within supply chain ecosystems and involving more and more interested parties. Both pilots were successful in enabling Walmart to identify systematic vulnerabilities in FSCs, fix broken food chains, and regain consumers’ trust and confidence in the food industry.

Both pilots showed the potential of BETS in improving the end consumers' confidence in the food industry. Even though the focus of these pilots was not to present the technology to end consumers, they benefited in various ways. By enabling all supply chain participants to digitally track the origin and movement of food products, BETS allowed restaurants and cafeterias to be confident in the safety of the products they serve customers. Nevertheless, the ability to obtain data like how and where the food was grown and how it was treated during transportation and storage, all from a single receipt, could significantly improve the response and management of future food incidents.

Due to its many now-proven benefits for supply chain participants, BETS gained considerable attention in the food industry. Soon after, in response to many E-coli outbreaks due to contaminated leafy greens in the US, Walmart decided to adopt its BETS in the respective FSC and get all participants on board (Collart & Canales, 2022). Collart and Canles (2022) state that the company intends to expand the use of BETS not only to other food products but also to other purposes, like environmental impact or other sustainability information.

Other large food retailers engaged in BETS initiatives in the industry. Similar to Walmart, Carrefour collaborated with IBM to fully implement BETSs in fresh produce lines in the European market (Collart & Canales, 2022). More specifically, Carrefour utilized BETS to track two types of tomatoes in France, and oranges in France and in Spain. Different from Walmart, Carrefour's BETS initiatives were consumer-focused. Collart and Canales (2022) state that preliminary reports on this pilot show positive consumer acceptance of food products with BETS. These reports showed that end consumers would spend up to 90 seconds acquiring information about the provenance of certain food products, all through a QR code. Moreover, the reports indicated a positive impact of the adoption of BETS on sales (Collart & Canales, 2022).

2.4.4. Implications of Enhanced Transparency

BETS application in FSC, like any other traceability system, can serve to tackle various challenges among multiple domains. These include addressing concerns in logistics and FSC management (Rejeb et al., 2021), food quality and safety (Q. Lin et al., 2019; Yuan et al., 2020), and credence attributes in marketing (Galvez et al., 2018; Yu & Qiao, 2017). Even though these processes are also included in traditional traceability systems, the authenticity of the data that these systems entail is difficult to ensure (Deng & Feng, 2020).

In logistics and supply chain management, BETS can be used to notably reduce transaction costs. Galvez et al. (2018) explain that this can be achieved by fully integrating the technology into the business. With the ability to share and verify information more securely and faster, a

BETS can reduce the administrative weight of audits by lowering the costs and time of processing paperwork, reconciling data, and managing delays (Collart & Canales, 2022). With the use of smart contracts (a form of digital contract enabled by blockchain), organizations can minimize counterparty risk and select partners with more confidence. This can be highly beneficial in order to develop trust and a proper working relationship with new suppliers and retailers (Treiblmaier & Petrozhitskaya, 2023). Several surveys have found that among the improved traceability and transparency, one of the main reasons that companies adopt blockchain is cost reduction (Collart & Canales, 2022; Galvez et al., 2018).

H5: End Consumers with knowledge of blockchain understand that the adoption of BETS results in lower prices of goods.

Regarding quality and safety, as I mentioned before, the real-time availability of data can drastically impact the timing and effectiveness of product recalls (Kamath, 2018; Rejeb et al., 2021). This allows for better responses to food safety outbreaks by accurately managing product recalls. Collart and Canales (2022) explain that in the case of Walmart's mango pilot, the time needed to track a product back to the source was seven days, and with BETS, only 2.2 seconds. Allowing the responsible parties to accurately identify the source and size of contamination within seconds can help in better containing the spread, leading to cost savings for companies and minimized impact on consumer trust.

Improved traceability can also lead to increased accountability of all parties involved in an FSC (Collart & Canales, 2022). In other words, enhanced traceability could incentivize FSC participants to increase attention to quality and safety while discouraging food fraud. Collart and Canales (2022) add that the improved ability to track inventories in a timely and accurate manner can lead to significant implications in fighting food waste and loss in FSC of highly perishable goods.

H6: End Consumers with knowledge of blockchain understand the benefits of accurate origination and provenance information provided by BETS.

In terms of marketing, food markets, restaurants, and cafeterias can utilize BETS to differentiate their products by guaranteeing quality and provenance to end consumers (Galvez et al., 2018). The enhanced traceability presents a critical competitive advantage for most FSC participants. At the same time, with real-time inventory management, companies could develop marketing strategies that push items close to expiration and, by doing so, reduce waste and loss. Moreover, environmental and sustainability information can also be used as part of the marketing strategy, thus addressing social concerns like unfair labor practices, animal welfare, CO_2 emissions, and more (Galvez et al., 2018).

H7: End Consumers with knowledge of blockchain believe that they can better abide by their values when buying a food product with BETS.

3. Methodology

In this chapter, I discuss the research method and tools used to conduct the study. Initially, I present the three main design approaches of academic research and provide arguments for my choice of methods. After, I justify my choice and present the tool used for acquiring the primary data. To conclude, I include a section regarding new information systems' adoption and usage intention. Based on this section, I developed several additional items for the study.

3.1. Research Design

Three main types of research designs are used for data collection and analysis: qualitative, quantitative, and mixed methods (Creswell, 2014). Contrary to what one might believe, the three designs are not separate categories, as Creswell (2014) explains: "*Qualitative and quantitative approaches should not be viewed as polar opposites or dichotomies; instead, they represent different ends on a continuum" p.3*. In other words, all studies have qualities of both qualitative and quantitative research. Therefore, using the correct definition, a research design can be more qualitative or more quantitative, and in case both sides weigh equally, the study uses a mixed methods approach.

Quantitative research is an approach that tests theories objectively by analyzing relationships between selected variables by collecting data from a large sample. The collected data serves as a measure for the variables and are presented numerically so that it can be analyzed using statistics. Commonly, quantitative studies have a rigid structure that includes an introduction, a theory chapter, methodology, results, and conclusions (Creswell, 2014).

On the other hand, qualitative research, which also historically came after quantitative, is an approach that investigates and uncovers the meaning that individuals or small groups assign to certain phenomena. This type of research tends to be more inductive, where the researcher usually develops new procedures for collecting the data from the respondents. These procedures aim to gain insights into respondents' thoughts by starting with particular themes and shifting to more general ones (Creswell, 2014). Qualitative studies have a flexible structure as the researcher makes interpretations of the meaning of the collected data.

Creswell (2014) explains that the mixed methods approach is a design that combines attributes of both quantitative and qualitative studies. This type of approach includes strong statements, both deductive and inductive forms, and requires both kinds of data, numerical and qualitative (Creswell, 2014). However, it is more than just that; using this method requires that the overall strength of the study is considerably higher than using either of the other approaches. Hence, choosing to select a mixed-methods approach means that the researcher must carefully evaluate the assumptions and attributes of interest to utilize each approach's tool accurately and select the ones that are more fit to the specific situation.

My study tends to be more quantitative. Intentionally I presented my thesis in the set structure presented by Creswell (2014). As it uses requires data from a large number of respondents and relies on objective literature and theory, I believe that focusing on the tools of this approach for collecting and analyzing data is best. The survey is one of the most commonly used tools for acquiring primary data, not necessarily only in quantitative research.

3.2. Survey Studies

Survey research is the most commonly used tool in quantitative designs and serves to acquire numeric descriptions of attitudes, trends, and opinions. It does so by selecting a group of individuals representative of the subjects of interest to draw conclusions for the whole population (Creswell, 2014). This method of acquiring primary data consist of questionnaires or structured interviews.

My thesis aims to examine end consumers' perceptions of BETS and analyze how previous knowledge of the technology affects their perceptions. In order to achieve this, I first find out how Albanian consumers understand the benefits of BETS and how they view its adaption in FSC, mainly in terms of food quality and safety.

After, I investigate whether there is any relationship between the level of understanding blockchain and recognizing the potential benefits in the food industry. I achieve this by using knowledge of blockchain technology as an independent variable and the end consumers' perceptions as the dependent one. For the purposes of my thesis, I selected questionnaires as an adequate tool for data collection.

3.2.1. Questionnaire Development

Based on the hypothesis derived from the literature review, I designed a preliminary survey questionnaire. I developed and constantly improved the relevant measurement items of the selected constructs based on the latest literature and journal articles on the topic. After, I invited five participants for a face-to-face pre-test. This process proved very beneficial for the study as it helped me ensure that the questionnaire statements were not misunderstood and biases were avoided. My main intention was to guarantee that participants correctly identified the meaning of each item in order to improve the accuracy of the results and findings.

Apart from the BETS-related items, I included several additional statements and questions in the questionnaire that would provide more in-depth information regarding end-consumer perceptions of such traceability systems. The majority of these additional items concern the demographics of the respondents. The purpose is to be able to investigate and identify differences in the perceptions between different age groups, income levels, or marital statuses. Another set of items incurs about the participants' past experiences with food safety. I believe that this factor could have a significant impact on the participants' acceptance of BETS and their general perception of food traceability.

As my study investigates respondents' perceptions of new technology, I deemed it necessary to add a fourth part to the questionnaire dealing with the novelty of the technology. I decided to do so based on the research of X. Lin et al. (2021) and Yeh et al. (2019), who both add empirically proven measures of testing psychological and social theories on the acceptance and use of new technology. Yeh et al. (2019) utilize the Unified Theory of Acceptance and Use of Technology (UTAUT) in developing measures for psychological traits like performance expectations, effort expectations, social influence, and facilitating conditions. On the other hand, X. Lin et al. (2021) rely on the Information System Success Model (ISS), which rather than testing the acceptance of all new technological developments, is focused only on one type of technology, information systems. For this reason, I selected the ISS as the adequate model to examine the technology acceptance aspect of end consumers' perception of BETS in the food industry.

