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Environmental Sustainability of the Digitalized Food Supply Chains in Indonesia

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Abstract

Background: Today, the environmental challenge presents a growing concern for the food supply chains around the world; and developing countries in particular, suffer from it. UN Global Compact has defined environmental sustainability as dealing with three main environmental challenges: climate change, water and sanitation, and food and agriculture. Digital tools have disruptive potential, especially in the food supply chains, and the adoption of these tools can be crucial to the success of food industry.

Purpose: In the light of the digitalization trend and the need to create environmentally sustainable food supply chains, it is of researchers' interest to investigate how digitalization benefits the environmental sustainability of the food supply chains in real-life companies; and what factors influence the digitalization process of the food supply chains. For the purpose of this research, a combination of various types of food supply chains was chosen in order to acquire generalizability. Indonesian food supply chains were chosen for research as agriculture plays a crucial role in the country's economy; additionally, the Indonesia's government currently emphasizes the digital transformation of the country.

Methodology: A qualitative methodology based on a Grounded Theory approach was applied in this study. The research questions were answered with the empirical data obtained through semi-structured interviews with ten experts from eight companies operating in Indonesia's food industry.

Results: This research paper uncovers that the digitalization process is very beneficial towards the environmental sustainability of the food supply chains in Indonesia. Three main benefits consist in added visibility, traceability, and optimization of the supply chains expressed through multiple sub-categories. Likewise, this study revealed that the digital transformation of the food supply chains in Indonesia is yet at an early stage. Multiple factors which influence that process have been identified and grouped into four families that drive the digitalization process: obstacles, pushers, challenges, and opportunities.

Importance: A lack of environmental sustainability within food supply chains may lead to negative environmental impact. This is putting in danger the environment and the profitability of the business as this issue leads to a loss of financial and natural resources.

Keywords: environmental sustainability, food supply chain, digitalization, Indonesia

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Alexandra Surdu & Farhan Muflih Sitepu

Chapter 1. Introduction

In this chapter, the background for the research study and the formulation of the problem area are presented. The purpose of the study is explained, and two research questions are formulated. Next, the delimitations of the paper are stated, and the perspective of the study is clarified. The chapter is concluded with an explanation of the structure of the entire research paper.

1.1 Background

"The concept of sustainable development was described by the 1987 Bruntland Commission Report as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."" (UNESCO, 2019).

With that definition, the sustainability issue has been placed on the international agenda, and the topic has gained a growing interest within the governments, academics, professions, and consumers ever since. We live in an industrialized society that encourages mass production and mass consumption which harms the environment (Teixeira et al., 2020). Food supply chains are becoming increasingly complex. Nowadays, food travels through an immense network of farmers, processors, storages, transporters, suppliers, distributors, and retailers before getting onto the consumer's plate (Kayikci, Subramanian, Dora, & Bhatia, 2020). Lengthy supply chains lead to more pressure on the sustainability of the food system and an increased environmental impact (Vanishree & Ramadas, 2018). According to Poore and Nemecek (2019), food supply chains generate around 13.7 billion metric tons of carbon dioxide equivalents, approximately 25% of the global greenhouse gas emissions (Ritchie & Roser, 2020). European Commission states that "food waste alone generates about 8% of Global Greenhouse Gas Emissions" and "some 33 million people in the EU cannot afford a quality meal every second day" (EC, 2019). Moreover, agriculture requires a lot of natural resources; it utilizes almost half of the world's liveable land, and around 70% of the global freshwater, while food production also causes 78% of eutrophication of the world's ocean and freshwater (Poore & Nemecek, 2019). Organizations, in general, are forced to reconsider and redesign their supply chains to tackle environmental issues (Ghadimi, Wang, & Lim, 2019; Panigrahi, Bahinipati, & Jain, 2019; Teixeira et al., 2020). However, as seen from the above figures, food supply chains, in particular, should be concerned with coming up with new ways to challenge the environmental sustainability issue.

In 2010, the United Nations Global Compact that promotes the adoption and application of sustainable and socially responsible businesses worldwide was formed (UNGC, 2021c). UN Global Compact has defined *environmental sustainability* as dealing with three main environmental challenges: climate change (the strive for zero-carbon economy); water and sanitation (the fight against water scarcity, pollution); and lastly, food and agriculture (the aim to create food safety and security, to eradicate food loss and waste, and to end hunger) (UNGC, 2021a). UN Global Compact promotes a precautionary approach for the businesses on their path to becoming environmentally sustainable, "the key being the idea of prevention rather than remediation" (UNGC, 2021b).

Another trend that has been growing in popularity in recent decades is the digitalization of the supply chains. Chalmeta and Santos-deLeon (2020) argue that "it [digitalization] will allow efficient resource allocation, which includes water, energy, raw material, and other products, based on data that is collected in real-time, resulting in new sustainable green practices" (p. 2). According to Creinin (2020), digital tools have disruptive potential, especially in the food supply chains, and the adoption of these tools can be crucial to the success of food production businesses. Various digital tools impact supply chains to different degrees. Blockchain technology for example can increase the transparency of the food supply chains by reducing the time for tracking the products' origins from seven days to a couple of seconds (Kamath, 2018). The IoT-based digital twins can help track the exact moments when a quality loss occurs within a food supply chain, thus enhancing transparency and visibility (Defraeye et al., 2019). Moreover, AI can be used to calculate the optimal routing for food transportation; thus, transportation costs and energy consumption can be reduced (Gui-E & Jian-Guo, 2020). These are just a couple of prominent examples of digital tools usage.

