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A case study.”

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“The use of Blockchain in Agro-food Supply Chain and its impact on consumers’ trust;

A case study.”

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Abstract

The agricultural products are part of the daily life of most of consumers, thus their trust on what they are consuming is essential. Nowadays, we see that more and more the consumers are prioritizing the sustainable and ethically produced products, the need of traceability is becoming more and more popular. The blockchain technology can help to enhance the supply chain tracking, efficiency and transparency.

Blockchain is one of the fastest growing emerging technologies in the world. The complexity of supply chains due to the globalization of the market has brought new needs. One of them is the need of transparency and visibility across the supply chain. The blockchain technologies target on providing a solution on this challenge.

This thesis will examine the use of advanced technology in the food supply chain.

Keywords

- Blockchain
- Agrofood sector
- Consumers trust
- Supply Chain
- Food Supply Chain
- Technologies in agrifood

Μεταπτυχιακή Διπλωματική Εργασία: Η χρήση της τεχνολογίας Blockchain στην Εφοδιαστική Αλυσίδα και ο αντίκτυπος της στην εμπιστοσύνη των καταναλωτών. Μια μελέτη περίπτωσης.

Όνομα συγγραφέα: Θεοδώρα Αγαδέλλη

Περίληψη

Τα αγροτικά προϊόντα αποτελούν μέρος της καθημερινότητας των περισσότερων καταναλωτών, επομένως η εμπιστοσύνη τους σε αυτά που καταναλώνουν είναι απαραίτητη. Στις μέρες μας, βλέπουμε ότι όλο και περισσότερο οι καταναλωτές δίνουν προτεραιότητα στα αειφόρα και ηθικά παραγόμενα προϊόντα, η ανάγκη ιχνηλασιμότητας γίνεται όλο και πιο δημοφιλής. Η τεχνολογία blockchain μπορεί να βοηθήσει στη βελτίωση της παρακολούθησης της εφοδιαστικής αλυσίδας, της αποτελεσματικότητας και της διαφάνειας.

Το Blockchain είναι μια από τις ταχύτερα αναπτυσσόμενες αναδυόμενες τεχνολογίες στον κόσμο. Η πολυπλοκότητα των αλυσίδων εφοδιασμού λόγω της παγκοσμιοποίησης της αγοράς έχει φέρει νέες ανάγκες. Μια από αυτές είναι η ανάγκη για διαφάνεια και ορατότητα σε όλη την αλυσίδα εφοδιασμού. Οι τεχνολογίες blockchain στοχεύουν στην παροχή λύσης σε αυτήν την πρόκληση.

Η παρούσα διπλωματική εργασία θα εξετάσει τη χρήση προηγμένης τεχνολογίας στην αλυσίδα εφοδιασμού τροφίμων.

Λέξεις – Κλειδιά

- Blockchain
- Αγροδιατροφικός τομέας
- Εμπιστοσύνη καταναλωτών
- Εφοδιαστική αλυσίδα
- Εφοδιαστική αλυσίδα τροφίμων
- Τεχνολογίες στα αγροδιατροφικά προϊόντα

Table of Contents

Abstract v
Περίληψη vi
Table of Contents vii
1. Chapter 1: Introduction 1
1.1 Introduction - Importance of the subject 1
1.2 Structure of the dissertation 2
1.3 Methodology 2
1.4 Aim 2
2. Chapter 2 : Blockchain 3
2.1 Blockchain Definition 3
2.2 Blockchain history 4
2.3 Technological architecture 5
2.4 Blockchain applications 6
2.5 Opportunities and threats using blockchain 8
3. Chapter 3: Agrofood 10
3.1 Agrofood Definition 10
3.2 The market of Agrofood 11
3.3 Technology used in Agrifood 12
3.4 Transparency in agrifood supply chain 13
3.5 Agrofood and sustainability 14
4. Chapter 4 : Consumer Trust 17
4.1 Consumer Trust: Definition and evolution of the term 17
4.2 Consumer Trust and technology 18
4.3 Consumer Trust and agrofood 21
5. Chapter 5 : Methodology 24
5.1 Methodological choices and research tool 24
5.2 Research ethics 24
5.2 Sample and sample strategy 25
6. Chapter 6 : Interviews and Discussion 26
6.1 Interviews to consumers 26
6.1.1 Consumer 1 26
6.1.2 Consumer 2 28
6.1.3 Consumer 3 30
6.1.4 Consumer 4 31
6.1.5 Consumer 5 33
6.1.6 Consumer 6 34
6.1.7 Consumer 7 36
6.1.8 Consumer 8 37
6.2 Interviews to food industry experts 38
6.2.1 Food Industry Expert 1 38
6.2.2 Food Industry Expert 2 40
6.2.3 Food Industry Expert 3 41
6.2.4 Food Industry Expert 4 42

6.2.5 Food Industry Expert 5....44
6.2.6 Food Industry Expert 6....46
6.2.7 Food Industry Expert 7....47
6.3 Interviews discussion....48
7. Chapter 7 : Conclusions....54
7.1 Conclusions....54
7.1 Limitations of the research & Suggestions for further research....56
References....57

1. Chapter 1: Introduction

1.1 Introduction - Importance of the subject

Food Supply Chain is constantly growing through the last decade. This is obvious in all markets all over the world. Everything that we are using in our daily lives are part of this chain. It can be quite complex, but very interesting and important/vital for the international trade. For each product there is a unique path to be followed from its birth to its consumption. Sometimes we are aware of its origin, but usually we are ignorant.

In a supply chain we have different parties with interests, which can be competing sometimes. In the beginning of the chain we have the farmer that has his land, then there are the industrial / packaging companies, the distributors, the retailers, HORECA companies. All of them have one same target which are the revenues. On the other side, at the end of the chain, we have the consumers whose interest focus on safety and quality of the products that they are purchasing (Lobb, 2005).

In this long process, there are many challenges. For instance, there is a difficulty of tracking provenance from the side of importers, to understand the place of origin, ingredients, and the quality of the imported products (Habashneh et al,2024). Furthermore, since the products move between multiple stakeholders the ownership or custodian information becomes difficult to trace. Overall, stakeholders lack transparency in this process and lose track of relevant transactions.

In order to tackle these challenges, we use the technology of blockchain. Any activity can be documented and stored in the distributed ledger available among all participating stakeholders, thus making the network more trustworthy than any other individual entity. Untrusted stakeholders can transact amongst each other through smart contracts without the need for a centralized body, since every stakeholder will have their own copy of the same distributed ledger that enables information access in real time (Al-Amin et al,2020).

Innovative technologies can help us make our agrifood systems become more efficient, inclusive, resilient and sustainable. Blockchain is a shared and decentralized database that, unlike traditional databases, uses a digital ledger that is simultaneously duplicated and distributed across a network of nodes on computers or servers (Monrat, et al 2019).

The Food and Agriculture Organization (FAO) of the United Nations is already using blockchain technology to ensure transparency, traceability and sustainability of food commodities.

1.2 Structure of the dissertation

The second chapter of this thesis explains the definition of blockchain, states its technological architecture, shows blockchain applications and reports both opportunities and threats while using blockchain technology. The next chapter contains information about the agrifood; its definition, the market of agrifood, the technology used in agrifood, the transparency in agrifood supply chain and the relation between agrifood and sustainability. The fourth chapter deals with the consumer trust. It is described the definition of the term, the correlation of consumer trust and technology, as well as the link between consumer trust and agrifood.

1.3 Methodology

The methodology used for this thesis is following quantitative methods. In the chapter number six are presented fifteen interviews that were conducted to consumers and food industry experts. More specifically, the questions that were addressed are related to their opinion for agrifood products, the frequency of their consumption, the trust that they have about the available food in the market, their point of view about sustainability in the agrifood market, the use of technology in agriculture, the importance of traceability of food through technology, and last but not least, they were asked about their knowledge of blockchain.

1.4 Aim

The aim of this thesis is to share knowledge about the benefits of blockchain technology use in the agri-food supply chain and its impact on consumers' trust. This is carried out by reflecting the theory in combination with research through the interviews.

2. Chapter 2 : Blockchain

2.1 Blockchain Definition

Blockchain can be described as a collection of records linked with each other, strongly resistant to alternation and protected using cryptography. Blockchain is a system in which a record of transactions is maintained across computers that are linked in a peer-to-peer network. It is an advanced technology that allows transparent information sharing without a business network. A blockchain database stores data in blocks that are linked together with a chain. In other words, it is a distributed digital ledger of cryptographically based transactions that are grouped into blocks. Each block is linked to the previous one (Lafourcade, P. and Lombard-Platet, M., 2020).

There are three special features that differentiate it from other distributed ledger technologies; anonymity, immutability and transparency. It is important to note that only once these three features are merged together, the blockchain can be effective and unique. This technology is open to anonymous users, which allows blockchains to preserve users privacy. Also, since it depends on a strong distributed consensus protocol, making the blockchain immutable, it protects from alteration attacks through strong and complex encryption algorithms, releases the system from centralized trusted authorities such as banks and allows entirely transparent validation by preserving full and public history of transactions (Monrat, et al 2019).

The blockchain became famous with the arrival of the Bitcoin cryptocurrency, which is undeniably a very successful blockchain application. The characteristics of blockchain technology, the decentralization, the protection of users privacy, the endurance to cyberattacks, attracted the attention of many different groups of interest. According to Ghiro, Lorenzo, et al. (2021) this led to the expansion of the application of blockchain technology to Supply Chain Management, Healthcare, Banking, E-Voting, Smart Grid, Smart Cities, Vehicular and Aerial Networks. It has been spreading out to many expressions of the Internet of Things (IoT), which makes it a universal technology (Upadhyay, 2020).

2.2 Blockchain history

Many would consider that blockchain started from the release of Satoshi Nakamoto's Bitcoin paper (2008), however bitcoin is built on earlier works which is often overlooked. The history of blockchain dates back to the early 1990s when Dr. Stuart Haber and W. Scott Stornetta started working on a method to timestamp a digital document which could be used for authentication. The original paper "How to time-stamp a digital document" was published in 1991. It showed how the various elements of a timestamp verification system would work in many ways. The main objective was to implement a system wherein document timestamps could not be tampered with. This work introduced the idea of chain to hashes to interlink documents with essentially everyone as witness. In 1993, Dave Bayer, Stuart Haber and W. Scott Stornetta in their paper "Improving the Efficiency and Reliability of Digital Time-Stamping" they upgraded their system to incorporate Merkle Trees that enhanced efficiency thereby enabling the collection of more documents on a single block. In fact the concept of Merkle Tree introduces the reduction of the storage and computation required. Their works later on became a key part of the bitcoin white paper, as well as the software that powers bitcoin blockchain.

On October 31st 2008, the Bitcoin Whitepaper was published under an anonymous name Satoshi Nakamoto. It wasn't until January 2009 that Nakamoto launched the bitcoin network and mined the first block, which is also called the "genesis block". Nakamoto publicly announced the bitcoin project through the P2P foundation forum in February 2009 writing the introductory post "Bitcoin open-source implementation of P2P currency", which emphasized the importance of having a decentralized and trustless monetary system. The receiver of the first bitcoin transaction was Hal Finney, who developed the "Reusable Proofs of Work" with a paper that was published in 2004.

In 2010 Nakamoto handed the network alert key and control of the code repository over to Gavin Anderson before disappearing (Dwyer, G. P. 2015). The "Bitcoin Foundation" page was later created in September 2012 to promote bitcoin's development and uptake, in order to bring back the reputation of bitcoin after several scandals. It focused on standardizing, protecting and promoting bitcoins.