3.3. Information System Success Model

Similarly to the UTAUT, the ISS model has elements regarding the performance and quality of the service provided. Precisely, ISS consists of system quality (SYQ), service quality (SEQ), and information quality (IQ) (DeLone & McLean, 2016). SYQ is concerned with the technical level of the IS and measures the efficiency and precision of the part of the system which produces data and information. The semantic level of the IS deals with the ability to convey the intended meaning, hence IQ. DeLone and McLean (2016) explain that SEQ is related to the influence or effectiveness level of the communication system and includes four dimensions, as presented in Figure 3: User Satisfaction, Individual Impact, Organizational Impact, and Use.

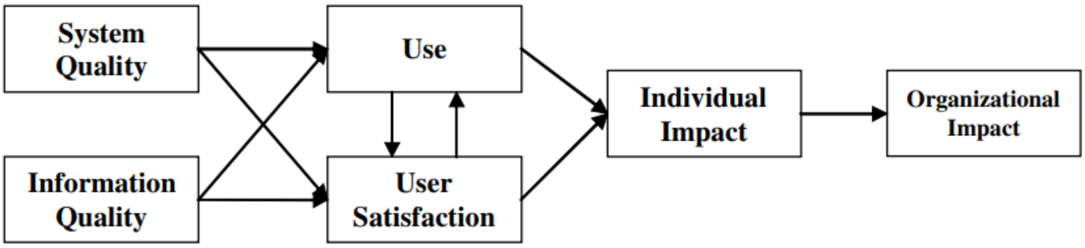


Figure 3. ISS Model (source: DeLone & McLean, 2016, p.5)

Based on this model, I developed the following hypothesis:

H8: System Quality positively affects user perception of BETS in food products.

H9: Information Quality positively affects user perception of BETS in food products.

H10: Service Quality positively affects user perception of BETS in food products.

4. Results

My thesis aims to examine end consumers' perceptions of BETS and analyze how previous knowledge of the technology affects their perceptions. In order to achieve this, I first find out how Albanian consumers understand the benefits of BETS and how they view its adaption in FSC, mainly in terms of food quality and safety. In addition, I investigate how respondents view the adoption of the new technology.

In that view, I collected data from 88 Albanian individuals with different demographics via the questionnaire developed in the third chapter. I used the acquired data to analyze and test the hypothesis developed in the theoretical part of my thesis. Intentionally, I selected a 10 Likert scale for all the questionnaire items (apart from the demographics section) to enable efficient comparability, utilizing statistical tools like the t-test and the chi-square test. For more information, I included the complete table of the responses in the Appendix chapter.

4.1. Demographic Qualities of the Sample

I start the analysis of the data by presenting some demographic attributes of the survey participants. Through this section, I describe the sample's representativeness in terms of the Albanian population. In addition to items like age, gender, and income, I collected data on respondents’ previous experiences with food diseases and their self-claimed knowledge in the blockchain domain.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	42	47.7%	47.7%	47.7%
	Female	44	50.0%	50.0%	97.7%
	Prefer not to say	2	2.3%	2.3%	100.0%
Total		88	100.0%		

Table 1. Frequency Table: Gender

In more detail, as I show in Table 1, 42 of the respondent were male, 44 were female, and two preferred not to provide their gender. The female gender represents exactly half of the selected sample. The distribution is somewhat equal; hence, in terms of gender, the sample can be considered representative of the Albanian population.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 20 years old	11	12.5%	12.5%	12.5%
	Between 20-30 years old	53	60.2%	60.2%	72.7%
	Between 30-40 years old	18	20.5%	20.5%	93.2%
	Between 40-50 years old	3	3.4%	3.4%	96.6%

	Between 50-60 years old	3	3.4%	3.4%	100.0%
Total		88	100.0%		

Table 2. Frequency Table: Age

In terms of age, the sample of my study is not completely representative of the Albanian population. This is because, as I mentioned previously, the majority of the study participants are less than 40 years old. More specifically, 11 respondents were younger than 20 years old, 53 belonged to the age group 20 to 30, 18 were 30 to 40, three were 40-50 years old, and three of them were 50 to 60. None of the respondents were older than 60 years old. Hence, the study sample is not representative of the Albanian population, as more than half of the respondents are between 20 and 30 years old.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High School	18	20.5%	20.5%	20.5%
	Professional Certificate	6	6.8%	6.8%	27.3%
	Bachelor's	37	42.0%	42.0%	69.3%
	Master's	18	20.5%	20.5%	89.8%
	MBA	7	8.0%	8.0%	97.7%
	Doctorate & PhD	2	2.3%	2.3%	100.0%
Total		88	100.0%		

Table 3. Frequency Table: Education

In Table 3, I present the educational level of the study's respondents. The highest share of the people who participated held a bachelor’s degree (42%). The second largest share belonged to two groups, one had only finished high school, and the other had a Master’s degree, with 18 respondents each. Six of the respondents held a professional certificate, seven of them had an MBA, and only two had graduated with a doctorate degree. In terms of education, I consider the sample representative of the Albanian population.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Married	40	45.5%	45.5%	45.5%
	Single	41	46.6%	46.6%	92.0%
	Divorced	6	6.8%	6.8%	98.9%
	Widowed	1	1.1%	1.1%	100.0%
Total		88	100.0%		

Table 4. Frequency Table: Marital Status

Table 4 includes the frequencies of the responses regarding marital status. Of the 88 people who participated in the study, 41 were single, amounting to 46.6% of the sample. Forty-one of them were married, six of them divorced, and only one was a widow. Therefore, also in terms of marital status, I consider the sample an adequate representative group for the whole population.

I have suffered from foodborne illnesses					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	22	25.0%	25.0%	25.0%
	Yes	66	75.0%	75.0%	100.0%
Total		88	100.0%		
Someone in my family or someone I know has suffered from foodborne illnesses					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	4	4.5%	4.5%	4.5%
	Yes	84	95.5%	95.5%	100.0%
Total		88	100.0%		

Table 5. Frequency Tables: Past Experience

As I present in Table 5, almost all of the people participating in my study had experienced illnesses due to food consumption either directly or through a relative. Only four respondents did not have a friend or relative who suffered from foodborne diseases. Regarding direct experiences, 22 participants had not experienced food poisoning or other issues from food consumption, while 66, or 75% of the sample, had not.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No Knowledge	23	26.1%	26.1%	26.1%
	Basic	30	34.1%	34.1%	60.2%
	Moderate	8	9.1%	9.1%	69.3%
	Advanced	22	25.0%	25.0%	94.3%
	Expert	5	5.7%	5.7%	100.0%
Total		88	100.0%		

Table 6. Frequency Table: Level of Knowledge

In Table 6, I present the results of the last question of the first part of the questionnaire, which was regarding the level of knowledge of blockchain technology. Again, the majority of the respondents claim to have at least some basic understanding of the technology, as only 23 have stated that they have no knowledge. 30 claim to have only basic knowledge, while 22 believe themselves to be at an advanced level. Only eight of them have selected the “Moderate” option, and five declare themselves experts in the field.

Even though Table 5 and Table 6 were included in the demographic section of the results, I did not develop these two items to judge if the sample is representative of the population. I developed these two items in order to serve as independent variables and allow me to test the hypothesis properly. I include dedicated sections to each test that I conducted in the following sections.

4.2. Descriptive Statistics

In this section, I present the results of the descriptive analysis of the variables of the study. In order to make the results easier to understand, I decided to utilize bar graphs and other visual tools extensively in this section. For the same purpose, the section is divided into three subchapters according to the structure of the questionnaire. Thus, in the first part, I present the results concerning the variables of blockchain technology. In the second, I discuss the perceived implications of BETS in the quality of food products, and in the third, the variables concerning the new technology adoption aspect. However, the results presented in Descriptive Statistics remain general and do not deal with hypothesis testing.

4.2.1. Blockchain Technology

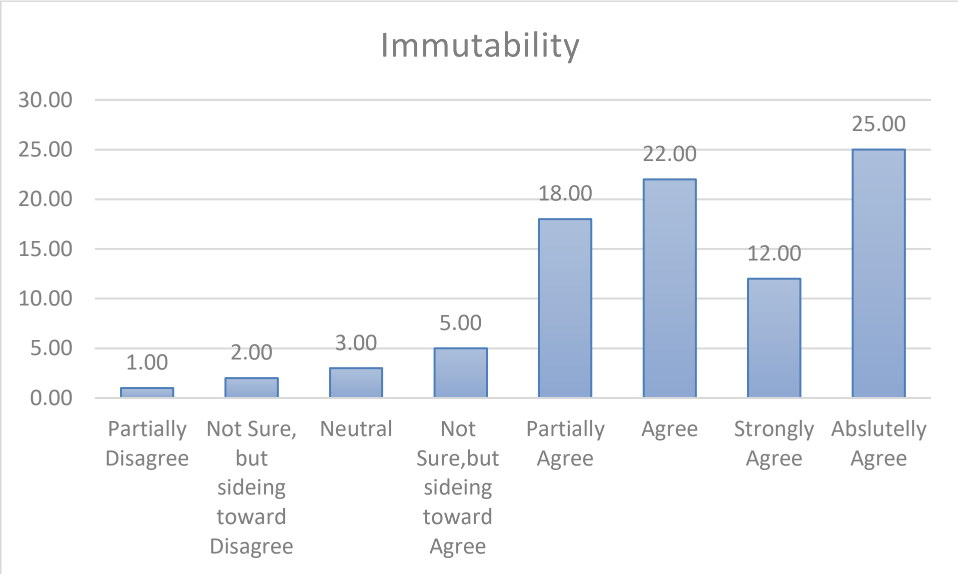


Figure 4. Responses on Immutability

Most people who participated in my study agreed with the first statement regarding blockchain technology. For the first variable, as I present in Figure 4, 25 people selected the highest level of agreement, 12 strongly agreed, 22 agreed, and 18 partially agreed. Ten of the remaining were either unsure or chose to stay neutral. Only one of the respondents partially disagreed with the statement.