1.2 Problem formulation

As seen from the above data, environmental sustainability is a critical challenge that businesses in the food industry currently face. Digitalization of the food supply chains might present a solution to this issue. Digitalization leads to increased visibility, traceability, and transparency of the supply chains. Therefore, food industry sustainability can be achieved by incorporating innovative digital tools (Ojo, Zigan, Orchard, & Shah, 2019; Annosi, Brunetta, Bimbo, & Kostoula, 2021). However, the existing research is scarce when it comes to the challenges and opportunities associated with the digital transformation of the food supply chains (Annosi, Brunetta, Bimbo, & Kostoula, 2021; Kittipanya-ngam & Tan, 2020). Moreover, there is almost

no empirical data regarding the effect of the digital transformation of the food supply chains and their environmental sustainability.

There are a multitude of food supply chain types, depending on the type of goods or foods that they are dealing with. Some types are more vulnerable than others regarding environmental sustainability. The fresh food or perishable food is particularly prone to deterioration because of its organic nature and presents increased safety issues (Kumar, Mangla, Kumar, & Karamperidis, 2020). Perishable food quantifies approximately 70% of the total food waste, and therefore, it also leads to the loss of large amounts of natural resources such as water and energy used in the production and transportation phases; thus, environmental footprint from the supply chains dealing with perishable foods is even greater. (ibid) Businesses operating with this type of product are forced to create temperature-controlled or cold food supply chains to increase food safety, which leads to further depletion of natural resources (Wang & Zhao, 2021).

The environmental sustainability issues, including food waste and the consequent loss of natural resources such as water, land, and energy, increased by the boost in consumption, have not yet been researched enough in developing economies (Joshi & Visvanathan, 2019). According to Pinstrup-Andersen et al. (2014), specifically in developing countries, food loss and waste happens more throughout the food supply chain stages like production, storage, and transportation, while in developed countries it occurs mainly at the consumers' side. Indonesia, for instance, is a developing country where the food industry plays a significant role. "Indonesia is a major agricultural player - the fourth largest global producer and an important exporter" (Soon, Tan, & Wibowo, 2021). In 2019, food exports represented 20% of the country's GDP (Economics, 2021). Yet, it is challenging for the country to compete on the global market due to the growing level of regulations in the industry; "food growers, manufacturers and distributors who supply perishable goods must ensure they are getting the right products to the right customers, but also that they are delivering goods in the right condition" (Fam, 2015). There is a need to optimize traceability and food safety, and security in the country. (ibid) According to Tompkins (2020), digital software can play a crucial role in addressing these challenges in Indonesia. Meanwhile, as a result of the world-famous Earth Summit held in Rio de Janeiro, Brazil, in 1992, Indonesia has set for itself the goal to produce food without harming the environment (Findiastuti, Singgih, & Anityasari, 2018).

1.3 Purpose of the study & research questions

In the light of the digitalization trend, the need to create environmentally sustainable food supply chains, and the lack of scientific literature focusing on empirical data from real companies; it is of researchers' interest to investigate how digitalization benefits the environmental sustainability of the food supply chains in real-life companies through explanatory research. The authors will strive to understand how food supply chains can benefit from the digital software in their journey to becoming environmentally sustainable, as per the UN Global Compact's definition of environmental sustainability. For the purpose of this research, a combination of various types of food supply chains was chosen in order to acquire generalizability. Indonesian businesses and their food supply chains were preferred to be researched in this paper.

In order to research the above-mentioned issues, two research questions were formulated:

RQ1: How does digitalization benefit the environmental sustainability of the food supply chains in Indonesia?

RQ2: What factors influence the digitalization process of the food supply chains in Indonesia?

The aim of the first research question (RQ1) is to develop an in-depth understanding of how digitalization, sustainability, and supply chain management are interconnected in the given empirical context. This will be done through the perspective of the managers that work within various food supply chains in Indonesia. The question has a targeted nature. Authors are particularly interested in the positive effects towards the environmental sustainability from the digital transformation of the food supply chains; thus, the existence of possible negative effects from digitalization are acknowledged by the authors, however, they are not researched in this specific thesis. The authors will analyse the digital transformation of the supply chains through digital tools, specifically digital software rather than hardware, because, as seen from above, digital software is specifically beneficial towards the increase of visibility, efficiency, and productivity which are needed for sustainable food supply chains.

To achieve the benefits from the digital transformation, companies must first embark on the digitalization process. As discussed by Long et al. (2016b), digitalization is a complex process. Furthermore, according to Liu (2020), it is slower in developing countries than in developed countries. Therefore, the aim of the second research question (RQ2) is to get a comprehensive

understanding of the digitalization process of the food supply chains in Indonesia. In order to answer this question, vital elements were investigated. These included: pushers, opportunities, challenges, and obstacles.