In 2013 a young programmer by the name Vitalik Buterin, published the "Ethereum White paper" that described a way to build decentralized applications. His idea got the attention of a few scholars who later on became a part of the long list of founders alongside Vitalik (Halaburda,et al 2021). Formal development of the software underlying Ethereum began early 2014 through a Swiss company called Ethereum Switzerland GmbH. Subsequently a Swiss non-profit foundation called the Ethereum Foundation was created. Development was funded by an online public crowd sale in which participants bought the Ethereum value token with another digital currency bitcoin. In July 2015 the Ethereum platform was officially launched and created its genesis block. Subsequently a Decentralized Autonomous Organization (El Faqir et al, 2020) called the DAO which is essentially a set of smart contracts was developed in 2016 on the platform. The project managed to raise a record of $150 million USD in a crowd sale to fund it. Unfortunately, the DAO was exploited in June 2016 when $50 million USD of DAO tokens were stolen by an anonymous hacker. This led to a split within the Ethereum community, into two blockchains which are now the Ethereum and the Ethereum Classic.

According to CNBC, in February 2021 bitcoin first hit the 1 trillion market capitalization milestone and was traded at around $53.000 per bitcoin (Pound, 2021). Further to that, in February 2024 the bitcoin market cap surpassed the 1 trillion dollars, while the investors overload the market (Alun, 2024). Although bitcoin is considered as one of the most revolutionary technologies, some developments believe that bitcoin was not quite there yet.

2.3 Technological architecture

Blockchain technology has made a significant impact in recent years through its fast-paced development and widespread adoption. Although currently the market seems to be a downturn trajectory, many believe that the blockchain industry will continue to thrive in the coming years.

The interesting thing about blockchain technology is that it is the by-product of the Bitcoin invention. Blockchain technology was created by fusing already existing technologies like cryptography, proof of work and decentralized network architecture together, in order to

create a system that can reach decisions without a central authority. There was no such thing as "blockchain technology" before Bitcoin was invented. But once Bitcoin became a reality, people started noticing how and why it works. Blockchain is to Bitcoin what the internet is to email; a system on top of which you can build applications and programs.

Blockchain's data architecture uses same structures as Python, SQLite, and REST ful API. The approved customer transaction record encrypts the information by using its private key and uploads it to the Blockchain database API. The data will be decrypted by using the private key from the Blockchain database API and strengthens the user authentication (Hasan, I. , Habib, M., et al, 2023). The Blockchain database API computes hash value with nonce till the next phase for any illegal change, and it is known as random string. The changes that happened in the API can be considerable and also guarantee the way the data are integrated.

The performance characteristics (e.g security, privacy, scalability, sustainability) and the system supported by evaluating the blockchain as a software link to determine the structural factors that are explicitly necessary and additionally, integrating blockchain as a software link together with the development of performance characteristics (Akram et al, 2020).

2.4 Blockchain applications

Blockchain has developed into one of the most prominent ground-breaking technologies over the last decade. It is already impacting so many industries; banking, finance, manufacturing, education, energy, etc. By 2014 people started to realize that there was more to Blockchain than just Bitcoin. Entrepreneurs began to put in more investments to discover how Blockchain could impact other industries.

In simple terms, blockchain is a distributed database that everyone can get a copy of. Every person with a copy can add new records to this database but cannot change any record that is already in there. This property makes a blockchain great to record data in a transparent manner because everyone gets to see what is in it (Köhler, et al 2022). The most popular application is the cryptocurrencies. When Bitcoin launched in 2008, it allowed people to

directly transact with one another without having to trust third parties, like banks. Since then over 1600 different cryptocurrencies have been created.

One application is in the cars industry (Chen, et al 2018). By tampering with the odometer someone can make a car appear to be newer and less worn out, resulting in customers paying more than what the car is actually worth. The government tries to counter this by collecting the milage of cars when they get a safety inspection but that is not enough. This could create a secure and digital certificate for each car. Due to the blockchain, no one can tamper with the data and everyone can lookup at a vehicle's history.

Blockchains are great at keeping track of things over time. For example, you can keep track of things like intellectual property or patents or it can function as a notary (Maesa, et al 2020), by confirming or verifying signatures on legal documents. Blockchain can be applied to this case, by adding digital documents on the blockchain.

Another interesting application is digital voting. Voting on paper costs a lot of money and electronic voting has security issues (Monrat, et al 2019). In recent years, we have even seen countries move away from digital voting and adopting paper again, because they fear that electronic votes can be tampered with and influenced by hackers. But instead of paper, we could use blockchains to cast and store votes, because such system would be very transparent as everyone could verify the voting count for themselves and would make tampering with it very difficult.

Blockchain technology can be used to track food products from the moment they are harvested or made to the moment they end up in the hands of the customers (Maesa, et al 2020). Almost half of million people die every year because of food-borne diseases and that's partially because it takes too long to isolate the food that is causing harm. Blockchains could help us to create digital certificate for each piece of food, proving where it came from and where it has been. So, if a contamination is detected, we can trace it back to its roots and instantly notify other people who bought the same batch of bad food. Walmart and IBM launched in 2017 a blockchain food safety system (Castillo 2016). This allowed them to trace the origin of a box of mangoes in just two seconds, compared to days or weeks with a traditional system.

Additionally, blockchain can be applied in tracking packages and shipments. That is something that IBM and MAERSK (van Kralingen, 2018) have developed together; a

decentralized ledger to help making global trade of goods more efficient. Their synergy aimed of beefing up the supply chain visibility, since there were many gaps on the existent procedures. The information could easily get lost, as many stakeholders are involved in the supply chain process. For example, blockchain helps to avoid delays due to customs procedures, and offer better visibility on container tracking and shipping documents along the chain.

Blockchains can be even more powerful, when we add smart contracts to them. These contracts are tiny computer programs that live on the blockchain and can perform actions when certain conditions are met. Insurance companies could use smart contracts to validate claims and calculate a payout (Chen, et al 2018). They can also allow us to only pay for car insurance when we are driving, by counting the kilometers driven.

With smart contracts we can secure our own data on a blockchain. They could for instance allow us to store medical records on a blockchain and only allow doctors to access them, when we approve it with a digital signature. In the same way, you could store your personal identity on there and choose what data you want to reveal (Chen, et al 2018).

2.5 Opportunities and threats using blockchain

With the use of blockchain the companies can benefit from the reduction of costs. The characteristics of blockchain are identified as synonymous with automation and transformation. The middle-men services, which are usually very costly, are eliminated.

The blockchain can be beneficial in the business sector by improving efficiency, personalized services, efficient delivery service, increased transparency, improved transactional efficiency, reduction of fraud, boost of innovation and development of new business models (Marr, B. 2021).

Further in finance, it increases the resilience of systems and data storage thanks to its nature, it establishes trust and transparency. In regard to the security, the tracking of deployment and usage of the user's software in a secure and tamper-resistant manner is a big advantage.

It is worth noting that the blockchain opportunities are remarkable as well in healthcare, supply chain, Internet of Things, education, government and energy (Monrat, et al 2019).

There is space for cost-effective, transparent, efficient and reliable projects, while using the blockchain technology.

On the other side, there are many blockchain adoption challenges. To begin with, there is high energy consumption. This is a major concern and the countries that are more involved with mining of bitcoins are facing serious problems. The computers that mine the process of proof-of-work to implement the blockchain transactions, are consuming tremendous load of energy. Also, its yearly production of carbon dioxide is remarkable and the carbon footprint is affecting negatively the society and our planet.

Since the adoption of blockchain technology is becoming more popular in different industries, it is deemed necessary the standardization of processes. This would benefit the firms to cooperate and harmonize their activities with existing systems. In spite of the fact that, the lack of interoperability allows the development of coding in different platforms, the blockchain networks are not interconnected but isolated. This situation is affecting the rise of blockchain.

Another challenge, according to Monrat et al (2019), is the scalability. As the blockchain is growing, there are increasing needs in the capacity and performance of transactions. There is a big amount of transactions, required time and complexity in the networks. Taking that into account, it is very important to tackle possible delays due to new technologies, understand and fix them in order to optimize the procedure.

Although, blockchain is assumed to be a safe technology, there are many concerns regarding its security(Upadhyay, 2020). On one point, it is widespread that can provide privacy and anonymity to the users, while on the other side, there are claims that the identity of users can be revealed through the links. Also, there are security issues such as the centralization of information, the flash loan attacks, coding loopholes (Alamsyah, et al 2024). During the last years, it was reported that hackers managed to succeed 51% attacks to blockchain networks, since decentralized blockchains are more vulnerable compared to centralized ones (Gogo, 2020).

3. Chapter 3: Agrofood

3.1 Agrofood Definition

Agrofood is the food produced as a result of agriculture. Within agrifood systems, food systems include all food products that come from crop and livestock production, forestry, fisheries and aquaculture, as well as from other sources such as synthetic biology, that are predestined for human consumption. Agrofood systems are a set of systems that are interlinked. Farming, harvesting, fishing, livestock rearing, storing, processing, transporting, selling, buying, eating and disposing of our food are all part of these complex systems (Ketels, C., & Protsiv, S. (2017).

Agrifood systems are at the heart of our society. They affect our health, our wellbeing, the landscapes we live in and our planet. They represent a complex set of interactions between all people involved in and their environment. Our systems are encountering many challenges, they struggle to provide inclusive growth, a decent livelihood, and adequate nutrition for all, while preserving the environment. A rapid transformation is needed if we are to achieve the Sustainable Development Goals of the United Nations (2023).

In an attempt to improve agrifood systems, FAO (Food and Agricultural Organization of the United Nations), the European Union and CIRAD (Agricultural Research for Development) have partnered with national governments to conduct local assessments in over 50 countries as a first step. Taking a systematic approach means that they look into things that help nutrition, education and put them all into agriculture. The initiative brought together key players from not only the private and public sectors but also from civil society, to take into account the wide range of viewpoints through series of unprecedented consultations, organized online, hybrid or in person.

Despite a huge agricultural biodiversity, for example, Madagascar currently is facing important challenges in feeding its 28 million population both in quantity and quality of food. Beyond these trends, there is the country's vulnerability to climate change together with population growth (Laborde et al, 2023).

3.2 The market of Agrofood

Food system assessment carried out in 2020 allowed the identification of five main intervention areas: managing soil fertility, investing in infrastructures, strengthening proximity advisory services, increasing decentralization and supporting inclusive and fair value chains (FAO, 2024).

One example is Peru, which is among the top ten countries with the greatest biological diversity in the world. There are great challenges to preserve it (Laborde et al, 2023). In the context of food systems evaluations, a series of dynamics have been identified that must be addressed in order to ensure its sustainability. The methodology applies a systemic approach and is centered around key questions related to the sustainability of the system. The aim is to understand the interactions between sectors and players and identify the needed policies and investments for future change. Food security is all about a multisectoral action, it also links to many other elements such as marketing, nutrition, etc.

There will be no sustainable development without a profound transformation of agrifood systems. We need food and nutrition security for all, more effective production and less waste, a preserved environment, decent livelihoods for all and more equity between agrifood systems actors and territories. We are all connected globally. Together we can identify and put into place innovative policies and investments.

Agrofood value chains connect important and diverse sectors of the economy including agriculture, the production and processing of agricultural commodities and foods and the distribution sector. Agrofood value chains play an important role for economic growth, social and environmental wellbeing, as well as for the health of citizens. Modern agrifood value chains face many challenges. These include globalization, climate change, quickly evolving consumer preference, as well as organizational challenges. These challenges put a lot of pressure to increase quality throughout all stages from production, processing and the distribution of food and agricultural products.

3.3 Technology used in Agrifood

Agri food is responsible for 21 to 37 % of all the global greenhouse gas emissions (United Nations, 2024). There have been researches from several universities including the University of Lincoln that aim to develop new technologies in order to deal with those emissions (University of Lincoln, 2024). For example, focusing on developing lightweight robotic vehicles powered by renewable energy instead of fossil fuels, machines which can wander around fields. Also, identifying pests and diseases, dealing with them in real time without using synthetic pesticides. Meantime, they are using AI to help farmers make better decisions, reduce food waste which will hopefully make a significant contribution to reducing the impact of agrifood system on our climate.