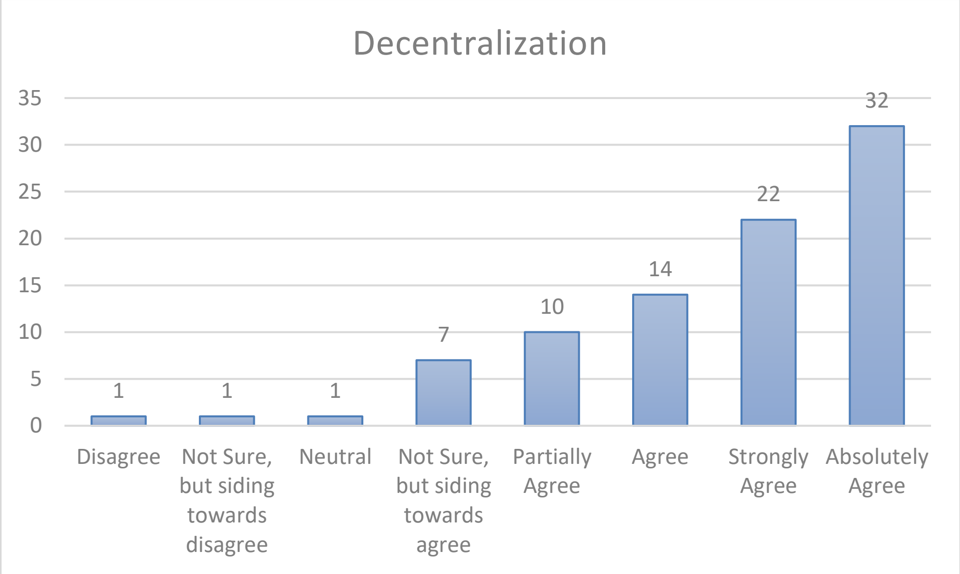


Figure 5. Responses on Decentralization

The results of the responses on the second variable of the technology are similar to the first. Also here, the majority of people agree with the statement, as I visually display in Figure 5. Here, the numbers are 32, 22, 14, 10, and 7, going in a descending order corresponding to the levels from "Absolutely Agree" to "Not Sure, but siding towards Agree." Only three of the respondents did not agree with this statement, one choosing to stay neutral, one siding towards disagree, and one disagreeing.

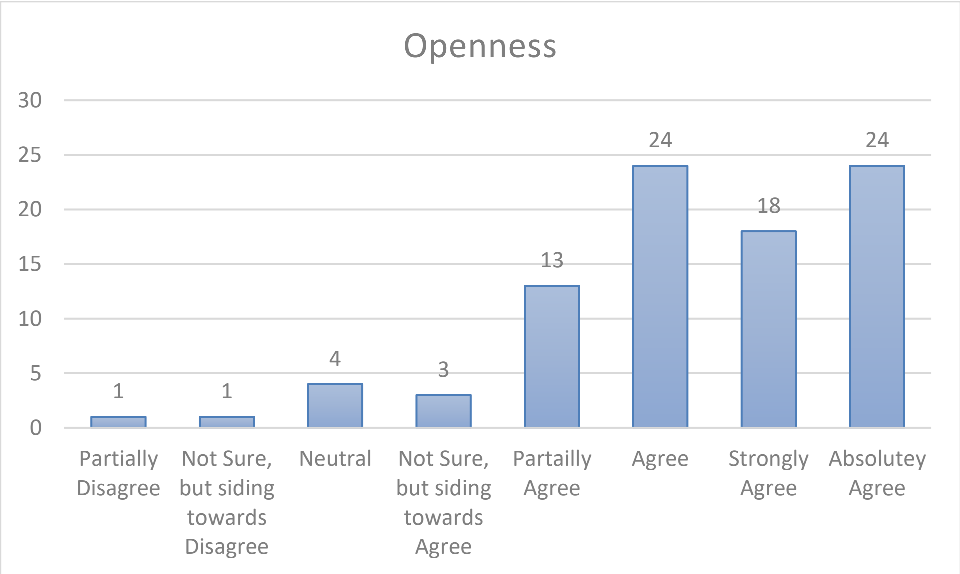


Figure 6. Responses of Openness

Figure 6 includes the responses to the third variable of the technology aspect of my study. Similarly to the previous two variables, most of the respondents agree with the statement, and only six remain neutral or disagree. The same number of 24 was for both "Absolutely

Agree" and "Agree," while 18 "Strongly Agreed" and 13 agreed only partially. Of the remaining, three sided towards agree, four were neutral, one sided towards disagree, and one partially disagreed.

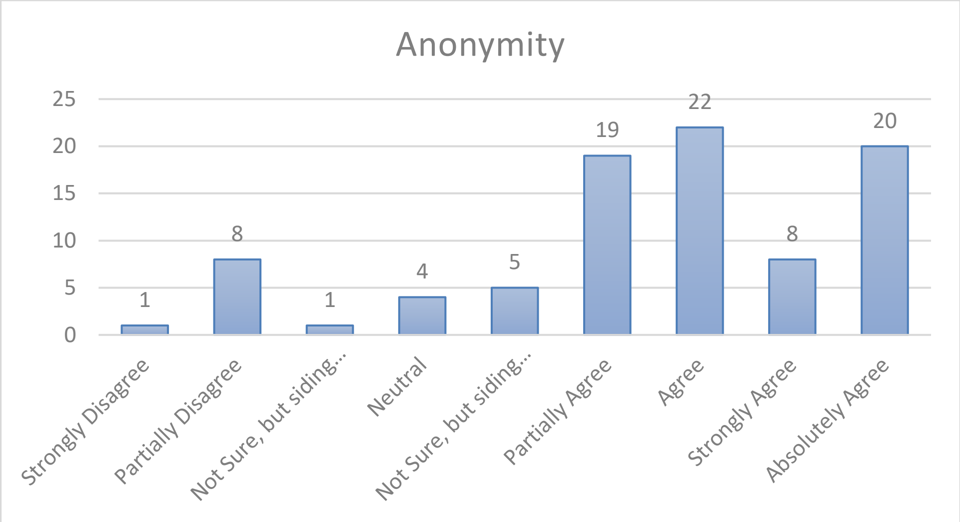


Figure 7. Responses of Anonymity

In Figure 7, I present the responses regarding the last variable of the blockchain technology section. Even though not as uniformly as for the previous variables, the majority of the respondents agreed with the statement. However, the number of people who disagreed was relatively high, with one choosing "Strongly Disagree," eight "Partially Disagree," and one siding towards disagree. Nevertheless, 20 chose the highest level of agreement, eight strongly agreed, 22 agreed, and 19 partially agreed.

4.2.2. Food Quality

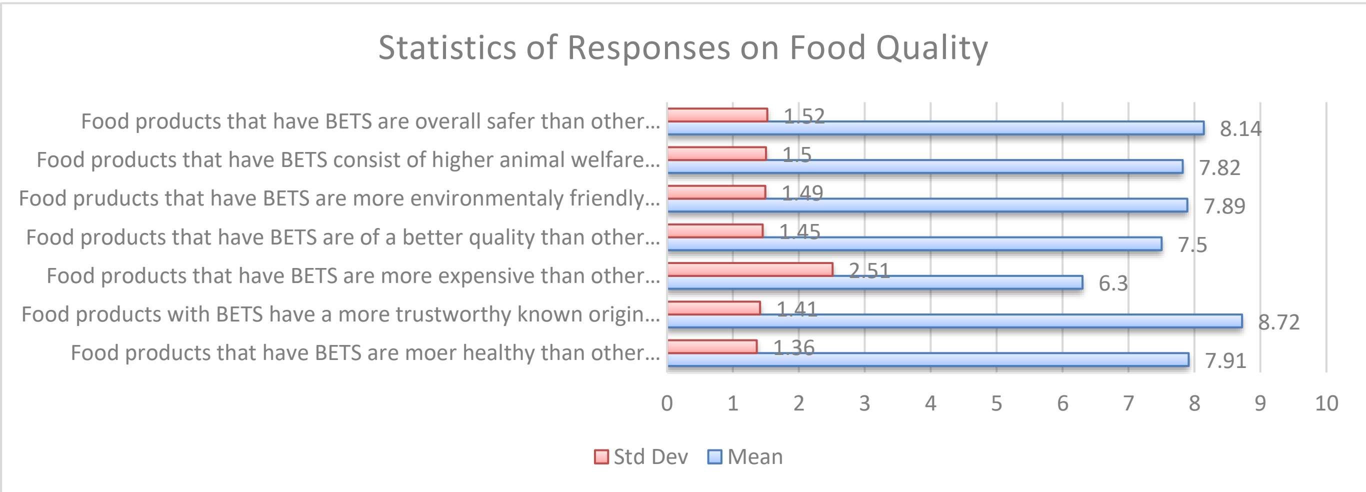


Figure 8. Mean & Std Dev Graph on Food Quality

As I hint in Figure 8, with a mean higher than 5 "Neutral," most of the study participants agree with all the statements in this section. The standard deviation shows that the ranges of the responses were somewhat small, hinting that for most statements, the respondent was of a similar mind. However, that was not the case for the statement regarding the price of food products utilizing BETS. For this variable, the mean is lower than the rest, and the standard deviation is considerably larger. I find the reasons why this is the case interesting, and I further investigate this variable as well as the others using more advanced tools.