1.4 Delimitations and focus

The thesis analyses the food industry with no limitations to the type of foods. Therefore, supply chains dealing with different types of goods are included in the research: fresh foods, frozen foods, fast-moving packed consumer goods, and nutritionals. Almost the entire stretch of the food supply chain is analysed: plantations, sourcing, first-mile distribution, manufacturing, warehousing, last-mile distribution to B2B or B2C customers depending on the business. The supply chain structure slightly varies depending on the company; some have the plantations, for example, and others are starting just with sourcing; all are called just food supply chains throughout the paper.

The study focuses only on the Indonesian market. Therefore, the operations happening only in Indonesia are analysed even for multinational companies. Moreover, when speaking of the digitalization process, the implementation of all types of software is implied. The automatization of the supply chains with robots or other hardware is not part of this research because the process of application and results from the use of software and hardware digital tools are too different in nature, to be combined into the same research paper. Additionally, the thesis is narrowed down to the environmental aspect of sustainability and how digitalization affects it. The social and economic aspects of sustainability are not part of the research. When analysing the effects of digitalization, authors focus on the benefits, the positive outcomes of the digitalization process.

Finally, the analysis is done through the respondents' lenses. The authors consider the managers that have participated in the interviews to be the experts, and the knowledge they share is taken as the only truth. Therefore, the authors acknowledge that a wider variety of factors may exist, but this paper focuses only on the respondents' perspectives and experiences.

1.5 Thesis structure

This thesis paper has been structured into five chapters. The chapter disposition is as follows. The first chapter is the introduction. Here, the topic's background is presented, and the problematization is done to see the importance of the issue researched. Additionally, the

purpose of the study is explained, and two research questions are formulated with a focused aim for each question. The chapter concludes with the clearly stated delimitations that show the focus of the thesis.

The second chapter consists of a literature review. It is conveyed to identify a knowledge gap in the existing literature and get a good understanding of the current situation in the field of food supply chain, digitalization, and environmental sustainability.

The third chapter encompasses the methodology of the research paper. Here the reader will find a detailed explanation of the methods chosen to research the topic, the sampling strategy selected, and a brief description of the chosen companies to be analysed.

The empirical data analysis chapter follows the methodology chapter. Here all the findings are analysed and structured into tables, diagrams, and figures to facilitate the reader's comprehension. Additionally, selected pieces from the empirical data, which are considered to be most representative of the findings, are presented.

The last chapter is the conclusion. Here, the research questions are answered, and the theoretical and managerial implications of the paper are given. Additionally, ideas for future research are presented, and limitations of the paper that could have influenced or restricted the research are discussed.

Chapter 2. Literature review

The following literature was compiled in order to give an overview of the researched topic. The chapter is divided into four parts. In the first sub-chapter, authors give an overview of the food supply chain (FSC) background, then this sub-chapter is divided into two parts. First authors looked into the importance of digitalization for the FSC based on previous studies; and second, a review of the current digital tools used in the FSCs around the globe is presented. In the second sub-chapter, authors offer the most important data regarding the food industry in Indonesia and market readiness for digital transformation. The third sub-chapter encompasses the challenges and opportunities for implementation of digitalization in Indonesia. The chapter is concluded with a review of the current condition and the importance of environmental sustainability in Indonesia. Hence, the literature review starts from a broad background of FSC and progresses towards the focused lens of the effect from the implementation of digital tools in FSC towards the environment in Indonesia. It should be kept in mind that authors have done their best to keep FSC, digitalization and environmental sustainability as the core focus of the literature review to enrich and enable further exploration within the area of interest.

2.1 Sustainability challenges in food supply chains

Technological advancement influences the food industries and the food supply chain (FSC) around the world; still, the challenge of creating sustainable FSCs that would have more positive impact on the Earth, has not been solved yet. UN (2019) is projecting a two billion or 25.9% increase in the population by 2050. Additionally, FAO data from Pardey, Beddow, Hurley, Beatty, and Eidman (2014) research shows that the average energy consumption per person is rising too; in 2009 the average consumption per person was 2831 kcal, and it is supposed to rise to 3129 kcal per person by 2050. These result to a future increase for food demand and natural resources because the increase in human population will be meaning that human will take up more land-space and water to manage their daily activities (Schmidhuber & Tubiello, 2007). Recognizing the issue of fast-paced rise in population and limited number of natural resources does not help with the recurring issue of climate change. (ibid) The rising temperatures, increase of CO2 levels, sea level rise and biodiversity loss become a major issue that will influence both agricultural production and food manufacturing (Parry, Rosenzweig, Iglesias, Livermore, & Fischer, 2004; Schmidhuber & Tubiello, 2007).

The demand for enlarged food production will increase the economic growth, however, it creates a heavier negative effect on the environment (Pardey et al., 2014). Subsequently, as a lot of countries around the world cannot produce and supply all the necessary materials and resources on their own, the demand for more movement of goods in the manufacturing activities grows and further worsens the environmental impact (Gharehgozli, Iakovou, Chang, & Swaney, 2017). Another reason for the growth of the outsourcing activities is the customers' demand for products from around the global; people are not satisfied any longer only having the locally grown and manufactured foods; therefore, food manufacturers will have to outsource at least the raw materials from other countries, making FSC a global chain with stakeholders scattered around the world (Gharehgozli et al., 2017).