One of the big problems that they are trying to solve by longterm autonomy and robots is the problem of food waste. Farmers need very accurate predictions of when the fruit is right, when it should be harvested and when they want to get it into the market. Machine learning techniques, AI and robotics can be used to make better predictions, so that we cut food waste and therefore have a positive impact on the carbon reduction. The ultimate goal is to move towards a fully automated software production, that means replacing carbon intensive workflows at the farms, all with electrical vehicles that can operate on their own.

The current ways of producing food rely on wide scale application of pesticides, this approach however is unsustainable due to unprecedented pressures. The robotic technology doesn't rely on spraying chemicals, their computer vision systems are able to identify individual beats and the robot is able to eradicate individual plants, whilst the navigation system is controlling the robot carrying UV light which is destroying powdery mildew in plants. The research team of University of Linkoln (2024) is working towards a direction of improving that technology so that it can work with any type of disease in different crops and in different fields. Another project that they are looking at is on biofuels, which are an alternative to fossil fuels, like gas and coal and these are just plants that we burn for electricity.

3.4 Transparency in agrifood supply chain

Agriculture is one of the most essential industries, since its output affects the national economy, food security and public health. The environmental, social and economic effects of food consumption are becoming more and more known (Hasan, Ikram, et al,2023). This is leading some groups of consumers, activists, agribusiness, and governments to focus on the necessity of sustainable supply chains. There are major concerns about the agrifood supply chain as a result of current consumption routines and the constant increasing population.

Consumers are nowadays really interested in knowing how the food ingredients and products are produced. In our days, the production process is not completely transparent therefore the food alternation is a big concern. For instance, the oils and honeys are the most common alternated foods that consumers are buying unknowingly (J. Astill, et al,2019). Additionally, there are industries that are widely at the mercy of fraud such as the seafood industry. Oceana recently reported that 44% of sampled seafood products were mislabeled in Canada. Generally, there is a major concern about the accuracy of labeled seafood, since many kinds of fish are grouped together under one label, so the consumers are far behind the truth regarding the seafood products which they buy. More specifically, in Europe it has been reported that 7% of tuna fish products were mislabeled.

Another case that caused a huge scandal was the food fraud when horse meat was discovered in multiple ground beef products in Europe. This had as consequence a decrease in sales and consumption of red meat and a general fear in the public. The lack of transparency is also leading to serious health problems. In 2014, melamine contaminated milk powder had as a result to 300.000 newborns becoming sick and six deaths in China (Huang, 2014). After this case, the Chinese government established new regulations for food additives, and rang a bell that the food production systems require a high transparency.

The agrifood supply chain is a very profitable industry globally. This is the reason why the food unsafety is on the central point of many discussions. There have been officially announced many food recalls around the world with consequence costs to many parties. Taking into account that the complexity of supply chains is huge, it is critical to find ways to increase visibility and transparency (Köhler, et al 2022). The end-to-end traceability cannot be achieved by the current systems and methods. This is where blockchain

technology can support and give the solution to this topic. With the use of blockchain technology, the consumers will be able to track in real time the origin of their food and the whole process from the farmers to distribution companies will be monitored.

3.5 Agrofood and sustainability

To compete in agribusiness, it is vital to master a variety of economic issues affecting the competitiveness and the sustainability of the other food sector. Sustainability can work as a competitive advantage through corporate social responsibility. Firms in the agrifood sector engage in relationships with their partners along the value chain. The type of relationship depends on many factors, including bargaining power, market power and the long-term goals of the individual sector.

It is worth mentioning that three targets of the Sustainable Development Goal (SDG) 2 "Zero Hunger" for the 2030 Agenda for Sustainable Development of the United Nations involve agri-food markets and their modes (United Nations, 2024).

Since the 1950s, agricultural production has grown exponentially thanks to the exploitation of high yielding crops, synthetic fertilizers, pesticides, and agricultural machinery. These innovations have drastically altered what some consider should otherwise be an inherently regenerative industry being food part of nature. Today the amount of energy required to sustain our diets is astonishing as well as the amount of food that gets thrown away together with the plastic that contains it.

A vast amount of finite resources is extracted from the earth; 41 rock minerals and elements serve the five major agricultural uses which include fertilizers, pesticides, herbicides and fungicides physical soil amendments. Animal and poultry feeds, food storage and processing make most agricultural activities powered by fossil fuels and plagued by an inefficient utilization of inputs that escalates even further the requirement of natural resources. Furthermore, water pollution is another major challenge deeply aggravated by the poor management of byproducts generated during food processing, distribution and packaging waste.

According to researches, Europe alone generates around 700 million tons of agrifood waste annually. That is approximately one-third of what is produced for human consumption. From this waste, only 2% of valuable biological nutrients in food byproducts and organic waste is composted or otherwise valorized. While a significant portion of the rust is often released untreated damaging the environment and threatening life.

It is believed that sustainability transitions in agro-food systems influence either positively or negatively the food availability/supply, the food affordability/economic accessibility, food utilization and/or agro-food system stability and resilience (Borsellino etc 2020). There are discussions about the link of food security with the agro-food system sustainability and the role of innovation in agriculture and food systems. In order to solve the problems of food insecurity and the malnutrition, more environmentally friendly forms of agriculture are taking the stage, such as organic agriculture. According to Garnett (2014), there are three wide aspects that can achieve at the same time food system sustainability and food security; efficiency increase (i.e. sustainable intensification, demand restraint (i.e. sustainable diets) and food system transformation (i.e. alternative food systems).

Taking into account the positive demographic trend, there are concerns about the stability of the food supply in the future. The growing food demand is increasing the challenges of the agro-ecosystem as well as the agro-food sustainability system. Towards that direction, the concept of "sustainable intensification" refers to a strategy that targets to improve productivity and environmental sustainability, which can be achieved by increasing diversity in cropping systems or ecosystem-based strategies (Sgroi, 2022).

Furthermore, the transition towards sustainability includes "sustainable diets", that are becoming a trend. People that change their diets to low-calorie, plant-based is said that can impact both their health and environment positively.

The food transformation system assumes that the market-driven relations in the food market system should change. For example, the farmers' markets, pick up on your own from the farm, community-supported agriculture are a few of the initiatives that can bring the change and increase sustainability, by mostly the reduction of food waste. Also, other advantage can be the reduction of greenhouse gas emissions while providing ecological, health and socio-economic benefits.

The latest years, the contribution of different factors have led to changes in the structure of agrifood markets globally. Since currently there is no sustainability on the agro-food production, processing, distribution and consumption models, it is critical for the society to change towards a more sustainable agriculture and food systems that can serve better the growing global population and ensure safe, nutritious food for all.

Nowadays, agrifood sustainability is a controversial topic on social media. Social media have brought new roles and new rules in the world (TM Stevens, N Aarts, CJAM Termeer and A Dewulf, 2016), since people are interacting with these applications on daily basis. Retailers promote their products traditionally and interact with customers to control the discussion about food and sustainability. Consumers, on the other hand, express their concerns about food safety, transparency and sustainability. Farmers use social media to engage with the consumers, voice their opinions and be open to online discussions.

Media advertising can influence public opinion and impact the agro-food systems. Topics such as the food scandal of salmonella in 2012 and the food scandal of horse-meat adulteration in 2013 were displayed a lot on social media and got the attention of the people, while increasing the concern of our food safety (Stevens, et al 2016). The dynamics of social media interaction are likely to encourage hypes on sustainability topics. This is the moment when influencers can shape the information flows and influence a large amount of consumers.

Social media seem to have played an important role in connecting people and ideas in the "food movements". The idea behind this is the alternative food, which is the opponent of the industrial food system. There are many ways how the social media is supporting these movements. There are individuals, networks, foodies, nutritionists, experts, fitness supporters that promote through their lifestyle and public daily view of their lives the sustainable food and nutrition. The food movements (fair-trades, organic local) promote the connection between the consumer and the producer, while emphasizing on the social and environmental origins of the food.

4. Chapter 4 : Consumer Trust

4.1 Consumer Trust: Definition and evolution of the term

Consumer trust is the belief or faith that a consumer has in a business with regard to doing what they say they will do and living up to their commitments. The consumer trust is not given, but it has to be earned over time. It is critical to a company's success, since it drives loyalty, which is vital to sales, continuous purchasing and reputation. The faithful customers would recommend a company to others either by mouth to mouth or through online reviews, which can boost the sales of that company. Furthermore, satisfied customers would stick to a brand and/or company for years, that increases the long-term success and fosters the long-term relationships (Alhabeeb, 2007).

Trust has always been the centerpiece of many organizations. Without earning trust of the customers, earning trust of the associates, in turning trust of the vendors, companies would not be able to reach success that easily. It should be a part of the cultural mission to tell the customer the truth, willing to build a long-lasting relationship and not just pursuing sales. It is important to mention that a company should keep its associates in line with the company's values; the company should spend some time training the employees on how to deal with customers and teach them how to gain customers' trust. This can be a key competitive advantage, while offering the best client experience.

In today's economy, it is crucial to maintain consumer trust. But what is consumer trust? Trust is an important factor in many food purchasing decisions made by individuals. There are many different definitions of trust; as Petts (2008) suggests, much of the trust literature revolves around five dimensions originally discussed by Renn and Levine (1991): competence, objectivity, fairness, consistency and empathy (Hobbs et al, 2015). Dunning et al. (2012) show that social/emotional aspects of trust cannot be underestimated and clearly there is a future need to address this aspect of trust in affecting various decisions made at the level of individual.

Ross et al (2014) showed that trust was an important predictor of acceptance of water recycling, both directly and indirectly through reducing risk perceptions, while Siegrist et al (2008) showed that trust in the food industry was important in influencing acceptance of functional foods and foods affected by nanotechnology. Lang (2013) examined which actors the public trusts with respect to genetically modified foods, finding that trust across

organizations is quite fluctuating. Furthermore, Janssen and Hamm (2014) report the value of trust in the adoption of certain types of organic food labels. All the above emphasize the connection between trust and risk perceptions and indicate that trust might be used in cases where lack of knowledge, experience or familiarity with firms, products and brands exist. Lack of trust in people or organizations could impact adoption of new technologies and obstruct changes in behavior that otherwise be beneficial (Hobbs et al, 2015).

The consumer trust is very important for the business growth for many reasons. First of all, the company can deliver better customer experience, once the consumer trusts the company. As soon as you gain their trust, you can have access to customer data, in order to build personalized experiences for each consumer. In addition to that, the consumer trust increases loyalty. If the consumer is determined that the company is providing the best experience possible, then they will spread the positive feedback.

4.2 Consumer Trust and technology

In a world where winning customer trust is harder than ever, how do brands find their balance between technology and human emotion? According to Zander Lurie, ex-CEO of SurveyMonkey (2019), winning trust is a crucial balance between technology and human emotion. People want to interact with brands they trust, 89% of consumers trust the new brand they are purchasing from for the first time at least a little. The difference in business, if you compare it with few decades ago, is how much technology has entered our world today. Artificial intelligence, algorithms, targeted advertising, chatbots, etc. There is a lot more machinery involved with the purchases we make, but we as human beings want to be treated as such unique.

Nowadays, technology has enabled us to scale fast and launch more advertising campaigns. We are watching hundreds of online ads daily and most people believe that marketing is selling what they don't want or need. Technology continues to open up new marketing channels and opportunities. According to the SurveyMonkey Social Media Advertising and Use Study, September 2017, 91% of consumers notice ads "follow" them across social media platforms. The 52% feel watched by advertisers, 36% feel creeped out and 17% feel disgusted. Therefore, the companies have to think about their customers and how do they

treat them. They should use technology wisely and not encircle the consumers with ads, that can be annoying and creepy. The reality is that the businesses can scale faster than ever now, but they can fail faster than ever, too, if they don't meet the needs of their customers. The balance is really sensitive.