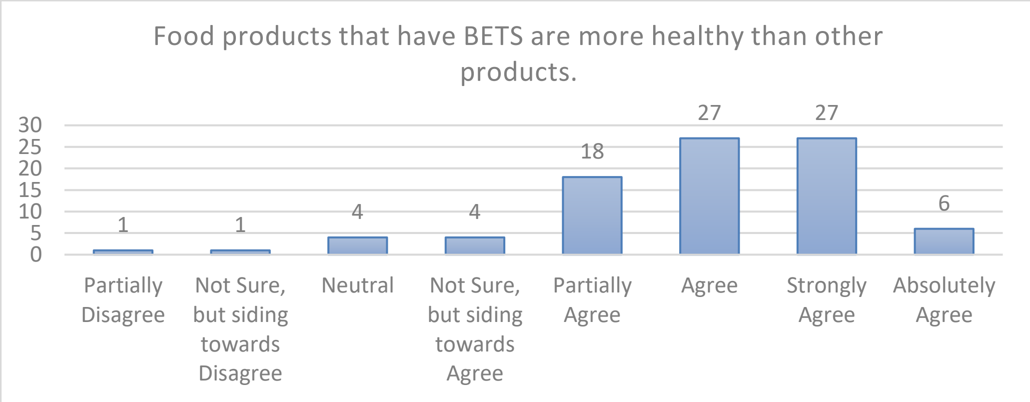


Figure 9. Responses of Perceived Quality Variable 1

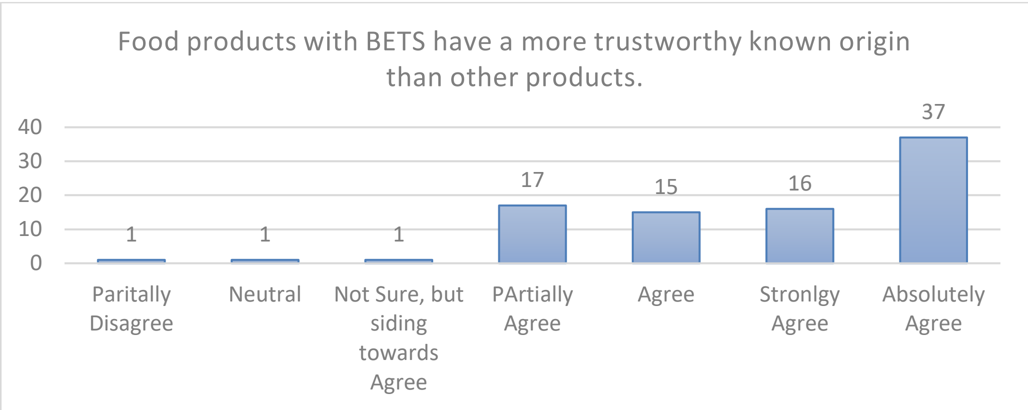


Figure 10. Responses of Perceived Quality Variable 2

In Figure 9 and Figure 10, I present the responses on the first two quality variables. As seen in the bar charts, the results are positive for both variables. However, I noticed that there is a stronger conviction regarding the second variable, as 37 selected “Absolutely Agree” compared to only six in the first variable. Additionally, only one person disagreed, and one chose to stay neutral with the second statement, while for the first, four selected “Neutral,” one sided towards disagree, and one disagreed.

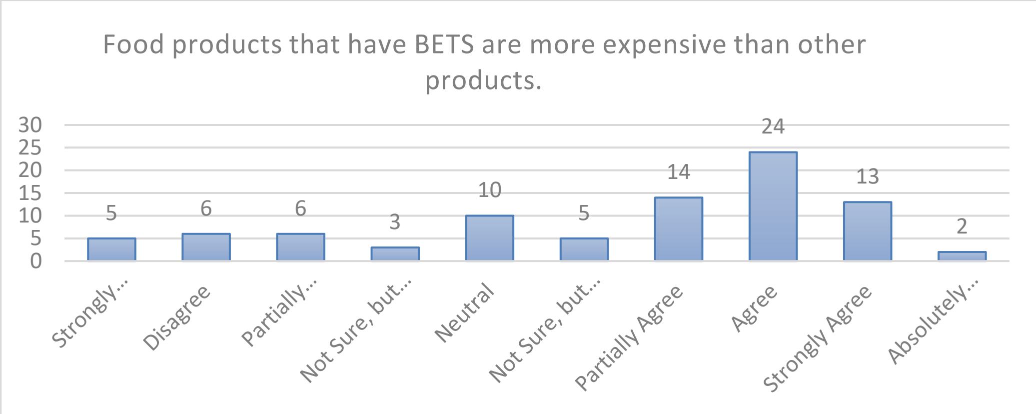


Figure 11. Responses of Perceived Quality Variable 3

As shown in Figure 11 and hinted in Figure 8, the results of the third variable of the perceived quality section do not show the same level of agreement as the other items. This is also the only case in which the respondents have utilized the full list of the available alternatives in a statement. Even though most of the study participants agree with the statement, there is a considerable number who do not, with five selecting “Strongly Disagree”, six “Disagree,” another six “Partially Disagree,” three siding towards disagree, and ten choosing to remain neutral.

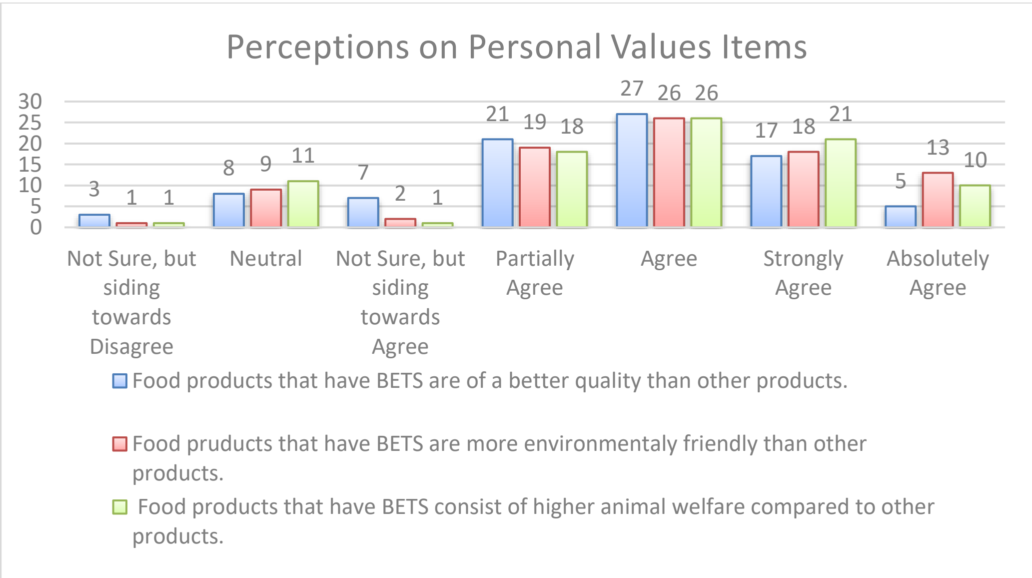


Figure 12. Responses of Perceived Quality Variable 4

Also, regarding personal values, the majority of the respondents agreed with the provided statements. As I present in Figure 12, the respondents selected mainly the positive alternatives in all three items that I developed for personal values.

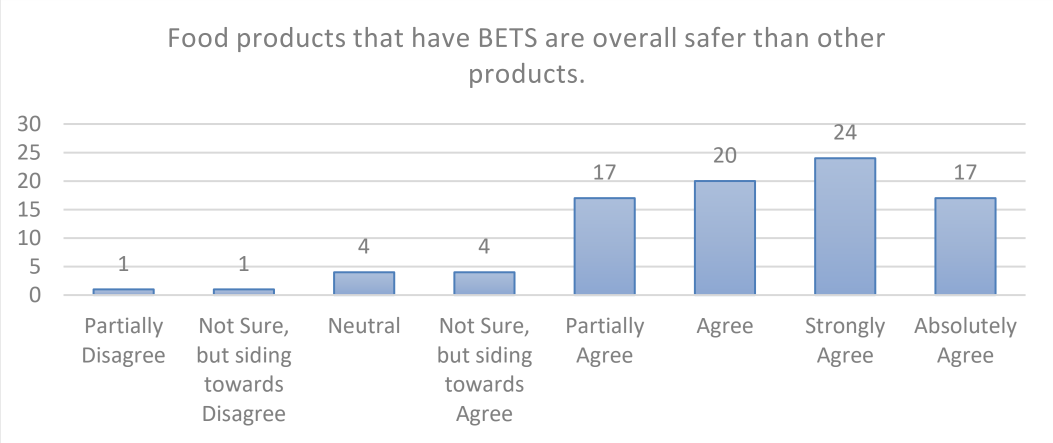


Figure 13. Responses of Perceived Quality Variable 5

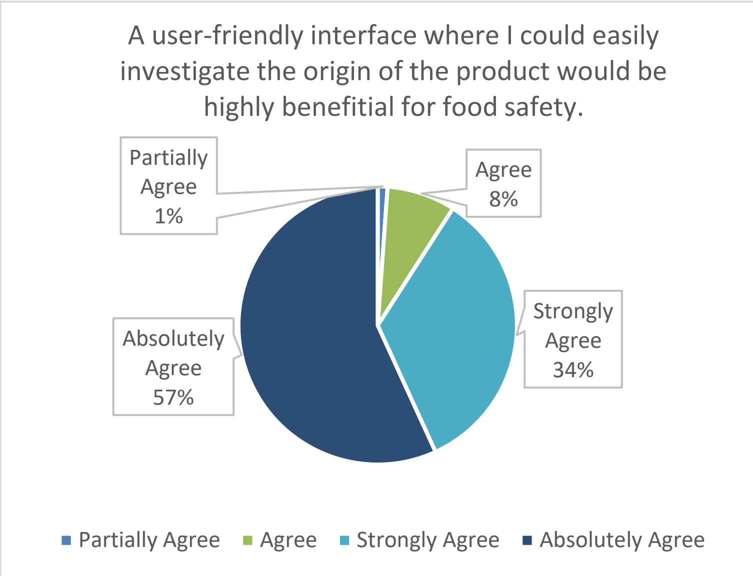
As I expected, the results of the last question of this section show a general agreement with the statement. Only 2 of the respondent do not agree, four remain neutral, while the rest show different levels of agreement.