Global FSC will become yet another challenge for the environment sustainability if the FSCs still operate in the old ways. FSCs used to be quite simple, including only several elements in the whole process from farm to fork; however, with the globalization, now they include more and more components, adding length and complexity to them (Dani, 2015; Nosratabadi, Mosavi, & Lakner, 2020). The long manufacturing process leads to more activities coupled with an increased energy use and CO2 emissions in the process (Gharehgozli et al., 2017). Additionally, global FSCs lead to the emergence of a single global market and trade (Gharehgozli et al., 2017; Nosratabadi et al., 2020).

Previously, FSCs relied heavily on concentrated and stand-alone management systems; yet global FSCs' demand the food industries to cooperate in order to fulfil the new demands and increased production (Saberi, Kouhizadeh, Sarkis, & Shen, 2019). In addition, the centralized and concentrated systems of the older FSCs, might be vulnerable to the corruption and data error (Dong et al., 2017). Likewise, the older distribution systems and transportation modes are becoming less efficient and are causing more environmental damage in this new global reality (Robinson, 2017). Hence, the global FSCs experience the urgent need to rely on recent, advanced digital tools, because s a modern global problem requires a state-of-art solution (Annosi, Brunetta, Bimbo, & Kostoula, 2021).

2.2 Role of digitalization in food supply chains

According to the previous studies in the supply chain field, digitalization is one of the key factors for the development of the field. Digitalization was marked by the emergence of the Industry 4.0 a decade ago, triggered by the development of the information technology (IT)

(Cetrulo & Nuvolari, 2019; Tjahjono, Esplugues, Ares, & Pelaez, 2017). The development of the IT and the internet era led to the expansion of the integrated tools which are beneficial for the appearance of the automated and efficient systems (Tjahjono et al., 2017). The emerging digital tools and technologies are supposed to be effective enablers for the integration of global FSCs (Sarkis, Kouhizadeh, & Zhu, 2021). Ehie and Ferreira (2019) agree that based on previous studies, technology development plays a critical role for the current FSC field, ultimately generating the enhanced industry performance (Ntabe, LeBel, Munson, & Santa-Eulalia, 2015). Innovative digital technologies allow companies to gain multiple benefits, such as trimmed operational cost, improved product quality, increased sales revenue, development of new products that satisfy customer demands, and most importantly it helps towards the environmental sustainability (Tan et al. 2017).

In line with the topic of this paper, focus of the digitalization will be narrowed down to the digitalization of FSCs; where implementation will benefit all parties within the food industry (Jiang, Han, & Huo, 2020; Sgarbossa & Russo, 2017). As mentioned earlier, nowadays customers are more educated in terms of environmental and social sustainability, hence the existing growing matter of food waste, especially within lengthy FSCs, lead to the demand for implementation of digitalization (Kittipanya-ngam & Tan, 2020; Nosratabadi et al., 2020). FSCs in the recent era gain heightened attention due to the rapid depletion of natural sources, and the demand for better quality standards for the food itself (Ghadge et al. 2017). This shows that today's customers are concerned with the sustainability matter of the product origin within the production, while the governments are now strengthening the environment regulations for food industry to follow the demand (Kanji and Chopra, 2010).

Having the environmental issue in mind, the importance of developing digitalized FSC is growing (Ciulli, Kolk, & Boe-Lillegraven, 2020; Kittipanya-ngam & Tan, 2020). Khajavi and Holmström (2015) claim that advanced digital tools have the ability to enable efficient and sustainable supply chain systems where all the technology would be integrated and will lead to efficiency food production. Integrated systems will create a more cost-effective labour, and will also improve the labour quality and traceability within food production, which will lead to enhanced food quality and safety as per customer demand (Roth, Tsay, Pullman, & Gray, 2008). Wehberg et al. (2017) also think that due to the availability of the real-time information, digitalized FSCs can obtain more flexible operations, making it easier for the industry to take quick decisions when needed. Furthermore, digitalization is assumed to contribute significantly

to solving the issue of increased food demand and usage of energy and natural resource (Carmela Annosi, Brunetta, Capo, & Heideveld, 2020). Solution lays in the gained transparency, security, reliability, and integrity between all the actors involved in the digitalized FSCs (Saberi et al., 2019).

The adaptation of digitalization in FSC also shows that all the stakeholders involved in the food industry confirm their stance and willingness to overcome the current issues faced by the food industry, starting from the internal and technical issues that prevent companies from gaining more profits, all the way to the global climate change issue (Astill et al., 2019). This should be possible thanks to the added connectivity and visibility from digitalization which improves information sharing for all the actors involved and leads to faster and more reliable data for both internal and external actors within the FSCs. Furthermore, Stevens and Johnson (2016) say that connectivity of data within the FSCs creates efficient flows of supply and demand, preventing overproduction and thus, leading to less costs and less food waste. Bajželj, Quested, Röös, and Swannell (2020) also highlighted that with the added resilient within the FSCs, it will improve the quality of the inventory level, hence it will decrease the amount of food waste.