Entire industries are facing a trust crisis today, and this is not related with the trust in technology industry. Technology faces every single industry we are in, such as banking, automotives, airlines, even traditional industries in a direction towards improvement and expansion of the businesses. Based on a survey in the U.S.A., Canada and the UK (SurveyMonkey / Global Consumer Trust Study, October 2018) regarding the reasons why consumers lose trust in a brand, they responded that either they have been watching offensive advertising, there was a leadership scandal, the customer service and/or product experience was poor, or there was a security breach.

The largest offence by far was the poor product experience and poor customer service. If the company goes global and serves millions of people, there is a need to staff up for success, because a subset of the consumers are not going to be happy with the product, or they might have questions about it, or they might want a refund since it didn't meet their needs. These people are online and have access to social media, they may write reviews about the brand or product. They can also tell their friends about it and rate poorly the brand if they were not happy about the product or service. The impact is huge in the trust that we have in a brand after an incident. Companies that are listening to the needs of consumers, tend to build trust and grow quickly.

In the web, if the information can be known, it will be known. The customers are going to go online and discuss, review and talk about the brand and customer service experience. According to SurveyMonkey / Audience Brand Trust Study, April 2018, the 82% trust the companies' customers more than the company itself. This is a great advantage for those who are launching products while listening to the needs of their audience. These companies are more likely to succeed and remain on the top. For big purchases, over a half of consumers prefer to do their own research by reading reviews or watching related videos on YouTube or talking to their friends or reading about the product in order to make a thoughtful considered purchase.

Top Fortune 500 Companies that care most about customers results in 2024 show that the company that had the most respect from customers and paid high attention to their customers was by far the Amazon (Jay, 2024). Other companies that rounded out the top three were Apple and Microsoft. The distinction was made due to the top-rated customer service, repeat business, fostering loyalty and efficient problem solving. Consistently in the survey it was cited that Amazon is a company that is treating the consumer like a human being, it is delivering on time, is meeting customer needs and largely delivering what you thought you would get. In addition to that, Amazon gives tremendous trust to its customers and is known for its no-questions-asked return policy. They are using innovative digital tools for convenient customer support, empowering customers, offering personalized engagement and ensuring that customer service is company's top priority.

Brands that deliver what they promise, continue to be rewarded through customer retention and customer referrals. In order to achieve that the main points that the companies should follow are; to treat customer relationships like their personal relationships; to listen at scale with tech, but respond fast with humans. It is fact that you cannot scale your company without technology but is the human being on the other end that is going to be satisfied or not with the services provided. Another important point is being present online. If there is no website, there is no trust, since customers cannot learn about the company, its values, its owners, etc. Also, people who had a negative experience may never purchase again, but most want to get a refund first. In that case you need to find out what went wrong and try to fix it, the customer needs to feel that the company is accountable.

There have been some surveys globally and the results are pretty consistent; less than half of all people say that they don't trust companies and 80% say that they don't trust advertising which is the voice of the companies. This is a real problem in the business sector, which is present for long time. It is believed that what companies say to us in advertising is different from how they really behave. However, in today's world that consumers have a way of sharing everything through internet and social media, we now have a way of sharing our experiences of brands and companies instantly and globally. By telling the truth, it is not just a cultural value, but after all it is smart business.

Technology has changed the way how we communicate, connect and collaborate. For consumers, it has developed the expectations of their interactions with brands they support. They want companies that can foresee their needs, understand them, and personalize their

experiences. For the business leaders, it matters how the customers can be satisfied through the use of technology. There are many new technologies that can help the delivery of continuous service, such as social media, artificial intelligence, even the use of mobiles. The customer experience is a constant process, that contains all interactions.

4.3 Consumer Trust and agrofood

Taking into account the amount of literature on trust decision making, much of which relates to how consumers react to new products, new processes, new technologies, new regulations related to the food system.

When you lack information behind any decision, trust is essential. The choices we make on the foods we eat are no exception. We cannot see the entire food network, so we rely on the trust we establish with different actors (farmers, manufacturers, retailers, government authorities) in this complex system. When we trust these actors, we are more confident in the foods we choose. This can help us embrace healthier and more sustainable diets.

Food scandals linked to safety and traceability have been making headlines for centuries. Distrust in food relates to not only food safety, but also to ethical and environmental concerns. Only 30% of European consumers trust that their food is produced in a sustainable way (EIT Food Trust Report, 2020). To create a future-fit food system, it is critical to work with consumers to increase transparency and provide healthy and sustainable food choices. Digital traceability can transform, empower and enhance consumer trust in the food system. Real time solutions that track supply chains can improve quality and reduce environmental footprint. Startups are already making progress to radically change the food system.

Many food producers are actually making concrete efforts to source locally and ethically. But what is missing is the tool to be able to gather all that information and to be able to showcase it to the consumer. While shopping for food, consumers can see a QR code on the package and use their smartphone to scan that QR code to access information about the whole food chain. Food safety is a big challenge, as it is highly complex. Everyday when you produce, you use raw materials from all over the world. You need to be absolutely sure of the quality and safety of these raw materials. Working in the food industry today is a huge

opportunity, but also a big responsibility for those who are involved in the process. By improving the safety, the quality, while feeding more people, we can have a big positive impact in our lifestyles. Digital traceability will help boost sustainability and build trust, leading to the future we want.

Consumer trust in the supply chain is really important both to the health and well-being of the consumers but also to the profits and well-being of food companies. There are communities such as the EIT Food, which is the European Institute of Innovation and Technology that are dedicated to make our food system more sustainable. The Consumer Trust Grand Challenge (2023) is working with consumers, food companies and other food supply chain stakeholders to implement and co-develop new initiatives to increase consumer trust in food. Their aim is to improve consumer trust by co-developing initiatives to increase trust in the food supply chain by working closely with food companies to implement these initiatives, to trial new innovative ways of increasing consumer trust.

The primary thing that needs to be done is better communication between consumers and actors in the food supply chain. Consumers want to see greater transparency in relation to ingredients of food, the providence of their food, how it's produced and to have faith that what they've been told by producers, that what they're eating in terms of the ingredients, or processing is actually true.

One of the initiatives involves an animal welfare application that is used by farmers and farm inspectors to assess the emotional wellbeing of the animals in the farm. This is a very innovative new initiative from which the farmers will pay more attention to the welfare of the animals and the consumers can be assured that those animals are happy animals and that their food comes from happy animals.

The downside of not having sufficient consumer trust in food and in the food supply chain is that consumers health and wellbeing will actually be lower than it would otherwise be, if consumers don't have trust in the food that they consume and don't trust the information that they're being given. Therefore, they're making decisions on a very poorly informed basis and that means that they won't be optimizing their food consumption either in terms of their enjoyment of food, the amount that they pay for the food that they eat, and their health and wellbeing in terms of the nutritional and other values of the food that they

purchase (de Jong, 2022). In addition to that, industry will feel the cost of a lack of trust, because those companies will feel it in terms of their profits and their sales.

The key is that consumers and food companies communicate to each other in the future through a variety of ways. The communication technologies and channels that we nowadays have with social media are much more advanced than they used to be years ago. Thus, there is no excuse for the food companies not to communicate with their customers and give them all the information that the consumers want to know about the food that they eat.

5. Chapter 5 : Methodology

5.1 Methodological choices and research tool

The methodology followed on this thesis is qualitative research. Since there was not enough audience; 150 specialists/employees that are working in food industry related sector, to conduct quantitative research with questionnaires. Therefore, interviews were conducted with a total of 15 participants, out of which 8 consumers and 7 food industry experts. The questions were divided into two different categories; first part is dedicated to the interviews of consumers and second part to the specialists in agrifood.

In the first part, there were seven questions addressed to consumers, which were related to their opinion about agricultural products, the frequency of their purchase, their trust in currently available food in the market. Also, the consumers were asked about their viewpoint of sustainability in the agrifood market, the use of technology in agrifood, the importance of tracing the origin and having traceability of their food through technology and last question was whether they are aware of blockchain or bitcoin.

Then, in the second part, the interviews were conducted to specialists and employees that are working in food industry related sector, who answered six questions. To begin with, they introduced themselves by specifying their occupation-profession. Next, they expressed their thoughts about digitalization of the agriculture, sustainability in the agri-food market, the use of technology in agrifood, the importance of tracing the origin and having traceability of their food through technology and last question is how the use of technology in the agricultural sector, according to their opinion, can improve the sustainability of agricultural products.

5.2 Research ethics

The sample of interview participants includes people from all genders, different ages, backgrounds, educational levels, so that we have a better overview in our research.

5.2 Sample and sample strategy

The interviews were conducted following research ethics, respecting the private data of the interviewers, who will stay anonymous. All their personal data will remain confidential.

The aim throughout the research interviews is to gather results that will be obtained from the answers to the relevant questions provided by the interviews to experts / employees that are working in food industry related sector. Also, the consumers who participate in the interviews will bring a holistic view of the impact of technology use on consumer's trust and attitude.

6. Chapter 6 : Interviews and Discussion

6.1 Interviews to consumers

6.1.1 Consumer 1

Question 1: What do you think about agricultural products?

I have a very positive view, I believe that the closer we are to the land and the agricultural products, the healthier life we have. What I like is, in most of the times, when we know the origin of the products, we can support the local economy and local producers. The agricultural products help in health, well-being, they have benefits and nutritional values. Raw materials contain the best nutrients and I prefer them in my diet, unlike processed products.

Question 2: How often are you buying /using them?

Regarding the agricultural products that I include in my diet, an important role plays the fact that my father is active in the production of cheese products (feta, yellow cheese, graviera, ladotiri,mitzithra) and other agricultural products such as eggs, potatoes, tomatoes, olive oil, olives etc that provides them to me at regular intervals and helps me to maintain a more balanced and healthy diet. I feel really lucky to have these benefits, even though that I live in Athens. In parallel, I buy oranges, apples and seasonal fruits from the flea market once every ten days. With regard to honey and wine, I go to various food fairs held in the area where I live, every two months and so, and I source from participating producers from different regions of Greece. Other products like bananas, kiwis, nuts, coffee, legumes, I buy once a week from the supermarket because I can't find them so easily in other markets. Concerning fish, I have the advantage that I come from a seaside area, and I know a few fishermen who supply me with fresh fish every month. Finally, as for the meat, I get it from a butcher in my neighborhood every week.

Question 3: Do you trust the food that is currently available in the market?

Not always. I am a person who is informed by the label of the product before proceeding with its purchase. I avoid processed foods, which often contain coloring substances and additives in general. I mostly trust products from local producers and the shops with local

traditional products. Also, in my daily life I choose to cook with healthy products, whose origin I know and I avoid many foods that exist in the market and in my opinion, have been prepared with substances that impact the aroma and taste, and can be often harmful to our health. For example, there are various products on the market that have additives to preserve them. One of these products are the frozen meatballs, ready to eat, which often, while they are tasty, do not offer to the consumer a healthy diet. In addition, various ready to eat snacks on the market, such as sandwiches and burgers, do not often meet the appropriate preservation conditions and can easily cause food poisoning.

Question 4: What do you think about sustainability in the agro-food market?

Now climate change is not helping and an important problem is that with the change of climate conditions in recent years, the production of agri-food has been affected dramatically. For example, the flood of Thessaly in September 2023 brought destruction to the production of the crops, which entails a rapid increase in prices on the shelves of stores. The state should provide farmers with financial support in the event of natural disasters with the aim of rebuilding agricultural systems. Additionally, the use of fertilizers and pesticides is harmful to health and therefore I prefer to buy organic products, such as organic fruits and vegetables and especially bananas, which I find tastier and I observe that they have longer shelf life.

Question 5: What is your opinion about technology use in agrifood?