4.2.3. Technology Acceptance & Usage Intention

	Mean	Std Dev
A user-friendly interface where I could easily investigate the origin of the product would be highly beneficial for food safety.	9.47	0.69
The response time and reliability of the tracking system are important factors that affect my intention to use BETS.	8.4	1.01
The quality and level of detail in the information provided are decisive factors in my intention to use BETS.	9.08	0.87
The accuracy and transparency of the information provided are decisive factors in my intention to use BETS.	8.91	0.97
The overall traceability and transparency of the system are decisive factors in my intention to use BETS.	8.57	0.98
The integrity and benevolence of the system are decisive factors in my intention to use BETS.	8.92	0.85

Table 7. Mean & Std Dev of Perception of Acceptance and Usage Intention

In this section, I present the results of the third part of the questionnaire. As it can be seen from the mean values in Table 7, the sample agreed with the statements even with more confidence compared to the previous statements. Additionally, the standard deviations are in almost all cases less than one (apart from one case where it is 1,01).



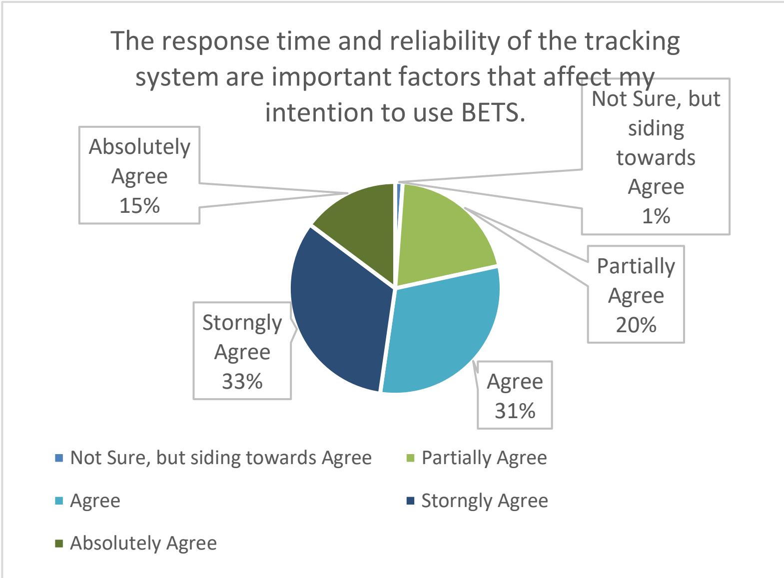


Figure 14. Pie Charts of Responses on SYQ Variable

Figure 14 shows the shares of the responses to the first statements in the last section of the survey. There is a strong agreement with the first statement, as 57% of the respondents have selected the alternative representing the highest level of agreement, and the lowest response is "Partially Agree" with only one respondent. Similarly, for the second statement, all respondents agree, however, only 15% chose the highest level of agreement, while the majority, amounting to 33%, selected "Strongly Agree."

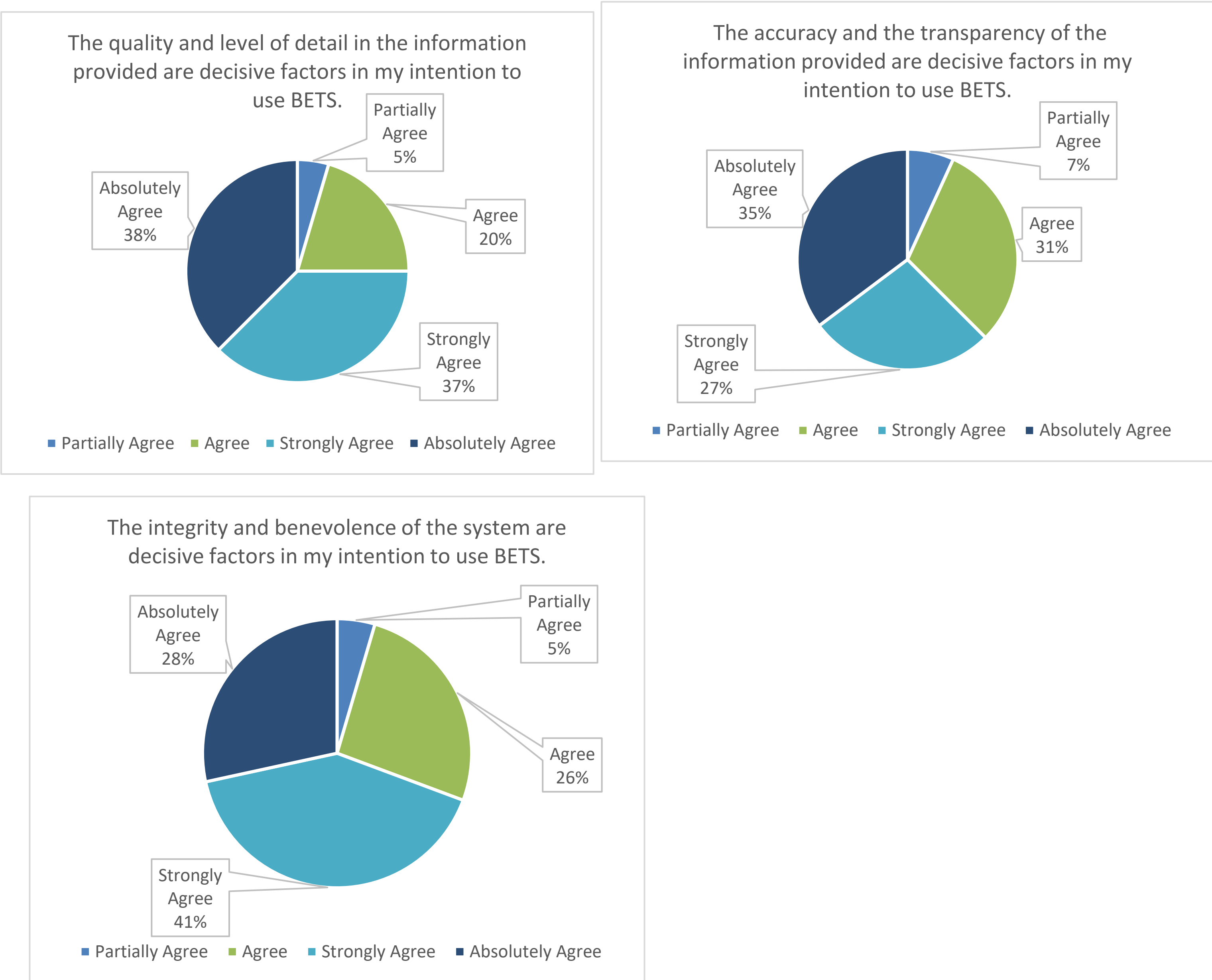


Figure 15. Pie Charts of Responses on IQ Variable

In Figure 15, I present the responses on the variables concerning IQ. As seen in the bar charts, the results are positive for both variables. In both statements, "Absolutely Agree" hold the largest share of responses with 38% and 35%, respectively. Again, in both statements, there are no respondents who disagree or who choose to stay neutral.

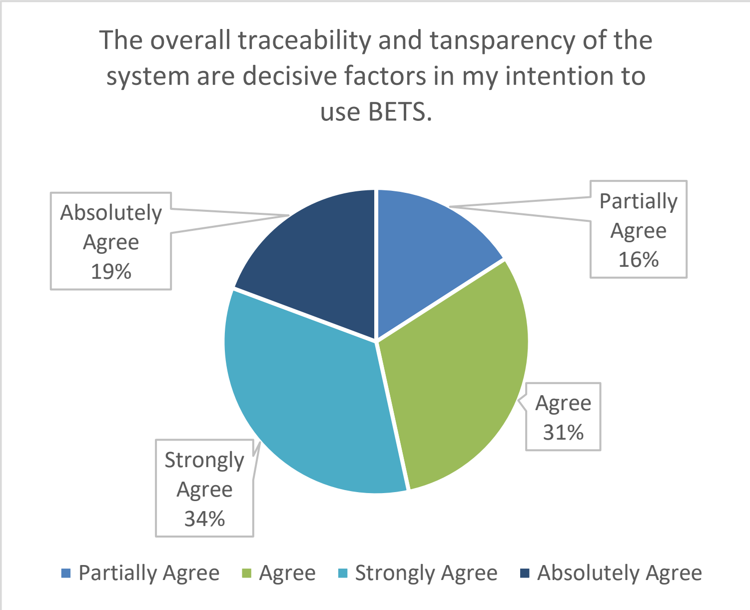


Figure 16. Pie Charts of Responses on SEQ Variable

The same is the case for the last two statements concerning SEQ. As seen in Figure 16, the study participants show a high level of agreement with the provided statements. The level of agreement appears to be slightly higher in the second statement, where 28% belong to "Absolutely Agree" and 41% to "Strongly Agree," compared to 19% and 34%, respectively, in the first statement.

4.3. Hypotheses Testing

In this section, I use the data collected to test the hypothesis developed in the theory section. As I do so, I describe the variables used as well as the measures selected to conduct the tests. In addition, I present the hypothesis in a structured way.

4.3.1. Blockchain Technology

H1: End Consumers with knowledge of blockchain understand that a BETS offers an immutable record of information regarding food products and their production.

H2: End Consumers with knowledge of blockchain understand the added benefits of a decentralized system in FSC.

H3: End Consumers with knowledge of blockchain understand the added benefits of the openness characteristic of BETS.

H4: End Consumers with knowledge of blockchain understand the added value of anonymity in BETS compared to traditional traceability systems.

To test these hypotheses, I decided to use a Kruskal-Wallis test, as there are more than two groups, and thus Mann-Whitney could not be used. In this case, the dependent variable is the level of agreement with the statements, and the grouping is done corresponding to the level of knowledge of the blockchain domain. I included the rank table in the appendix section, and chose to present only the Chi-Square values in Table 8.

Construct	p-value
Immutability	.000
Decentralization	.000
Openness	.179
Anonymity	.000

Table 8. Kruskal-Wallis Test on Blockchain Technology Variables

In three of the items above, the p-value is less than 0.05, which means there is a statistical significance in the perceived benefits of BETS based on knowledge of the domain. In other words, the null hypotheses are rejected in three of the constructs developed for the first part of the study. The only construct that did not allow for the rejection of the null hypothesis was openness, with a p-value > 0.05. Hence, hypothesis one, two, and four can be approved with confidence, while hypothesis three does not show validity.