Nonetheless, digitalization of the FSCs goes hand in hand with a new challenge, a need for a more advanced infrastructure which would be able to cope with the new standards of practices in the operations (Verdouw, Wolfert, Beulens, & Rialland, 2016). Furthermore, Bai and Sarkis (2013) explained that if digitalization is implemented without being backed up by proper research and development, it may create more negative impact towards the environment; for instance: increase in energy usage, decrease in resources, and creation of unknown hazardous materials. This is drawn from the fact that current researchers have only studied the benefits from the implementation of technological tools and the reasons for implementation of digitalization only in isolated areas, without relating it to all the actions and actors within the grater supply chain system (Büyüközkan & Göçer, 2018). But such controversy in the adaptation of digitalization can be lessened if every company from the food industry will do a proper research before implementing any type of digital tools; this is crucial due to the difference in needs within various FSC processes (Jiang et al., 2020).

While there are many opportunities for the sustainability challenges to be tackled by digitalization, FSC digitalization process is still being delayed; according to Long, Blok, and Coninx (2016), this is caused by the difference in focus and targets of the food industries and technology developing companies. It is found that large capital investments have to be made

by the food industries to train the employees to build new skillsets and competences, and to make a thorough analysis of the existing tools to be able to select the most optimal ones from the array of digital tools provided on the market today; while technology companies should take into account the intricacy of the digital tools, as there may be a big gap between the current tools in practice, in the field, and the new tools offered (Long, Blok, & Poldner, 2016).

2.2.1 Contemporary digital tools in food supply chains

Digital technology is advancing fast. Just during the last decade, the digital tools applied in the FSCs have changed drastically; the new generation of technology is more complex, yet due to its integrative nature, it is easier in use and has a wider impact (Marion & Fixson, 2021). Industry 4.0 has disrupted the food industry and led to the development of new paradigms and models in the FSC management (Ivanov, Dolgui, & Sokolov, 2019). However, various digital tools have different degree of impact. There are some digital tools that are seen more effective in comparison to other tools, creating more sustainable practices, better collaboration within all the stakeholders, and enhanced profitability in the process (Cane & Parra, 2020; Kumar, Graham, Hennelly, & Srai, 2016). However, to stay focused within this research topic, only software based digital technologies will be researched. Several software based digital tools have been proven to be more effective compared to the others; these are Artificial Intelligence (AI), Internet of Things (IoT), Blockchain technology, Big Data analytics, and cloud computing (Gharehgozli et al., 2017; Kittipanya-ngam & Tan, 2020; Kumar et al., 2016; Pang, Chen, Han, & Zheng, 2015; Sarkis et al., 2021; Wehberg et al. 2017). Thus, in this sub-chapter, authors will try to explain the mentioned digital tools and the benefit they bring to the food industry and FSCs.

The rise of digitalization has put more pressure on companies to embark on the digitalization process to be able to stay competitive, and especially, to be able to compete on the global arena; nonetheless, a great number of actors in the industry have not had the ability to implement most advanced tools due to economic challenges, making it hard to align their businesses with the global standards (Lewis, 2017; Wehberg et al. 2017). It is particularly true for the developing countries where most transactions are still done manually and shipment of the commodities is done by the third-party logistics companies that rely heavily on the abilities of the drivers rather than digital tools (Pang et al., 2015). Moreover, as mentioned earlier, a good infrastructure is needed in order to uncover the full potential of digital tools within the supply chain operations

(Verdouw et al., 2016). However, it encompasses a big challenge for the digitalization of supply chains in developing countries particularly (Bukht & Heeks, 2018)

To facilitate the understanding of the benefits provided by various digital tools for FSCs, authors will describe shortly each tool and its usability in the industry. Firstly, Artificial Intelligence (AI) is a digital tool that recreates human intelligence using computer systems and integrated digital tools (Dirican, 2015). AI in supply chain processes enables higher accuracy of problem solving with a large amount of data being input (Kohtamäki, Parida, Oghazi, Gebauer, & Baines, 2019). According to Kittipanya-ngam & Tan (2020), the use of AI in FSCs will bring a more objective quality control assessment and precision towards the food products. Hence, the development of AI creates a promising future development for the agri-food industry where food quality is a significant issue (Ben Ayed & Hanana, 2021). The main benefit from AI in agri-food industry is the potential increased productivity of FSCs created by the precise processes through enhanced analyses and focused decisions based on exact forecasting achieved through data analysis (Sun, Zhang, & Mujumdar, 2019). In terms of environmental sustainability, AI based digital tools can help food industry reduce food loss and waste, improve the quality of products, and create traceability within the whole FSC system (Ben Ayed & Hanana, 2021; Di Vaio, Boccia, Landriani, & Palladino, 2020; Sun et al., 2019).