The use of technology is only good. Thanks to it, you reduce the production time and you can achieve the production of more products with the use of modern machinery. Also, with the use of technology, you can collect more information about a product, and based on that you can choose it to buy it or not. For instance, the searching for organic foods has become easier online so that I can find the nearest store to get them. Nowadays most of the products have a QR code with which I can search for the company of the product, its origin, data on its nutritional value, suggested recipes, as well as participations in competitions.

Question 6: Have you heard about blockchain? If not, have you heard about bitcoin?

No. Only for the bitcoins, which I have heard that they are cryptocurrencies that you buy on the internet.

Question 7: Would you consider important to be able to trace the origin and have traceability of your food through technology?

I consider it very important. As I mentioned earlier, I like to source from local producers and it would help me in my daily life to choose the products that suit me in the easiest and fastest way. A food can have many raw materials from which it is derived, so you can reject a raw material that may cause you intolerance. I want to ensure that the food I will consume will contain nutrients. Another advantage of traceability is the identification of a pathogenic microorganism, which has infected me or another citizen, and facilitates the withdrawal of specific batches from the market to prevent the infection of more people. It makes me feel secure to be able to know more details about the food I will consume, and at the same time I like to know the producer that I will support financially.

6.1.2 Consumer 2

Question 1: What do you think about agricultural products?

They are very important for our diet. However, it is very negative the fact that agriculture has retreated in Greece, due to the wrong policy we adopted as members of the European Union, with the result that we end up importing agricultural products and as consumers we buy them very expensive . The primary sector should play an important role in the country's economy, something that is not happening and thus we are led to be a service country with a nonexistent primary sector in the economy. It is impermissible that with the policy of green development the land use changes, and instead of growing agricultural products, solar panels and wind turbines are installed, which burden the natural environment and the companies that produce them make big profits.

Question 2: How often are you buying /using them?

Daily. My diet is based on agricultural products, as it consists of the use of legumes, vegetables, fruits, cereals. A healthy Mediterranean diet relies mostly on the consumption of agricultural products on a daily basis.

Question 3: Do you trust the food that is currently available in the market?

Not too much. Due to the widespread use of pesticides used to improve the production and thus maximize the profits. In addition, I check the country of origin and if they are imported,

I don't buy them, I prefer only the domestic ones. That's why I don't buy products that don't exist in the country in a specific time period, for instance lemons in the summer, which I know that in the Greek market will be imported during summer. This is one of the reasons that I systematically buy some products from the organic market.

Question 4: What do you think about sustainability in the agro-food market?

At this moment when agricultural products are fundamental for the Mediterranean diet, it goes without saying that we should take care of their sustainability, in the sense of keeping them in our diet now and in the future. So agriculture should continue to exist as the primary sector of the economy, at the same time there should be no reckless use of pesticides in crops and there should also be a legislative restriction on this matter. Furthermore, the cultivable land should be used for the production of agricultural products and not for other purposes. Critical would be that the western world population to avoid over-consumption, since it leads other populations of the earth to starvation and death. Also, limiting the pollution of the environment by industrialized countries to limit the climate crisis, so that the areas of arable land remain and are not desertified by the rise in temperature. Even with the policy followed internationally, of wars that destroy the environment, with the dropping of so many bombs and chemical elements. In addition, I do not think that the green transition goes hand in hand with sustainability in the agri-food market. And this is because while the green transition preaches the protection of the planet, it actually contributes to its ecological destruction, by covering arable land with photovoltaics and mountains with wind turbines.

The natural resources of the earth would be sufficient to feed the world's population if there was no abuse, over-consumption by the populations of the western world and at the same time there was an equal distribution of mass populations across the planet and not over-concentration in certain areas of the planet.

A change in economic policy is therefore required for the sustainability of our planet itself, for it to be able to feed us. Curbing the greed of the financial elite that controls the destinies of our world.

Question 5: What is your opinion about technology use in agrifood?

I am in favor of the use of technology, if by this term we mean the advanced form of agricultural machinery that will contribute to the increase of production and the facilitation of agricultural work (reduction of costs, labor effort). However, I am against technology in

terms of the production of agricultural products if we mean by this term the production of products in a laboratory. An agricultural product should come from growing it in the traditional way from the land and not be supplied to the food chain prepared in a laboratory with dubious quality raw materials and dubious methods of preparation.

Question 6: Have you heard about blockchain? If not, have you heard about bitcoin?

No. But if it's related to bitcoin, I know it's a cryptocurrency. And I am against the digitization of our economic life. For man to be free, he must have control over his own finances, and not the banks. He must have cash in his pocket, otherwise he is a slave.

Question 7: Would you consider important to be able to trace the origin and have traceability of your food through technology?

Yes, of course, this would be very correct and good to exist, but it presupposes the existence of some principles: honesty, the priority of public health against economic interest. And because we live in the age of the most cruel and immoral economic liberalism, I think that facts will be provided that will not correspond to reality.

6.1.3 Consumer 3

Question 1: What do you think about agricultural products?

I like them and think that they are important for a balanced diet. Agricultural products must be included in our diet because they have many benefits for our body.

Question 2: How often are you buying /using them?

I buy them on a weekly basis and use them daily, as they are an important part of my diet.

Question 3: Do you trust the food that is currently available in the market?

No, I don't trust them that much. Nowadays, in order to meet the growing needs of agricultural products in the market, the methods of production and cultivation of agricultural products have changed, therefore the quality of these products is reduced. Based on my personal experience, the quality of agricultural products in the last few decades has dropped a lot. I notice a significant difference in the taste of the products, which I think is probably due to climate change and the new cultivation methods used.

Question 4: What do you think about sustainability in the agro-food market?

Due to the climatic, environmental and economic challenges I believe it is necessary to have a more sustainable agricultural sector. I believe that in order for sustainability to exist there should be actions that help economic development with an ecological consciousness in mind.

Question 5: What is your opinion about technology use in agrifood?

I believe that the use of technology has helped a lot in the development of the production of agricultural products and not only that. Due to climate change, technology can help with modern methods such as soil measurement, production monitoring to ensure the quality and better management of agricultural products. Throughout the production, processing and distribution cycle of products, technology plays a very important role.

Question 6: Have you heard about blockchain? If not, have you heard about bitcoin?

Yes, I have heard about blockchain and know it's a way to do secure transactions.

Question 7: Would you consider important to be able to trace the origin and have traceability of your food through technology?

Yes, I think it is important for the consumer to have detailed information about the origin and ingredients of the product. I believe that it is crucial to be able to cross-check the information about the origin and in particular this is extremely important for me for the products that I eat / consume. More and more lately we see on food labels the phrase "Made in EU", where the exact country of origin is not specified and this worries me, because I would like to know more details about the particular product which I buy. I think that there is not enough information on the labels about the nutrients, important tips about the storage conditions and preservation of each product based on its specifications. This is where I believe the use of technology for better traceability of products in the food chain could help a lot.

6.1.4 Consumer 4

Question 1: What do you think about agricultural products?

I prefer Greek agricultural products. I think that the majority of them are very good and of high quality, and that's why I use them.

Question 2: How often are you buying /using them?

I preferably buy them at the flea market twice a week. Otherwise, I buy agricultural products from the supermarket, with a strong preference for Greek products.

Question 3: Do you trust the food that is currently available in the market?

Yes, I trust it by certain criteria. I choose the food that I will buy and consume based on criteria such as the origin, the list of ingredients, the nutritional table, as well as the conditions for the preservation of each product.

Question 4: What do you think about sustainability in the agro-food market?

There are many times that I choose products which are organically grown, however I believe that there is a general ignorance and insufficient education and information of consumers regarding those products in the market. To be more specific, I often cannot recognize them in order to buy them, and also their price, which is more expensive, is often a deterrent.

Question 5: What is your opinion about technology use in agrifood?

As far as the producer is concerned, technology has helped to make productions easier and faster. Also, the consumer can be better informed regarding specific products, their production method and origin. In general, I believe that technology is very useful.

Question 6: Have you heard about blockchain? If not, have you heard about bitcoin?

No, neither about blockchain nor bitcoin.

Question 7: Would you consider important to be able to trace the origin and have traceability of your food through technology?

Yes, I consider it very important. I would feel more secure about what products I consume, not only for financial reasons, but also for my health. Since I want to have a healthy and balanced diet, I would choose products that are beneficial for my health. An important factor is avoiding anything that could cause a risk to my health. As a health scientist, I would like to be updated and informed about food technology (their production, their traceability and their preservation), so that to ensure and follow a balanced diet and a healthy lifestyle. After all, we are what we eat.

6.1.5 Consumer 5

Question 1: What do you think about agricultural products?

I have noticed that the prices of agricultural products during last year have increased dramatically, as for example the price of olive oil has skyrocketed. This is mainly due to the increase in their production costs. Usually smaller producers have better quality products, compared to mass productions.

Question 2: How often are you buying /using them?

Every four days or so I buy fruits and vegetables. I prefer to buy agricultural products from my neighborhood grocery store; I believe they have better quality products that are produced by local producers, which are purer. In this way I contribute to the strengthening of the local economy. I use agricultural products on a daily basis, as they are the primary part of my diet. I would like to note here that I also produce my own agricultural products in my garden, various fruit and vegetable products such as potatoes, tomatoes, onions, lettuce, pumpkins, cucumbers, beans, parsley, watermelons, lemons, oranges. Someone could say that I am self-sufficient in many agricultural products, especially in the summer.

Question 3: Do you trust the food that is currently available in the market?

I am careful about what I buy and what I eat. I make sure that what I purchase are organic products, I am a fan of organic farming. Based on the price, there are products of different quality in the market. As an example, I can mention that there are honeys in the market, originating from Bulgaria, which are very economical compared to the average price of Greek honeys. However, the quality of the cheap honeys is very low, so I can't trust them.

Question 4: What do you think about sustainability in the agro-food market?

As I already mentioned, I am for organic farming, i.e. the non-use of fertilizers and pesticides. In this way, our health benefits and we also protect the planet.

Question 5: What is your opinion about technology use in agrifood?

Certainly technology helps in the development of agriculture, with the use of modern machines the production and harvesting of products increases, it becomes faster and easier. If one considers that a few decades ago farming was done with the use of animals, today with the industrialization of production, farming is done with the use of machines and let's see how it will be in the coming years, I bet that technology will surprise us!

Question 6: Have you heard about blockchain? If not, have you heard about bitcoin?

No, I have heard only about bitcoin, the cryptocurrency but I don't know much.

Question 7: Would you consider important to be able to trace the origin and have traceability of your food through technology?

Yes, it is very important to know the origin of the products I consume. It is one of the factors that influence me in buying the food I get. Generally speaking, I prefer to support local producers. As far as traceability is concerned, its existence plays a major role in locating food where a problem occurs, mainly of quality. It is not rare that products have been withdrawn from the market due to some problem or contamination during production. This is quite common especially in dairy products. With the use of technology, the specific lot can be identified and in case of risk it can be withdrawn from the market preventing more people from being infected.

6.1.6 Consumer 6

Question 1: What do you think about agricultural products?

They are very important for the human survival. It is the primary sector that it secures firstly job positions, secondly produces vegetables and other types of foods such as fruits, cereals, that are basic for a balanced diet and vital for our health. Furthermore the agricultural products secure food resources to more people, especially to the populations that are more vulnerable economically.

Question 2: How often are you buying /using them?

On a daily basis I am using vegetables, fruits, cereal, flour, etc. Certainly I am buying them weekly, and some times more often. Since I live in Athens, I am trying to go once a week to the flea market to purchase agricultural products. Once a week I am also going to the supermarket to buy vegetables and fruits.

Question 3: Do you trust the food that is currently available in the market?

Yes I trust them, since I consume them, however I would prefer to buy mostly from flea markets, so that I reduce the waste of plastic, because in the supermarkets most of products are packaged. In general, I trust the products in the market either flea market or

supermarkets. I would like to mention that once I bought diary products that were rotten; a moldy cheese and a melted butter.

Question 4: What do you think about sustainability in the agro-food market?