4.3.2. Food Quality Perceptions

H5: End Consumers with knowledge of blockchain understand that the adoption of BETS results in lower prices of goods.

H6: End Consumers with knowledge of blockchain understand the benefits of accurate origination and provenance information provided by BETS.

H7: End Consumers with knowledge of blockchain believe that they can better abide by their values when buying a food product with BETS.

For this section, the constructs developed do not have a one-on-one relationship with the hypothesis, apart from **H5**. The perceived **health**, **origination**, and **quality** are the constructs developed to test **H6**. While the perceived **environmental impact** and **animal welfare** are constructs corresponding to **H7**. As for the last construct, perceived safety, it can serve to test both **H6** and **H7**. A better representation of the constructs and the corresponding hypotheses can be seen in Table 9.

	Construct	p-value
H6	Perceived Healthiness	.011
H6	Perceived Origination	.000
H5	Perceived Price	.000
H6	Perceived Quality	.006
H7	Perceived Environmental Impact	.001
H7	Perceived Animal Welfare	.001
H6/H7	Perceived Safety	.000

Table 9. Kruskal-Wallis Test on Food Quality Variables

As seen in Table 9, all the p-values of the attributes belonging to the food quality perceived implications are smaller than .05. Thus, I can confidently reject the null hypothesis. In other words, the results of this analysis show that there is a difference between groups in the perception of the quality of the food, depending on the level of knowledge that the respondent has on blockchain technology. Connecting these results with the results from 4.2.2, I can confidently state that knowledge of the blockchain domain positively affects the perceived quality of food products that use BETS.

4.3.3. Technology Adoption & User Intention

In comparison to the two other parts, I decided that previous experiences are better suited as categorial variables for this part of the analysis. As there are only two categories, 0 for "No" and 1 for "Yes," I used a Mann-Whitney Test to examine the statistical significance of the variables. Hence, I test the last three hypotheses by using the past experiences construct as a medium to conduct the analysis.

H8: System Quality positively affects user perception of BETS in food products.

H9: Information Quality positively affects user perception of BETS in food products.

H10: Service Quality positively affects user perception of BETS in food products.

		Mann-Whitney U	WilcoxonW	Z	p-val.
H8	User-friendly interface (SYQ)	648,5	901,5	-0,85	0,397
H8	The response time and reliability (SYQ)	666	919	-0,6	0,547
H9	The quality and level of detail (IQ)	544	797	-1,86	0,062
H9	The accuracy and transparency (IQ)	658	911	-0,69	0,491
H10	The overall traceability and transparency (SEQ)	608	861	-1,19	0,236
H10	The integrity and benevolence (SEQ)	634	887	-0,94	0,348

Table 10. Results of Mann-Whitney Test on Adoption and Intention Variables

As seen in Table 10 and Table 11, for each hypothesis there are two corresponding constructs. The **interface user friendliness** and the **response time and reliability** are the construct developed to test **H8**. The **quality and detail level** and the **accuracy and transparency** constructs are the ones developed to test **H9**. Lastly, for **H10,** the constructs used are the **traceability and transparency** as well as the **integrity and benevolence**.

		Mann-Whitney U	WilcoxonW	Z	p-val.
H8	User-friendly interface (SYQ)	105,5	115,5	-1,42	0,155
H8	The response time and reliability (SYQ)	105	115	-1,31	0,189
H9	The quality and level of detail (IQ)	58,5	68,5	-2,33	0,020
H9	The accuracy and transparency (IQ)	95,5	105,5	-1,53	0,127
H10	The overall traceability and transparency (SEQ)	148,5	3718,5	-0,41	0,684
H10	The integrity and benevolence (SEQ)	142,5	152,5	-0,54	0,588

Table 11. Results of Mann-Whitney Test Part 2

Table 10 shows the p-values for all the items in relation to the variable of direct past experience, while Table 11 does the same but in relation to indirect past experiences. In both cases, it is clear that the p-values are larger than 0.05. Hence the null hypothesis can not be rejected. In other words, past encounters with foodborne diseases appear not to have an effect on the adoption or usage intention of BETS, regardless if the experience was direct or indirect.

5. Conclusions

In this chapter, I discuss the implications of the results of this study and present the findings. I try to describe the findings in line with the topics mentioned in the theoretical part of the thesis. Afterward, I present the newly acquired knowledge in the form of potential implications for the food industry stakeholders to help them understand the possible benefits that BETS can introduce. Moreover, this section also deals with the acknowledgment of the limitations of this study and proposes ways in which future research can be improved.

5.1. Findings

Overall, I consider the results of my study quite pleasing. On average, respondents showed positive levels of agreement with the provided statements. As the statements were developed based on the literature review, the positive level of acceptance shows that end consumers perceive BETS as an effective tool to address the issue of traceability and transparency in FSC. In the responses to some of the statements, there were no participants who disagreed at all. The two prevailing items were decentralization and immutability, followed by openness and anonymity. With the help of the Kruskal-Wallis test, I confirmed that there is a relationship between knowledge of the blockchain domain and the level of agreement. In other words, knowledge of blockchain technology positively influences the perceived benefits of BETS due to blockchain technology.

Regarding food quality perceptions, the results of the descriptive statistics analysis showed that most respondents believed that a food product that had BETS is safer, healthier, and better abiding by the social norms of end consumers. However, there appeared to be confusion regarding the price of food products with BETS. Here, contrary to what the literature suggests, most of the respondents believe that food products that have BETS are of a higher price compared to other products. For this section also, I used the Kruskal-Wallis test to examine the relationship between blockchain knowledge and perceived benefits. Similarly to the first part, there appears to be a positive correlation between knowledge and food products' improved quality and safety.

The results of technology acceptance and usage intention are also positive. I initially believed that previous experiences with foodborne illnesses would impact the respondents' perceptions of this section. However, after conducting a Mann-Whitney test, the results showed no statistically meaningful relationship between the variables. Nevertheless, all three attributes derived from the literature, SYQ, IQ, and SEQ, appear to be important aspects to end consumers.

5.2. Industry Implications

Given the importance of the topic and the potential of BETS in solving the underlying issues of the food industry, FSC participants and policymakers alike have to incentivize end consumers to learn more about blockchain technology. By doing so, end consumers can better grasp the potential benefits that BETS introduce and rebuild their trust in the industry. I believe that special attention should be given to the pricing aspect and ensure all members of the FSC that BETS ultimately results in lower costs for the whole value chain.

In addition, given the high level of perceived benefits in terms of quality and safety, BETS can also prove to be a competitive advantage in terms of marketing for restaurants and food retailers. By providing access to enhanced tracking information by simply scanning a link, food retailers enable end consumers to make safe and responsible purchases with confidence. The information available to end consumers would allow them to buy products according to their personal values and needs.

Another important finding of my study concerns the adoption of the new technology. The findings suggest that end consumers value all three items of IS. In other words, for a BETS to fulfill its main purpose, it should offer access to end consumers through a user-friendly interface. In addition, the responsiveness and reliability of the system have to be guaranteed, and the information it provides should be trustworthy and transparent.

5.3. Limitations and Avenues for Future Research

I believe that there are certain limitations to my study that I need to acknowledge. First, the sample size of 88 respondents is relatively small to be representative of the whole Albanian population. In addition, a small sample can have other implications in the analysis, like the Type 2 error in testing the hypothesis. Also regarding demographics, the sample selected was not fully representative because the majority of the respondents belonged to younger generations and lacked older age groups, as more than 93% were younger than 40 years old.

Moreover, the data was collected via convenience sampling, for which I used my family and friends. This can prove to be a limitation as it allows selection biases, preventing the results from being generalized adequately for the whole population. Thus, in case of further interest in the topic, I suggest that the sample from which the data should be acquired using probability sampling.

6. References

Astill, J., Dara, R. A., Campbell, M., Farber, J. M., Fraser, E. D. G., Sharif, S., & Yada, R. Y. (2019). Transparency in food supply chains: A review of enabling technology solutions. *Trends in Food Science & Technology*, *91*, 240–247. Thttps://doi.org/10.1016/j.tifs.2019.07.024

Bigliardi, B., Filippelli, S., Petroni, A., & Tagliente, L. (2022). The digitalization of supply chain: A review. *Procedia Computer Science*, *200*, 1806–1815. https://doi.org/10.1016/j.procs.2022.01.381

Cao, S., Powell, W., Foth, M., Natanelov, V., Miller, T., & Dulleck, U. (2021). Strengthening consumer trust in beef supply chain traceability with a blockchain-based human-machine reconcile mechanism. *Computers and Electronics in Agriculture*, *180*, 105886. https://doi.org/10.1016/j.compag.2020.105886

Collart, A. J., & Canales, E. (2022). How might broad adoption of blockchain-based traceability impact the U.S. fresh produce supply chain? *Applied Economic Perspectives and Policy*, *44*(1), 219–236. https://doi.org/10.1002/aepp.13134

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed). SAGE Publications.