Second, the emergence of integrated supply chains is in part due to the rise of Internet of Things (IoT); IoT itself can be defined as the integration of all entities, therefore it creates interconnection and interrelation of all the elements into one big system (Mishra et al., 2016). Integrated IoT-based tools help companies to track and trace the supply chain activities from the upstream to the downstream, hence it can provide feasible traceability within the whole system (Miorandi, Sicari, De Pellegrini, & Chlamtac, 2012; Mishra et al., 2016). IoT-based tools provide instant, real-time information, thus can greatly benefit food industry; IoT can aid companies in their strive to diminish the amount of food wasted throughout all the processes; as it enables companies to evaluate the condition of the FSC, and to constantly increase its quality (Manavalan & Jayakrishna, 2019; Tsang et al., 2018). IoT also helps the food industry to fight the climate challenge; CO2 emission can be decreased thanks to the accurate planning of transportation, on-time delivery, and back-up plans for situations when errors happen during the process- all of these being enabled by IoT-based digital tools (Tsang et al., 2018).

Third digital tool is Blockchain. It is an emerging digital technology that has allowed more transparent financial transactions among all the parties in the supply chains without the need

of a third-party such as a bank (Kamilaris, Fonts, & Prenafeta-Boldύ, 2019). With the transparency and efficiency offered by the cryptocurrency, the usability of blockchain has gained interest from the FSC field as there are often multiple actors that require access to the data regarding all the transactions (Tripoli & Schmidhuber, 2018). Blockchain is allowing a shorter digital flow within the FSC system by using QR codes, RFID, NFC, to enable a more accurate and transparent process where everything is connected through one server (Kamilaris et al., 2019). According to the findings of Kamilaris et al. (2019), the current usage of blockchain within the FSC industry is focused on the food security, food safety, food integrity, support of small farmers, waste reduction and environmental awareness, and a better management of the supply chain in general. Blockchain technology also allows companies to trace the CO2 emissions of the whole FSC by providing the FSC with an integrated mapping system which allows companies to apply low-carbon emission throughout all the whole process (de Sousa Jabbour et al., 2019). Finally, according to Ivanov et al. (2019) blockchain contributes to a vaster traceability and visibility throughout the whole process, which enables companies to perform risk-assessments and eliminate disruptions.

Big Data analytics is another significant tool for FSCs. The new, lengthy FSCs generate a set of Big Data within the network, therefore, the development of big data analysis is crucial towards the industry's supply chains (Salam, 2019; Nosratabadi et al., 2020). Previously, supply chains were made of a number of actors each having their own system with no data integration between the actors; however, thanks to the digital transformation of the supply chains, companies can have now integrated data to work in unison (Sarkis et al., 2021). Nevertheless, the large amount of data created by these networks cannot be processed manually any longer; Big Data analysis is required for the companies to have an accurate analysis that supports smart operations and manufacturing (Salam, 2019). Thanks to the accurate measurement and analysis properties, Big Data analysis can provide multiple benefits and green solutions towards the environmental sustainability of the FSCs; to name a few: optimized the energy usage, reduced CO2 emission, reduced food loss and waste, and water and natural resource usage optimization (Ajagekar & You, 2019; Sarkis et al., 2021).

Last but not least, the trend for cloud computing will aid the integration of all the data throughout the FSCs. Within cloud computing, all the data can be stored in the cloud system, facilitating all the actors to store and process it in real-time (Vazquez-Martinez, Gonzalez-Compean, Sosa-Sosa, Morales-Sandoval, & Perez, 2018; Xu, Li, Chen, & Wei, 2018). This

will enable a rapid market acquisition and will take the FSCs to the next level of digital infrastructure as everything is stored in the cloud (Vazquez-Martinez et al., 2018).

To conclude, there are clear benefits for the FSC from the implementation of the advanced digital software, however, this process requires a long-term strategic commitment which will in turn enable a greater success (Kittipanya-ngam & Tan, 2020). Additionally, with the never-ending process of development, digital tools and information and communication technologies (ICT) will always change, therefore food industry will need to constantly adapt and find the perfect digital tools to maximize their potential (Van Knippenberg, Dahlander, Haas, & George, 2015).

2.3 Indonesia's food industry overview

Indonesia is the world's largest archipelago country that comprises over 17.000 islands with the fourth largest population in the world - over 270 million people (Indonesia Embassy in New York, 2017). Indonesia is located off the coastal area of the mainland South East Asia region, and in between Pacific and Indian oceans (Indonesia Embassy in Kazakhstan, 2018). Indonesia is known to be grouped up into five main islands: Sumatera, Borneo, Sulawesi, Java and Papua, and these different islands give out different resource for the Indonesia's economy (Suryahadi, Suryadarma, & Sumarto, 2009). Due to the fact that Indonesia is located in the tropical rainforest area and surrounded by water, Indonesia has a lot of natural resources such as palm oil, minerals, gas, plants and animals (Kurniawan & Managi, 2018). The local climate is beneficial for the farming of crops and animals; thus, a large amount of population is involved in the agri-food industry (Kurniawan & Managi, 2018); Suryahadi et al., 2009).