I don't believe that exists. The plastic has overwhelmed our lives. I think that the way of production and the middlemen, the packages of the products are not contributing to the sustainability. If a person can buy without the plastic bags, carrying his trolley with him, this is more sustainable and eco-friendly way for purchasing. From my point of view, I see that there is a lot of waste, especially in big supermarket chains that are packaging the vegetables, fruits, cheese in plastic packs. I don't like that.

Question 5: What is your opinion about technology use in agrifood?

Since the world population is growing, the technology can help to produce faster. Also, some products that are seasonal, technology can find ways to produce them all year round. It can help to grow products in areas where it is necessary. Technology can support the transportations, too, for distant areas, such as islands that don't have access to some products. Important part are the pesticides and fridges that keep them maintained , not rotten , without worms.

Question 6: Have you heard about blockchain? If not, have you heard about bitcoin?

No, only about bitcoin, but I don't know exactly what is it.

Question 7: Would you consider important to be able to trace the origin and have traceability of your food through technology?

Yes it is important and if you want to get informed or to file a complaint there should be an online platform or a phone number available to get in touch with the company. Once I bought mushrooms from the supermarket and there was no expiration date written on the package. Of course, I knew that I had to consume them immediately, but this incident stressed me and I was worried to consume them. Also, there was not much information on the label. I believe that all the detailed information about the product should be displayed on the label and in case that not everything is there, there should be a way to get in touch with the company. I will never buy the mushrooms from this brand again. At the same time, I try not to buy products that are packaged in plastic packaging, as I want to avoid to "produce garbage" and I prefer to buy products from the flea markets.

6.1.7 Consumer 7

Question 1: What do you think about agricultural products?

I am in favor of agricultural products, they play an important role in consumption and they play an important role in our own diet, the Mediterranean one.

Question 2: How often are you buying /using them?

Since I live in Thessaloniki, I prefer to buy agricultural products from the local flea market of Voulgari (the largest local market in Thessaloniki) Twice a week from the local market and three times a week from the supermarket. I personally want the agricultural products to be fresh, for this reason I make sure to buy/stock up often. I buy honey from a local producer whom I know. As indicative examples I choose Naxos potatoes, Zagori apples, Cretan avocados, Cretan oranges. I buy mountain tea from a local grocer, originated from Kozani. I am very picky about the products I buy and consume.

Question 3: Do you trust the food that is currently available in the market?

Personally, I think that the packaged products have undergone a further process, that's why I don't prefer them. I don't trust packaged products such as ready-to eat salads, cheese or packaged turkey. I do not trust canned products such as corn, anchovies, sardines, mackerel, tuna with vegetables, etc. I don't trust meat or fish from the supermarket, I prefer to buy from the local butcher or fisherman, so that to know the origin and that what I eat is reliable.

Question 4: What do you think about sustainability in the agro-food market?

Sustainability is essential, it boosts tourism and supports the Greek economy. I believe it is very important and helps to promote and develop our country. Some products are well-known abroad and foreigners visit our country to try them up in person. To bring a few examples, some tourists visit our country to taste our wines (wine tourism), others to see up close the mastic villages in Chios, to taste the Cythera bread rusks or to experience the life in a farm (agrotourism).

Question 5: What is your opinion about technology use in agrifood?

It has certainly contributed through technological innovations, helping to evolve to ensure the best quality of products. Its role is multidimensional and decisive.

Question 6: Have you heard about blockchain? If not, have you heard about bitcoin?

No I don't know about it. I have only heard about bitcoin, but I cannot analyze it.

Question 7: Would you consider important to be able to trace the origin and have traceability of your food through technology?

If the label of a product is incomplete, I do not proceed with its purchase. I consider it a critical factor to have direct access to the details of a product such as origin, ingredients, nutritional table. Also, as a consumer, I would like to know how the production is done, to scan and through photos to see very quickly the production process, what stages were followed to get this product to my hands.

6.1.8 Consumer 8

Question 1: What do you think about agricultural products?

I believe that it is very good to have them in our diet. I definitely prefer to use the products that I produce myself, such as cucumbers, tomatoes, cabbage, cherries, oranges, strawberries, peaches, apples, watermelons, instead of those available in the market, which may contain fertilizers.

Question 2: How often are you buying /using them?

I have the advantage to live in the countryside and I have my own property and garden, where I grow enough fruits and vegetables that my family needs. I use them on daily basis especially during the summer months. From the supermarket I buy products that I am not growing myself.

Question 3: Do you trust the food that is currently available in the market?

No. That's why I prefer to buy seasonal products. For example, I don't buy tomatoes in the winter, because I know that they go through extra processing, because they are not a product of the season.

Question 4: What do you think about sustainability in the agro-food market?

The price is determined based on the products available on the market. Because there is a need for larger mass productions, new ways have been developed, which yet have negative effects on the environment and ultimately on human health because they use a lot of

chemicals and pesticides. Consumers have turned to organic products more. However, the high prices of organic products do not help.

Question 5: What is your opinion about technology use in agrifood?

The machines, diggers, lawnmowers have helped a lot in the cultivation of agricultural products and facilitate production. With the tools you gain time, convenience, keeping the soil fertile, etc. Also, the internet helps in education about crops.

Question 6: Have you heard about blockchain? If not, have you heard about bitcoin?

No. I have heard only about bitcoin, that you can put money in an application and depending on the demand you win or lose your money. However, it hasn't bothered me more to deal with it.

Question 7: Would you consider important to be able to trace the origin and have traceability of your food through technology?

I would like to know, before a food reaches my plate, what stages it went through, what the production process was. As long as this can be reliable information and be controlled by some control bodies. However, you can never be sure of the origin of a product.

6.2 Interviews to food industry experts

6.2.1 Food Industry Expert 1

Question 1: What is your activity/occupation?

I have a bachelor's in economics sciences and a master's in electronic commerce. Currently working as an Information Technology System Administrator at an exports company of agricultural products (olive oil, olives, figs).

Question 2: What do you think about digitalization of the agriculture?

In Greece we have fallen far behind as a country, compared to advanced countries in agricultural production like the Netherlands. There is no information-education among the average farmer to take advantage of the tools and advantages that a digital transformation can give us nowadays.

Question 3: What do you think about sustainability in the agro-food market?

Sustainability is a key condition for the agri-food market to function properly. It would be good to have healthy entrepreneurship and, through this, to achieve the right price for the producer. In today's era of globalization with easy imports from third countries, which have low cost of production, they make it very difficult to carry out healthy entrepreneurship in the domestic market. For example, tomatoes with a shelf purchase price close to €2 could theoretically give a "fair" price to the grower. Nevertheless, a month ago (May 2024), at the tomato auctions in Crete there was no demand at all, the price reached below €0.50 as a result of which the tomatoes ended up in landfills, because the imported cheaper tomatoes were preferred (Neakriti, 2024).

Question 4: What is your opinion about technology use in agrifood?

Technology has great potentials, which if we used it, we could have more efficient and better quality yields in production. Unfortunately, there is a deficit. The average farmer is not in the mood to educate himself. The use of new technologies can do wonders and develop the respective sector.

Question 5: Do you think that for the customer is important to be able to trace the origin and have traceability of their food through technology?

Yes, I think it is very important. This will also allow for product price differentiation. Apart from the fact that I know what I'm eating, it also plays a serious role in shaping the perception around the particular product. For example, if it is proven that a product is a PDO, then the producer can better justify the price of the product, but the consumer also becomes aware of the price-quality relationship of the product to be consumed.

Question 6: How could the use of technology in the agricultural sector improve the sustainability of agricultural products?

The use of technology can have positive effects on the quality, quantity-performance of agricultural production and this can lead to a better income for the farmers. As an example we can cite the use of olive harvesting machines in Portugal and Spain where the use of machines that shake the olive has significantly reduced the cost of harvesting (reduction of labor costs). This increases the profit margin for the producers.

6.2.2 Food Industry Expert 2

Question 1: What is your activity/occupation?

I have studied in the Department of Environment and I have done postgraduate studies in the Department of "Environment and Development".

Question 2: What do you think about digitalization of the agriculture?

My opinion is that it is a tool that can help us to be informed, for example if the crop is doing well, it helps us to identify and consider the conditions and resources of a place based on which we can make appropriate crop decisions. Through the use of digital applications we can check the altitude, ground conditions, sunshine, humidity, generally the prevailing weather conditions with the aim to optimize production and increase efficiency.

Question 3: What do you think about sustainability in the agro-food market?

An organic crop takes more time to complete compared to a regular crop. The fact that the producer does not intervene helps the soil to recover its nutrients in a reasonable period of time. It is good not to intensify agriculture by repeated use with regular cultivation of products. On the contrary, a mass cultivation can offer a lot of products, but it can be very burdensome for the environment.

Question 4: What is your opinion about technology use in agrifood?

The use of technology helps us produce more products, make more money, save time and feed more people.

Question 5: Do you think that for the customer is important to be able to trace the origin and have traceability of their food through technology?

It is useful for the consumer to know about the origin of the product that he is consuming, the production process, the pesticides and sources are being used. I believe that it is important to know the working conditions, too. I would like to know if the workers are working under exhausting conditions. Some companies promote in their values that they respect their employees, they respect the environment. Furthermore, usually the products that have higher quality, have higher price too. As far as the traceability concerns, there should be an easy way to contact the company either via their website or writing an email, or through phone, in case that there is a complain to record. This way you can inform the company about an issue and help them to improve possible problems. For instance, last

week my colleague told me that she found a live frog in a package of "Ready-to-eat salad with lettuce", so she called the company to file a complaint and they sent her a box full of gifts as an apology.

Question 6: How could the use of technology in the agricultural sector improve the sustainability of agricultural products?

Technology is very important in every field. It can help us from the production point to the point that the product will arrive to the store to the final consumer. You can easier find out where there is waste of resources and through technology you can find solutions to reduce that. One example is reduce the waste of water or reduce use of pesticides, in order not to burden the environment. Technology is definitely a means, a tool that can improve our life!

6.2.3 Food Industry Expert 3

Question 1: What is your activity/occupation?

Senior sales manager at Digital marketplace in the agrifood industry.

Question 2: What do you think about digitalization of the agriculture?

Digitalization of the agriculture is already happening and it will blow up over the following years. There are some studies according to which till 2026, more of ¼ of B2B businesses will operate through online channels. After the covid pandemic most of the companies started promoting B2B online sales, and this situation was actually established and is happening till today. Both consumers and businesses realized how online digital tools can transform their transactions. Thus digitalization will modernize the agriculture, increase the competitiveness and support the sustainability.

Question 3: What do you think about sustainability in the agro-food market?

Sustainable agriculture is essential for the future as it has numerous benefits. While conventional farming methods are posing a threat to the environment, sustainable agriculture practices offer a viable solution that guarantees food security, safeguards our environment and promotes economic growth. We need to make sure that our generation will ensure the minimum possible impact on the environment for future generations.

Question 4: What is your opinion about technology use in agrifood?

Technology can provide very helpful tools in agriculture and thus in food production. The usage of GPS, drones, remote monitors, and similar technological achievements that oversea the soil, the microclimate and the conditions of the cultivations can improve the environmental impact of agriculture. Additionally, biotechnology with the evolution and development of new varieties will help farmers face the challenges posed by the climate change.

Question 5: Do you think that for the customer is important to be able to trace the origin and have traceability of their food through technology?

Technology is part of our daily life and we are used to control many aspects of it through its applications. So using technology to trace food origin will help consumers feel more confident about what they consume, also help them track its origin and its ingredients.

Question 6: How could the use of technology in the agricultural sector improve the sustainability of agricultural products?

Technology can provide many innovative tools to support sustainability of agriculture. For example, lately high technology drones are used to fertilize fields located in unapproachable lands. Similarly other technological improvements will contribute in the production of nutritious food, in an ecological and responsible manner.