Creydt, M., & Fischer, M. (2019). Blockchain and more—Algorithm driven food traceability. *Food Control*, *105*, 45–51. https://doi.org/10.1016/j.foodcont.2019.05.019

DeLone, W. H., & McLean, E. R. (2016). Information Systems Success Measurement. *Foundations and Trends® in Information Systems*, *2*(1), 1–116. https://doi.org/10.1561/2900000005

Deng, M., & Feng, P. (2020). A Food Traceability System Based on Blockchain and Radio Frequency Identification Technologies. *Journal of Computer and Communications*, *08*(09), 17–27. https://doi.org/10.4236/jcc.2020.89002

Galvez, J. F., Mejuto, J. C., & Simal-Gandara, J. (2018). Future challenges on the use of blockchain for food traceability analysis. *TrAC Trends in Analytical Chemistry*, *107*, 222–232. https://doi.org/10.1016/j.trac.2018.08.011

Garaus, M., & Treiblmaier, H. (2021). The influence of blockchain-based food traceability on retailer choice: The mediating role of trust. *Food Control*, *129*, 108082. https://doi.org/10.1016/j.foodcont.2021.108082

Kamath, R. (2018). Food Traceability on Blockchain: Walmart's Pork and Mango Pilots with IBM. *The Journal of the British Blockchain Association*, *1*(1), 1–12. https://doi.org/10.31585/jbba-1-1-(10)2018

Lin, Q., Wang, H., Pei, X., & Wang, J. (2019). Food Safety Traceability System Based on Blockchain and EPCIS. *IEEE Access*, *7*, 20698–20707. https://doi.org/10.1109/ACCESS.2019.2897792

Lin, X., Chang, S.-C., Chou, T.-H., Chen, S.-C., & Ruangkanjanases, A. (2021). Consumers' Intention to Adopt Blockchain Food Traceability Technology towards Organic Food Products. *International Journal of Environmental Research and Public Health*, *18*(3), 912. https://doi.org/10.3390/ijerph18030912

Matzembacher, D. E., Carmo Stangherlin, I. do, Slongo, L. A., & Cataldi, R. (2018). An integration of traceability elements and their impact in consumer's trust. *Food Control*, *92*, 420–429. https://doi.org/10.1016/j.foodcont.2018.05.014

Pal, A., & Kant, K. (2019). Using Blockchain for Provenance and Traceability in Internet of Things-Integrated Food Logistics. *Computer*, *52*(12), 94–98. https://doi.org/10.1109/MC.2019.2942111

Rejeb, A., Keogh, J. G., Zailani, S., Treiblmaier, H., & Rejeb, K. (2020). Blockchain Technology in the Food Industry: A Review of Potentials, Challenges and Future Research Directions. *Logistics*, *4*(4), 27. https://doi.org/10.3390/logistics4040027

Rejeb, A., Rejeb, K., Simske, S., & Treiblmaier, H. (2021). Blockchain Technologies in Logistics and Supply Chain Management: A Bibliometric Review. *Logistics*, *5*(4), 72.

https://doi.org/10.3390/logistics5040072

Santeramo, F. G., & Lamonaca, E. (2021). Food Loss–Food Waste–Food Security: A New Research Agenda. *Sustainability*, *13*(9), 4642. https://doi.org/10.3390/su13094642

Spink, J., Ortega, D. L., Chen, C., & Wu, F. (2017). Food fraud prevention shifts the food risk focus to vulnerability. *Trends in Food Science & Technology*, *62*, 215–220. https://doi.org/10.1016/j.tifs.2017.02.012

Tan, B., Yan, J., Chen, S., & Liu, X. (2018). The Impact of Blockchain on Food Supply Chain: The Case of Walmart. In M. Qiu (Ed.), *Smart Blockchain* (Vol. 11373, pp. 167–177). Springer International Publishing. https://doi.org/10.1007/978-3-030-05764-0_18

Teigiserova, D. A., Hamelin, L., & Thomsen, M. (2020). Towards transparent valorization of food surplus, waste and loss: Clarifying definitions, food waste hierarchy, and role in the circular economy. *Science of The Total Environment*, *706*, 136033. https://doi.org/10.1016/j.scitotenv.2019.136033

Tolentino-Zondervan, F., Ngoc, P. T. A., & Roskam, J. L. (2023). Use cases and future prospects of blockchain applications in global fishery and aquaculture value chains. *Aquaculture*, *565*, 739158. https://doi.org/10.1016/j.aquaculture.2022.739158

Treiblmaier, H. (2018). The impact of the blockchain on the supply chain: A theory-based research framework and a call for action. *Supply Chain Management: An International Journal*, *23*(6), 545–559.

Treiblmaier, H., & Petrozhitskaya, E. (2023). Is it time for marketing to reappraise B2C relationship management? The emergence of a new loyalty paradigm through blockchain technology. *Journal of Business Research*, *159*(April), 113725. https://doi.org/10.1016/j.jbusres.2023.113725

Yeh, J.-Y., Liao, S.-C., Wang, Y.-T., & Chen, Y.-J. (2019). Understanding Consumer Purchase Intention in a Blockchain Technology for Food Traceability and Transparency context. *2019 IEEE Social Implications of Technology (SIT) and Information*

Management (SITIM), 1–6. https://doi.org/10.1109/SITIM.2019.8910212

Yiannas, F. (2018). A New Era of Food Transparency Powered by Blockchain. *Innovations: Technology, Governance, Globalization*, *12*(1–2), 46–56. https://doi.org/10.1162/inov_a_00266

Yu, J., & Qiao, J. (2017). Consumer Concern About Food Safety and Its Impact on Their Familiarity With Food Traceability Systems in China. *Journal of International Food & Agribusiness Marketing*, *29*(1), 16–28. https://doi.org/10.1080/08974438.2016.1241733

Yuan, Y., Liu, X., Hong, K., Song, S., & Gao, W. (2020). Trustworthy Traceability of Quality and Safety for Pig Supply Chain Based on Blockchain. In H. Lu (Ed.), *Cognitive Internet of Things: Frameworks, Tools and Applications* (Vol. 810, pp. 343–355). Springer International Publishing. https://doi.org/10.1007/978-3-030-04946-1_34

Zheng, Z., Xie, S., Dai, H. N., Chen, X., & Wang, H. (2018). Blockchain challenges and opportunities: A survey. *International Journal of Web and Grid Services*, *14*(4), 352. https://doi.org/10.1504/IJWGS.2018.095647

7. Appendix

7.1. Questionnaire

Questionnaire

Title: End consumers' Perceptions of Blockchain-Enabled Traceability Systems in the Food Industry

The following survey is intended to gather perceptions of blockchain-enabled traceability systems (BETS) in the food industry. You are requested to input your level of acceptance with the statements provided below. The data gathered will not include any identifying items and will not be made public in order to ensure your anonymity. The gathered data will be used to analyze the use intention of such systems in the Albanian market. The survey takes 5-8 minutes to complete. In the first part of the questionnaire, you are requested to select the alternative which represents you best. In the following parts of the questionnaire, you are requested to provide your level of acceptance with the given statement of a level from 1 (Strongly Disagree) to 10 (Strongly Agree).

Part One - General Information

1. I am

◯ Male ◯ Female

◯ Other ◯ Prefer not to say

2. I am

◯ Less than 20 years old ◯ Between 20-30 years old

◯ Between 30-40 years old ◯ Between 40-50 years old

◯ Between 50-60 years old ◯ Older than 60 years old

3. My highest level of education is

◯ High School ◯ Professional Certification

◯ Bachelor's ◯ Master's

◯ MBA ◯ Doctorate & PhD

4. My marital status is

◯ Married ◯ Single

◯ Divorced ◯ Widowed

5. I have suffered from foodborne illnesses

◯ Yes ◯ No

6. Someone in my family or someone I know has suffered from foodborne illnesses

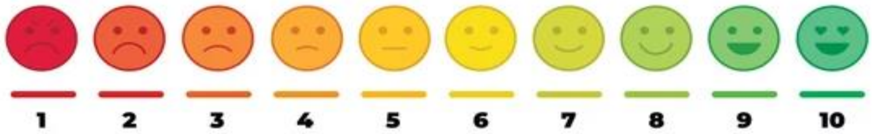
◯ Yes ◯ No

7. My level of knowledge regarding Blockchain is

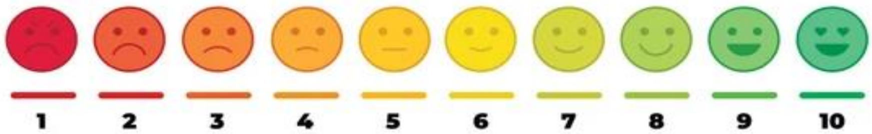
◯ No Knowledge ◯ Basic ◯ Moderate ◯ Advanced ◯ Expert

Part Two – Blockchain Technology

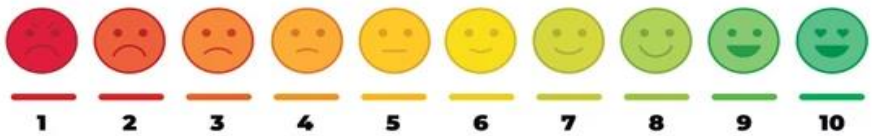
1. Due to the immutable characteristics of blockchain technology, BETS provide a permanent and authentic record of the value chain.



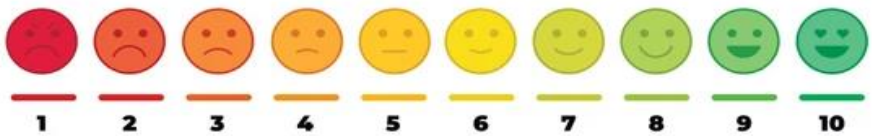
2. The decentralization that blockchain technology presents makes a BETS better than other tracking systems.



3. The open nature of blockchain technology makes a BETS better than other tracking systems.

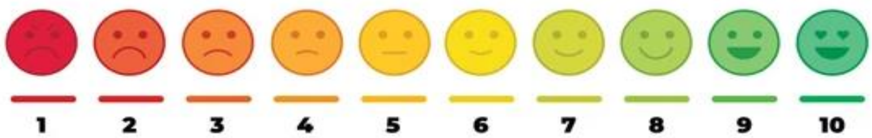


4. The anonymity of blockchain technology makes a BETS better than other tracking systems.

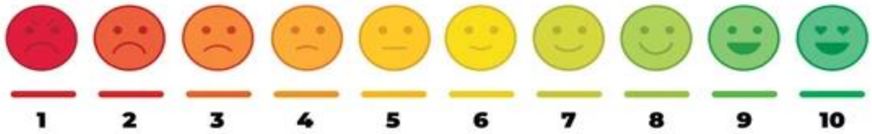


Part Three – Food Quality Perceptions

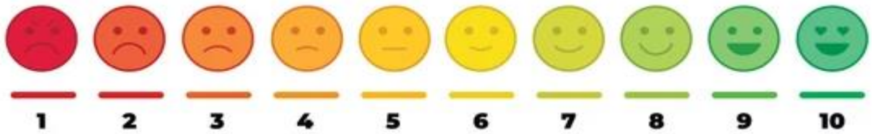
5. Food products that have BETS are more healthy than other products.