Indonesia's archipelagic position is a major issue for its the food industry because it is problematic to obtain simultaneously effective and sustainable operations in these geographical conditions (Findiastuti et al., 2018; Kurniawan & Managi, 2018). Prior to the Industry 4.0 era and the digital transformation of the FSCs, Indonesian food industry actors used to cut corners and strive to obtain efficient business operations which came with the cost of environmentally and socially unsustainable operations (Susilo, 2020). According to Nosratabadi et al. (2020), FSCs consist of a multitude of actors involved that work at the farm/producing, processing/manufacturing, distribution and retail; shortly: farm to fork; thus, a supply chain is a network made of all these actors rather than a number of stand-alone businesses. Therefore, Saberi et al. (2019) suggests that if Indonesia fights the transformation towards such a network

and continues operating as single and stand-alone systems, it will create FSCs prone to error and data manipulation and will create a non-sustainable industry not only from the environmental aspect, but also from the social and economic aspects.

The initiative and announcement of "Indonesia 4.0" by the Ministry of Industry, brought a lot of light onto the country's digitalization issue; following the announcement, a lot of stakeholders now look forward to collaboration and investment into the Indonesian food industry (Kemenperin, 2021a; Susilo, 2020). This is also due to the fast-paced development of Indonesia's economy, which makes it promising for other actors to invest in the country's digitalization (Mulia, 2019; Susilo; 2020). The initiative of Indonesia 4.0 is also accompanied by the term "Indonesia Emas 2045" (Golden Era of Indonesia by 2045); because by the year 2045, Indonesia will be one hundred years old and 70% of its population will be of productive age (15-64 years); thus, the government and the younger generations want to enhanced the digitalization of the country before it reaches its fullest potential in terms of productivity capacity (Hasudungan and Kurniawan, 2018). Having in mind the goal towards 2045, the issue of inequality in the infrastructure and economy development became a major issue because the readiness of many regions in Indonesia is questionable; 60% of the national economic activities are concentrated only in Java and Jakarta, the capital region and city (Faturay et al., 2017). An extensive research of Indonesia's regional economy is needed to enable investors and stakeholders to select the correct trajectory for the investments, as well as help from the Indonesia's government is required for the development of the infrastructure in the underdeveloped regions (Poma et al., 2020, Faturay et al., 2017).

In his research of the digitalization readiness of Indonesia's regions, Susilo (2020) has analysed the country by four criteria: penetration rate of internet user; ICT access and infrastructure, human development; and gross regional domestic product (GDRP). Based on this research, Jakarta is the main area of investment, especially for the Industry 4.0; but there are multiple areas that showcase great potential for the digital transformation, such as East Java, West Java, Central Java, Riau, Banten, South Sulawesi and East Kalimantan. Judging by the fact that there are multiple areas which show potential for the digitalization process, Indonesia is ready for the industry paradigm shift and Industry 4.0 approach. Additionally, the Audit Board of the Republic of Indonesia, is confirming that Indonesia is increasing its connectivity by developing digital infrastructure in every region (BKPM, 2017).

Indonesia's Ministry of Industry also stated that despite the COVID-19 pandemic, Indonesia's productivity in the manufacturing industry increased by around 15% in its optimization in September 2020 as compared to 2019 (Kemenperin, 2020). According to Kemenperin (2020) this increase in optimization of the current industry has a lot to do with the implementation of Industry 4.0 and the digital tools, as it creates a more efficient and integrated market both locally and internationally in the FSCs. The fast expansion of digitalization within Indonesia showcases the readiness of the country to become a digitalized nation, where the food industry also shows 2.45% growth after the first quarter of 2021, making it even more important for the Indonesia's economy (Kemenperin, 2021b).

2.3.1 Indonesia market readiness for the digital transformation

Due to the fact that agriculture has a big impact on the economy in Indonesia, and 90% of country's population is engaged within the agricultural industry, the government has an increased focus on the development of a more sustainable and digitalized food industry (Indonesia Embassy in New York, 2017). Furthermore, the above-mentioned statistic of 2.45% increase in the agri-food industry despite the world pandemic, shows the potential of the sector for Indonesia's economy when coupled with the digital tools (Kemenperin, 2020, 2021b; Masudin & Safitri, 2020). Thanks to the opportunity to pump the economy, extensive research and development of the food industry become one of the major goals for Indonesia, thus many collaborations were formed focusing on the development of Indonesia's food industry (Kemenperin, 2021a). Additionally, Indonesia is viewed as a market with a big potential due to the size of the market and the big consumption rate within the population (theinsiderstories.com, 2020).

Despite the large natural resources and population of Indonesia, there are major challenges for food industry's grow in the country. The biggest challenge is the poor, unevenly developed infrastructure (Indonesia-Investments.com, 2017). Because Indonesia is an archipelagic country divided into five major islands, there is a different pace of development within each island. Java island act as the main driver for the economic growth of Indonesia; here business activities are focused in Jakarta, West Java and East Java, while the other islands are also centralized in their activity; this creates inequality between the major cities and their surroundings (Indonesia Embassy in New York, 2017). Furthermore, the inequality of infrastructure and the difference in GDRP create imbalances that might impact the implementation of the ICT infrastructure (Susilo, 2020). Which in turn will decrease the

optimal digitalization of Indonesia (Iswara, 2020). As stated by Kamble, Gunasekaran, Parekh, and Joshi (2019) the digital transformation of the food industry requires high operating cost, in the absence of which optimal digitalization is not possible.