6.2.4 Food Industry Expert 4

Question 1: What is your activity/occupation?

I am a graduate of the Department of Agriculture, majoring in crop production.

Question 2: What do you think about digitalization of the agriculture?

In my opinion, the digitization is deemed necessary, since it can lead us to better production and therefore better products. It includes to some extent replacement of current cultivation methods by advanced tools. The producers should take into account not only the climate of their area but also the microclimate, in order to apply the most suitable methods during the production process. For example, this can be achieved by the use of electronic thermometers which are placed in a particular field and are checking the average temperatures per day and are connected to a database, The data that arise can help in the verification, more correct use of pesticides and help the farmers to take better decisions.

Question 3: What do you think about sustainability in the agro-food market?

The population of the earth is constantly increasing. The available areas to be used for cultivation are specific and as the population of the earth increases, the products produced reach the level of not being sufficient to feed the entire population of the earth. It is therefore deemed necessary to find new methods. This can be achieved firstly by optimizing the production to satisfy the current population of the earth and secondly by optimizing the nutritional value of the products, so that the needs of the essential nutrients required for our body are covered. The nutritional value of the products can be optimized by the accomplishment either the creation of new varieties or through the use of genetically modified foods (attention! I don't mean totally modified – transformed foods! I mean the ones that their DNA has changed only in one part and not totally.).

Question 4: What is your opinion about technology use in agrifood?

I believe that technology is the future of agricultural cultivation, as through the use of technology the optimal performance of each crop is brought about. Modern agriculture, as well as the one predicted for the future, includes the use of modern tools such as drones, robot tractors, digital thermometers and reduction of manual labor.

Question 5: Do you think that for the customer is important to be able to trace the origin and have traceability of their food through technology?

Yes, I believe it is important because that way the customer can find out from where the product comes from, in terms of location. He can see if it is a PDO (excellent quality) product, he can know the producer, if it is from Greece, and this can be achieved through the use of QR code that is on the label. If I see this on the scientific way, based on the origin of a product there will be a differentiation of agricultural products. Each country has different food legislation (use of agricultural pesticides), thus we can check easier if the regulations are being followed. Unfortunately, there are still many labels in the market that they don't show many information on them, so the consumer stays ignorant about useful information that should know before consuming something.

Recently I was at the supermarket and I found on the shelf a rice from a well known Greek brand that had specified on the label the origin of that rice, which was a small village where that rice was grown. That village happened to be my grandfather's village and I felt very proud and happy to see that on the label. It is really important to know the origin of the raw

materials and in my case that can be a reason why to purchase something. If we take this a step further, I believe that this could also be a good advertisement for places that are not very popular to the public and could benefit agrotourism to grow.

Question 6: How could the use of technology in the agricultural sector improve the sustainability of agricultural products?

Through technology, agricultural medicines can be created, tools that they are much more advanced than the existing ones. There is great development; the creation of pesticides that are less destructive to the environment. Also, the use of computers, digitization of production in combination with modern tools give us better results in the agricultural sector with maximum efficiency.

6.2.5 Food Industry Expert 5

Question 1: What is your activity/occupation?

Engineering – R&D at a meat processing factory, designing machines for the needs of the production line.

Question 2: What do you think about digitalization of the agriculture?

I think that we are far behind as a country in this part, compared to other European countries where everything is much more automated, designed and developed. As we are looking for workers, in other countries the industry has provided the solution.

Question 3: What do you think about sustainability in the agro-food market?

The food industry is not sustainable. There is a lot of food waste, it would be sustainable if we had found the golden section between food waste and real demand. We have reached a point to replace non-productive areas that are indirectly useful for humans (such as the existence of virgin forests that serve as lungs for humans). More specifically, in the Amazon we have a replacement of the virgin forest with palm trees for the production of palm oil. McDonalds and other corporations exploit the forests to satisfy their production which hence brings about the goal of profit.

Question 4: What is your opinion about technology use in agrifood?

There are pros and cons. Technology in agrifood helps mass production, gives industrial solutions in the primary sector, so that the world's population can be fed. However, I believe that mass production lowers the quality of products, even though production can be achieved faster.

Question 5: Do you think that for the customer is important to be able to trace the origin and have traceability of their food through technology?

No, speaking of processed final products, for me it is secondary to have full traceability because in reality I do not know what I am eating, because the place where a food was processed may be dirty. By that being said, I mean that a raw material could be excellent, but the factory is not following fully the guidelines of hygiene. For example, I know a Greek company of pork meat processing producer where they had a vertically integrated production with their own meats and farms, that their factory did not meet the correct standard specifications. If the factory is not clean and does not meet the right specifications, it doesn't matter that the raw material is of excellent quality. At the end of the day, the factory will not be able to produce a good product, even if it has good raw materials. In case that not all x-ray tests are performed, then tests should be performed for solid bodies in production, e.g. plastics.

Question 6: How could the use of technology in the agricultural sector improve the sustainability of agricultural products?

I believe that technology cannot help. First, the mindset/philosophy of the people, businessmen who have the demand on their hands should change. The entrepreneur who will produce a product has to consider if the product that he wants to create is sustainable. Technology plays a secondary role. For example, Haribo, the company that produces candies, does not offer something meaningful to the environment. In my point of view, the products that are produced should be something that is necessary in the food chain. In our days, it is a matter of marketing to design new products that have nothing to add to our lives. As a matter of fact, it has become a trend to consume protein products. Therefore, there are so many new products in the market that promote the "healthy" lifestyle by consuming high amounts of protein. Following this mindset, there are new pasta products, ice creams, dairy products that have high protein. Since all these products go into the same production line, I

believe that in this case scenario the technology doesn't improve the sustainability of agricultural products.

6.2.6 Food Industry Expert 6

Question 1: What is your activity/occupation?

My job background is at Sales and Exports of FMCG, wines & spirits, olive oil & olives products, frozen meat products. Currently working as exports business development manager.

Question 2: What do you think about digitalization of the agriculture?

I believe that digitalization is necessary, because first of all, digitalization will help the producers and the rest of stakeholders involved in the process. It helps to have better monitoring of the production process, and generally a more optimized process.

Question 3: What do you think about sustainability in the agro-food market?

Sustainability is a big thing. The buyers of big companies worldwide and more and more all the consumers today emphasize to sustainability and want to support and cooperate with companies that are supporting sustainability. What I see in the market today is that ESG is very important nowadays and has become a standard for every company to adopt. It is a common thing that if a company does not comply with the ESG standards, it doesn't get funds from the banks.

Question 4: What is your opinion about technology use in agrifood?

The use of technology is of great importance, providing the tools that enable producers and manufacturers to implement processes, monitor procedures, and secure the result of their production by minimizing risks. Technology also helps the rest of the supply chain until the goods reach consumers' tables.

Question 5: Do you think that for the customer is important to be able to trace the origin and have traceability of their food through technology?

Traceability just like sustainability, is becoming even more popular among the consumers. In a rapidly changing world of new global food habits, where zero waste, healthy lifestyle and organic are important parameters, the brands that provide consumers the ability to track

back the origin of their food have a huge competitive advantage. Imagize a QR code on the packing material that can be scanned and provide full traceability. 100% consumer education and satisfaction because the consumers get to know. Once they are aware, they start building trust. When trust is built then consumers tend to be brand loyal. And this is not the case only by younger demographics.

Question 6: How could the use of technology in the agricultural sector improve the sustainability of agricultural products?

The use of technology can for sure improve the sustainability of agricultural products. Imagine for instance all the tools that QA departments have available, but also new digital models / software that can identify risks and optimize harvests results for instance.

6.2.7 Food Industry Expert 7

Question 1: What is your activity/occupation?

I am an agronomist specializing in smart farming technologies. I have obtained a master's degree in Smart Agriculture Technologies and I currently work as an agronomist at an Innovation & Impact Hub office. As a member of the office, I participate in projects related to the use and application of smart farming systems and IoT in the primary sector. My interests include the application of high technology in Greek agriculture and the environmental impact of agricultural activity.

Question 2: What do you think about digitalization of the agriculture?

The digitization of agriculture, meaning the integration of digital technologies into primary production, represents an important development in addressing global challenges such as climate change, food security and sustainability. Through the use of technologies such as satellite data, sensors, weather stations help to save resources, make correct decisions in farming practices, reduce waste, and improve the quality and quantity of agricultural production.

Question 3: What do you think about sustainability in the agro-food market?

Sustainability in the agri-food market is nowadays a factor of competitiveness and trust for consumers. Businesses that integrate technologies and sustainable practices ensure the

origin and quality of their products, gaining a more loyal clientele, a credibility thus enhancing their corporate image.

Question 4: What is your opinion about technology use in agrifood?

The use of technology has the potential to upgrade the quality and safety of agri-food products. The use of sensors in the fields, automation and traceability offer solutions that improve efficiency as well as transparency in the supply chain.

Question 5: Do you think that for the customer is important to be able to trace the origin and have traceability of their food through technology?

Yes, the ability for the consumer to trace the origin and have food traceability (via QR Qodes) is critical. This increases trust in the product and strengthens the consumer's commitment to companies that offer transparency and validity.

Question 6: How could the use of technology in the agricultural sector improve the sustainability of agricultural products?

Various forms of advanced technologies for agriculture such as field sensors, IoT systems, disease prediction models, actuators for automated irrigation and use of drones are tools that can generate real-time data that is then converted into agricultural advice for the producer to follow. Now precision agriculture is the solution in today's era which will help the primary sector to face the various challenges like climate change as well as reduce the cost of inputs over time.

6.3 Interviews discussion

All the interviewers had a very positive view about agricultural products. They believe that they are very important for a healthy lifestyle and balanced diet. They should be included to our diet, as part of the Mediterranean diet. Their nutritional value adds many benefits to our health and body, embracing the well-being. Most of the consumers pointed that they prefer to purchase Greek agricultural products and tend to support the local producers and local economy. It was mentioned that the smaller producers have higher quality, compared to mass cultivations. One consumer commented about the import policy which is being followed by many countries, included Greece, and this has a negative impact for the local

economy. According to this view, the primary sector should play a focal point for the country's economy and that the producers should be supported more by the government. The consumers mentioned as well, that the price of Greek agricultural products has increased significantly lately, this was explained by the import policy and the general increase in production costs such as energy, fuel, raw materials, etc.

Since the agricultural products are part of a balanced diet, most of the interviewers replied that they are using them on a daily basis. However, their buying behavior depends on many factors. Some of them are buying weekly, other twice a week, other every ten days, depending on the flea market schedule, as well as on their schedule. It was reported that they prefer to have fresh fruits and vegetables in their household, and that they prefer the neighborhood's grocery store and butchers', to support the local markets and farmers. The consumers that live in big cities; Athens and Thessaloniki, show a tendency for a preference to buy mostly their groceries from flea markets, instead of supermarkets. There are also cases where their family or themselves are growing their own fruits and vegetables, which is a great benefit for them.

In the question whether they trust the food that is currently available in the market, the opinions are divided. Some of the consumers replied that they avoid processed food which contain additives, ready-to-eat salads, sandwiches and canned products. Also, they don't trust fish or meat from the supermarket because they are not sure about their origin. There are a few that have strong preference to the organic products, since due to their way of farming are healthier and consumers trust them for consumption. It was also mentioned about the quality of the products, that has dropped during the last decades in the market. This was explained by the growing needs of global population, the climate change and new cultivation methods that are being used. Usually, the cheaper products have lower quality. Consumers trust the food in the market by certain criteria; for example important role plays the origin, the nutritional value, the ingredients, and storage conditions. Most of them agreed that they prefer to buy their food from local producers and that they are not buying products that are out of season.