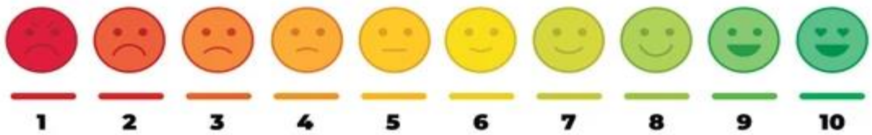
6. Food products with BETS have a more trustworthy known origin than other products.



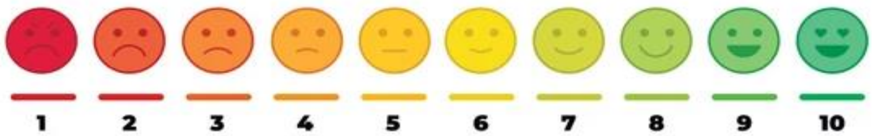
7. Food products that have BETS are more expensive than other products.



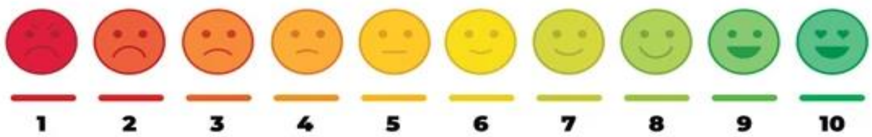
8. Food products that have BETS are of a better quality than other products.



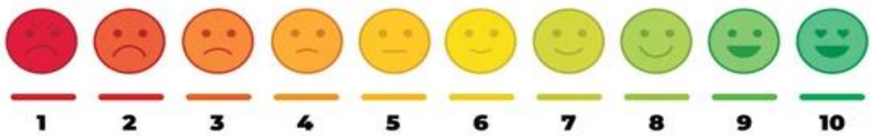
9. Food products that have BETS are more environmentally friendly than other products.



10. Food products that have BETS consist of higher animal welfare compared to other products.

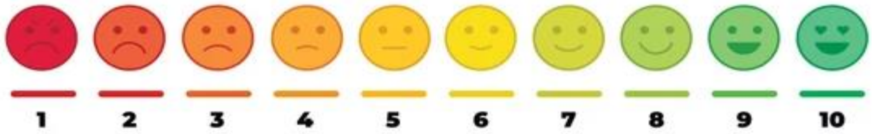


11. Food products that have BETS are overall safer than other products.

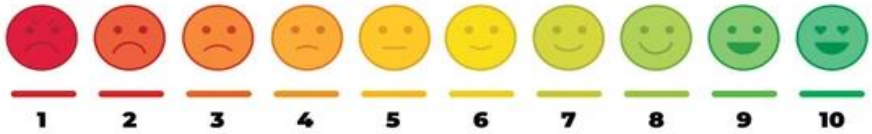


Part Four – User Intention

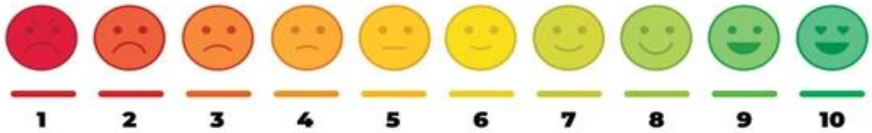
1. A user-friendly interface where I could easily investigate the origin of the product would be highly beneficial for food safety.



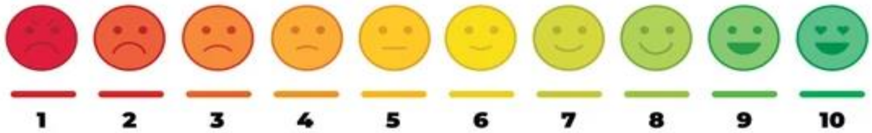
2. The response time and reliability of the tracing system are important factors that affect my intention to use a BETS.



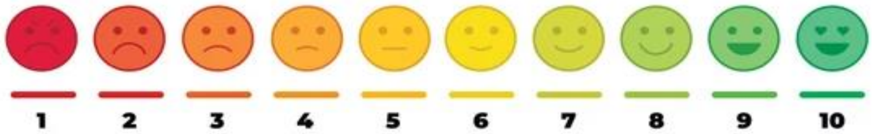
3. The quality and level of detail in the information provided are decisive factors in my intention to use BETS.



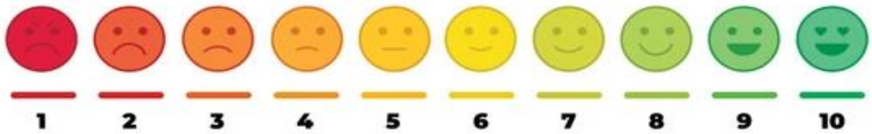
4. The accuracy and transparency of the information provided are decisive factors in my intention to use BETS.



5. The overall traceability and transparency of the system are decisive factors in my intention to use BETS.



6. The integrity and benevolence of the system are decisive factors in my intention to use BETS.



7.2. Analysis

7.2.1. Rank Table of Kruskal-Wallis Test for Blockchain Technology

Ranks

		N	Mean Rank
Due to the immutable charchteristics of blockchan technology, BETS provide a permanent and authentic record of the value chain	No Knowledge	23	29.30
	Basic	30	34.47
	Moderate	8	60.19
	Advanced	22	61.20
	Expert	5	76.00
	Total	88	
The decentralization the blockchain technology presents makes a BETS better than other tracking systems	No Knowledge	23	22.24
	Basic	30	42.10
	Moderate	8	59.00
	Advanced	22	59.41
	Expert	5	72.50
	Total	88	
The open nature of blockchain technology makes BETS better than other tracking systems.	No Knowledge	23	38.65
	Basic	30	43.27
	Moderate	8	50.25
	Advanced	22	44.84
	Expert	5	68.10
	Total	88	
The anonymity of blockchain technology makes BETS better than other tracking systems.	No Knowledge	23	20.33
	Basic	30	41.18
	Moderate	8	61.56
	Advanced	22	60.36
	Expert	5	78.50
	Total	88	

7.2.2. Rank Table of Kruskal-Wallis Test for Food Quality

Ranks

		N	Mean Rank
Food products that have BETS are moer healthy than other products.	No Knowledge	23	31.26
	Basic	30	43.13
	Moderate	8	49.88
	Advanced	22	54.39
	Expert	5	61.50
	Total	88	
Food products with BETS have a more trustworthy known origin than other products.	No Knowledge	23	19.22
	Basic	30	38.55
	Moderate	8	63.38
	Advanced	22	67.59
	Expert	5	64.70
	Total	88	
Food products that have BETS are more expensive than other products.	No Knowledge	23	62.26
	Basic	30	56.70
	Moderate	8	28.63
	Advanced	22	18.36
	Expert	5	30.00
	Total	88	
Food products that have BETS are of a better quality than other products.	No Knowledge	23	29.70
	Basic	30	51.45
	Moderate	8	59.38
	Advanced	22	42.39
	Expert	5	56.40
	Total	88	
Food pruducts that have BETS are more environmentaly friendly than other products.	No Knowledge	23	27.54
	Basic	30	52.08
	Moderate	8	62.06
	Advanced	22	43.82
	Expert	5	51.90
	Total	88	
Food products that have BETS consist of higher animal welfare compared to other products.	No Knowledge	23	25.59
	Basic	30	53.13
	Moderate	8	55.63
	Advanced	22	46.61
	Expert	5	52.60
	Total	88	
Food products that have BETS are overall safer than other products.	No Knowledge	23	20.61
	Basic	30	39.02
	Moderate	8	61.88
	Advanced	22	64.50
	Expert	5	71.50
	Total	88	

7.2.3. Rank Table of Mann-Whitney Test for Acceptance & Intention

Ranks

		N	Mean Rank	Sum of Ranks
A user-friendly interface where I could easily investigate the origin of the product would be highly benefitial for food safety.	No	22	40.98	901.50
	Yes	66	45.67	3014.50
	Total	88		
The response time and reliability of the tracking system are important factors that affect my intention to use BETS.	No	22	41.77	919.00
	Yes	66	45.41	2997.00
	Total	88		
The quality and level of detail in the information provided are decisive factors in my intention to use BETS.	No	22	36.23	797.00
	Yes	66	47.26	3119.00
	Total	88		
The accuracy and the transparency of the information provided are decisive factors in my intention to use BETS.	No	22	41.41	911.00
	Yes	66	45.53	3005.00
	Total	88		
The overall traceability and tansparency of the system are decisive factors in my intoention to use BETS.	No	22	39.14	861.00
	Yes	66	46.29	3055.00
	Total	88		
The integrity and benevolence of the system are decisive factors in my intention to use BETS.	No	22	40.32	887.00
	Yes	66	45.89	3029.00
	Total	88		

Ranks

		N	Mean Rank	Sum of Ranks
A user-friendly interface where I could easily investigate the origin of the product would be highly benefitial for food safety.	No	4	28.88	115.50
	Yes	84	45.24	3800.50
	Total	88		
The response time and reliability of the tracking system are important factors that affect my intention to use BETS.	No	4	28.75	115.00
	Yes	84	45.25	3801.00
	Total	88		
The quality and level of detail in the information provided are decisive factors in my intention to use BETS.	No	4	17.13	68.50
	Yes	84	45.80	3847.50
	Total	88		
The accuracy and the transparency of the information provided are decisive factors in my intention to use BETS.	No	4	26.38	105.50
	Yes	84	45.36	3810.50
	Total	88		
The overall traceability and tansparency of the system are decisive factors in my intoention to use BETS.	No	4	49.38	197.50
	Yes	84	44.27	3718.50
	Total	88		
The integrity and benevolence of the system are decisive factors in my intention to use BETS.	No	4	38.13	152.50
	Yes	84	44.80	3763.50
	Total	88		