Regarding sustainability there were many opinions, however almost everyone mentioned the organic farming and the non-use of pesticides and fertilizers. They prefer consuming organic products, due to the benefits that offer to human's health and also protect the planet, even though the prices of organic products are higher and it can be a barrier for some people

to buy. There was a concern that sustainability does not exist in the agro-food market due to the increased presence of plastic packages in the supermarkets (packaged vegetables, fruits, cheese, etc). Furthermore, the climate change has affected dramatically the production of agri-food. The big flood in Thessaly in September 2023 had as a result to destroy the crops of thousands producers and increase the prices of agricultural products. Many of the consumers agreed that the government should take actions in order to help the economic development of the primary sector, support financially the producers and place regulations regarding the use of pesticides in crops. The not equal distribution of mass populations across the world and the increasing world's population is causing over-consumption which incommodes the sustainability. One consumer mentioned the negative effect that wars have in the environment and that the green transition contributes to ecological destruction by the installation of photovoltaics and wind turbines. Another interesting point of view was the importance of sustainability for the tourism industry and especially the agrotourism. Some Greek agricultural products that are popular abroad can be the reason why some tourists visit Greece.

All the consumers replied that the use of technology in agrifood is positive and can be multidimensional. First of all, in the production contributes to the reduction of production time and costs. The development of technology has brought modern and advanced machinery that can help in many ways the increase of production. Also, the use of internet is helping the consumer to collect information about a specific product, before or after purchasing it. The consumer can decide whether to buy it or not according to information provided such as origin, nutritional value, production methods. One consumer mentioned that she is against the technology used for development of new products that are produced in the laboratory, since according to her opinion the agricultural products should only grow by the traditional way from the land.

Seven out of eight consumers have not heard about blockchain. They have never heard about this word and they definitely do not know its applications and existence. Almost all of them, except of one, have heard about bitcoin, however they are not able to provide much information. Most common answer was that it is a cryptocurrency.

Referring to the last question to the consumers whether they consider important to be able to trace the origin and have traceability of their food through technology, they replied that it is very important. Many of them believe that the detailed information on the packaging –

label of the product should be a requirement. Incomplete labels would be a reason of not proceeding with a purchase of the product. There way a few examples from consumers that were not satisfied with the labels and lack of information on them about certain products. Knowing the origin of the product is considered as a critical factor for the consumers. They mostly like to support local producers for financial and quality reasons. This way they feel more secure about what they eat. They commented that the use of technology can help them follow a balanced diet and healthy lifestyle through easy and fast scanning QR codes, checking the nutritional table, ingredients, origin etc. For example, they would not prefer to buy a product with the sign "made in EU" since the exact origin is not defined on the label. Furthermore, the lot can be traced easily and in case of a problematic batch, a lot of specific products can be withdrawn from the market and prevent the fact that more people could be infected by something dangerous. Consumers can trace and contact the company in my ways via internet to get any kind of information related to the product, or even can file a complaint.

The interviews that were conducted to the food industry experts were very interesting and the interviewers come from different backgrounds. Some of them are currently working in the agrifood sector in various kind of positions such as IT, sales, R&D and engineering, agronomist in smart farming technologies and others have university degrees from related fields such as agriculture and environmental sciences.

All experts agreed that the digitalization of the agriculture is necessary for its development. Based on studies, until 2026 the one fourth of the B2B businesses will operate through online channels. Especially after the Covid-19 pandemic most of the companies promote the B2B online sales and it is a common fact that the digital tools can transform the transactions. According to the experts, the digital applications can help in many ways. The digitalization modernizes agriculture, increases competitiveness, supports sustainability, optimizes the monitoring of production processes, improves the quality and quality of agricultural production. The replacement of current cultivation methods by advanced tools, such as electronic thermometers, satellite data, sensors can lead the farmers to take better decisions for their crops and increase efficiency. At the same time, they pointed some concerns that the average farmer in Greece is not so well educated and informed, in order to take advantage of the tools and advantages that digital transformation can give us today. However, other European countries are using the most advanced and automated technological means in agricultural production.

Following the interviews to the food experts about sustainability, we notice that there are many different point of views. Most of them emphasize that sustainability is a big thing and it has numerous benefits. Sustainable agricultural practices can guarantee food quality and security, safeguards the environment and promotes economic growth. These practices enhance both the trust of consumers and the loyalty of buyers of big companies, who support the companies that are following sustainable standards. More specifically, following and adopting the ESG standards has become essential for firms during the last years (it is criteria for getting financial funds). Another point is that the constantly growing world's population has created the need to find new methods that could help the agrifood sector to feed more people by optimizing the production and the nutritional values of the products. Sustainability can be a key condition for the agrifood market to function properly, if there is healthy entrepreneurship that encourages the domestic market to grow and supports the local producer. However, the today's globalization makes it difficult to happen. Interesting mention was the fact that one food expert pointed out that food industry is not sustainable due to food waste and the replacement of virgin forests, with the aim of some big corporations to gain profit.

The use of technology is of great importance and has great potentials, being the future of agricultural cultivation. For instance, based on the interviews, the use of technology can upgrade the quality and safety of agri-food products. The modern agriculture provides helpful tools such as GPS, drones, robot tractors, remote monitors, that help the production to be more efficient, decrease manual work and optimize the performance of each crop. In addition to that, the automation and traceability can offer solutions, increase transparency and efficiency in the supply chain. Further, the use of biotechnology and development of new varieties can help the farmers face today's challenges due to climate change. There was also a point of view that even though the use of technology gives industrial solutions in the primary sector, the mass productions can lower the quality of products. Another concern that was raised is that the average farmer is not willing to educate himself about the new technologies in agrifood.

It is very important for the customer to be able to trace the origin and have traceability of their food through technology. While scanning the QR code on the packing of the product, the consumers can have full traceability about the origin, the ingredients and every information that the company is willing to share. According to the experts, the companies

that offer transparency and provide information about them, tend to increase their validity, build trust for the consumers, which will lead to loyalty from the latter. The end users will feel more confident about what they consume, will be able to shape perceptions on specific products and realize how price differentiations are adopted. Furthermore, they will have access to useful information about the company's values, production processes, contact details. Agrotourism can grow, as well, since some specific areas are becoming well known for their local and unique products. There was also an opinion that knowing the origin of a product is not always important, because you can never be 100% certain of what someone is consuming taking the case of processed final foods. This was explained as a situation if a factory is not complying with the hygiene and international food standards.

The use of technology in the agricultural sector could improve the sustainability of agricultural products, according to the opinions of food industry experts. There are positive effects on quality, quantity-performance of agricultural production, technology can help from the production point to the point that the good reaches the final consumer. Technological improvements can contribute to the production of nutritious food taking into account ecological and sustainable factors. The use of computers, software, innovative tools that support sustainability of agriculture such as high technology drones that fertilize fields in unapproachable areas, field sensors, IoT systems, disease prediction models are some of the tools that can generate real time data and convert them into agricultural advise for the farmers in order to identify risks, optimize harvest results and eventually increase his income. Additionally, it is easier to find where there is waste of resources and through technology to find solutions to reduce that (i.e. reduction of water waste, use of pesticides) and develop new technology pesticides that are less destructive for the environment. Finally, critical is the role of the entrepreneur whose mindset can determine the production. According to this opinion, the technology plays a secondary role in the sustainability since the focal point there is the promotion of some specific products, such as high protein products, which are not significant or meaningful for the environment.

7. Chapter 7 : Conclusions

7.1 Conclusions

Through this thesis, it becomes evident that the consumers show a strong preference for buying their agricultural products from local producers. They reported that they would trust more the food they consume if they know its origin and even better knowing the farmer himself. Considering the situation of food safety supply chain issue, especially at third world countries, it is emerging that solutions need to be find. The only way to identify fraud and have transparency is though the use of technology. This is where blockchain can help to solve the problem.

Efficient agri-food supply chain is essential for the assurance of a safe journey and supply of high quality food from the farm to consumers plate. It is reported that the adoption of advanced technologies, including traceability systems, blockchain and data analytics are gradually being integrated into agro-food so that to improve transparency and boost efficiency. As the world's population is increasing and demand for food is rising, the focus should be on optimizing the agro-food supply chain to ensure safe food.

Nowadays, the integration of blockchain technology into supply chain management has been remarkable in many ways. By introducing a decentralized and transparent ledger, blockchain increases traceability, ensuring that the customers can build trust, make wise choices and feel more confident about what they consume. This technology enhances efficiency, transparency and authenticity, while at the same time it is reshaping each industry.

The blockchain chain was firstly introduced in the financial sector through bitcoin. Even though most people today know of bitcoin only, and they haven't heard about blockchain in general, the blockchain's technology has been designed and applied to many different fields, such as supply chain, healthcare, governance, finance, banking, insurance, retail, energy, food, etc., since its decentralized and secure manner make it ideal for safe transactions. Agri-food sector has also benefited from blockchain applications, which includes food security through origin traceability, information systems, IoT systems and e-commerce.

As a matter of fact, the advanced applications of blockchain in agriculture have just started to gain popularity and show a lot of potential for the future of the field. The farmers can

benefit from the advantages of new technologies, in order to make better decisions for their crops and grow their business, but the customers can also gain confidence and through the information provided, their satisfaction can increase. Undoubtedly the more information shared with the consumer, the more trust they gain about a product and the more likely the customer is to become loyal to that specific product.

In addition to that, blockchain can ensure smoother transactions with transparent payments, assuring a greater quality control and food safety focusing on more sustainable methods. Due to the climatic changes, environmental and economic challenges we face today, along with the ever- growing global population, it is critical to have a sustainable agrifood sector. The increasing demand for sustainable and ethically produced products both from the consumers and the companies prioritized the adoption of such practices essential to the market, so that to ensure the origin and quality of the products.

The current agri-food supply chain is interacted dynamically with numerous trends and features. From the farms to consumers' tables, there are multidimensional processes that take place, which are influenced by the technology integration, adoption of sustainability practices, globalization and trade, supply chain resilience in recent disruptions such as Covid-19 pandemic, consumer awareness and preferences, regulatory compliance, e-commerce impact and partnerships through the supply chain.

The contribution of blockchain technology is inevitably critical. It is providing traceability and transparency; through the tracking the customer will be able to verify the origin, organic certification, fair and ethical practices during production, sustainable sourcing. Also, there is increased visibility, having real-time data in all stages across the supply chain. The elimination of intermediaries, the reduction of paperwork, increase of automations, real-time monitoring has increased the efficiency in the supply chain. It has been noted that the quality assurance and food safety play an important role in agri-food sector and the tamper-resistant nature of blockchain technology can ensure that once the data is recorded, it cannot be changed later. This boosts the consumers' trust. There is a secured system which guarantees the authenticity of food products and protects customers from frauds. The data privacy is important while sharing information between different stakeholders and the new technology of blockchain can secure and enhance the collaboration within the parties.

7.1 Limitations of the research & Suggestions for further research

In conclusion, this thesis examines the use of blockchain in agri-food supply chain and its impact on consumers' trust. There were many articles used to get information from major online databases, as well as online publications on websites and blogs. It is important to note that blockchain research was limited to a few countries. Some assessments show that the blockchain has attracted attention for a greater future in agriculture. According to the available literature studies, it was found that for the traceability sector for agricultural products such as meat, chicken, tea and animal food, there is very little literature. This creates new opportunities and challenges to explore for research in the agroindustry, taking into account that the agri-food products are so many, with different features.

As for the future of blockchain in the agri-food supply chain, it requires collaboration among stakeholders to build a resilient, sustainable and responsible supply chain that meets the needs and challenges of today's world, taking into account the next generations, too. The global food supply chain system is very complex and it is easy that essential information can get lost through the way. The proposed digital flow will track the information during transportation and storage improving accountability and efficiency.

This thesis has the aim to inform about the use of blockchain in the agro-food supply chain sector and its impact on the consumers' trust. It is based on theory and research on consumers and food industry experts. It is necessary to conduct research about the real applications of blockchain technology in the food industry, in order to rate its actual success. This limitation of the thesis can open new interesting paths for researchers to investigate further.

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