Another challenge for optimal digitalization in Indonesia is caused by the population itself. According to Susilo (2019) Indonesia's population with technological skills is limited to the citizens that live mainly in Java island; this showcases how underdeveloped the other areas are. The difference in digital knowledge will only slow down the pace of the digital transformation. This problem urges the government to prioritize the development of the underdeveloped regions by transferring technological knowledge and by creating standards for operations (Susilo, 2019., Masudin and Safitri, 2020). The complex nature of digitalization can potentially become a further obstacle for the employees if they lack the required skills, thus the benefits towards the industry will be lessened (Sarker, Islam, Murmu, & Rozario, 2020)

Lastly, the lack of research regarding the digitalization and the benefits towards the industry encompass a challenge; the benefits have to be considered in comparison to the cost of implementation (Ben-Daya, Hassini, & Bahroun, 2019). According to de Sousa Jabbour et al. (2020), implementation of costly digital tools without comprehensively exploring their impact and benefits towards the company's FSC might become a waste, because Indonesia's food industry is very diverse, and companies require different tools depending on the challenges faced and the areas of the supply chain that need to be improved. Factors like existing digital infrastructure, digital savviness of the employees, and the forementioned particular challenges of each company have to be researched before adopting the digitalization strategy and purchasing the digital software (Ben-Daya et al., 2019; Kamble et al., 2019; Sarker et al., 2020). According to Annosi et al. (2021), without tackling the challenges first, advanced technologies will only bring complexity of data and will cause drawbacks to the industry.

However, there are important opportunities for the food industry and FSCs in Indonesia in terms of digitalization. As seen from above, agri-food industry in Indonesia is one of the key contributors to the economic growth of the country; the amount of GDP coming from the activity of the agri-food industry comprises around 36% from total of Indonesia's GDP (BPS.go.id, 2021b). With the fast-paced development of Indonesia, the country's government shows the ambition to develop the food industry through "Indonesia 4.0" project, which will be beneficial for both the economy and the eradication of the sustainability issue (BKPM, 2017; Santika et al., 2019; Susilo, 2020). Moreover, the support from the Indonesia's government

creates one of the biggest opportunities, as it shows the readiness of Indonesia's market to be digitalized and shapes the collaboration between the food industry and the international market (Masudin and Safitri, 2020).

Second, Indonesia's government awareness regarding the environmental challenge and willingness to tackle it, is an opportunity. This increase of the environmentally sustainable thought and activity is pushed by the demand from the international market for sustainable activity, which otherwise, will bring to an end the market collaboration (Mukherjee & Sovacool, 2014). As digitalization is connected to sustainable operations, this pushes further the need for development of the digital infrastructure of the underdeveloped areas in Indonesia, because it will enhance Indonesia's economy and will open up bigger chances for international trade (Susilo, 2020., Masudin and Safitri, 2020).

Third, Indonesia's large population and the number of natural resources show that the country has great resources to create a significant value when going digital (Susilo, 2020., (Kemenperin, 2021a). This becomes one of the major benefits for investing in Indonesia, where it will bring up more extensive opportunities and trade-markets by creating chances for the population (Kemenperin, 2020). Despite the lack of digital knowledge in the country (Susilo, 2020), Indonesia's government was able to show that even before the implementation digital technologies, Indonesia's food industry was already competing on the international arena, and the report proves that Industry 4.0 will enable further increase in productivity of the industry (Kemenperin, 2020, 2021a, 2021b).

Lastly, Indonesia's business activity in the agri-business sector amounts to 90% of the country's business activity; meaning that the food industry will likely remain the core area for Indonesia for many years to come (Indonesia Embassy in New York, 2017). Therefore, it is of great importance to focus on the development of this industry to maintain Indonesia's activity on the local and global market. These opportunities are only some of the major factors that will enable and push the implementation of digitalization as it shows how beneficial the implementation will be, though, authors acknowledge that there are many more opportunities that were not included here.

2.4 Environmental sustainability issue in Indonesia

Sustainability is defined as a principle in which today's actions will not limit the economic, social, and environmental matters in the future (Elkington, 1998). Carter and Rogers (2008) introduced the triple bottom line approach which became a major factor in the world for both the industries and governments to follow in order to enable a better future where the balance of the three factors will be a main focus when it comes to managing industries and their supply chains (Seuring et al., 2008). In line with the declining number of natural resources, environmental sustainability plays a significant role for FSCs as it relies greatly on all types of natural resources (Tsai & Pawar, 2018). The FSC management and the environmental dimensions are inseparable as every activity within the FSC is interrelated and dependent on resources (Ojo et al., 2018; Tan et al., 2017).

Due to the fast-paced nature of the current era, industries must be more aware of the growing customer demand and growing competition (Guo, 2007). Furthermore, due to the declining amount of natural resource, the environmental degradation, and increased customer demand, implementing sustainability within FSCs is considered important to improve the industry performance (Ojo et al., 2018). The main benefits that industry can obtain from practicing sustainability is added cost leadership and product differentiation, which will give huge boost to the public awareness in comparison to the competitors; however, benefits are not limited to the financial dimension (Ghadge et al., 2020). Moreover, as mentioned in the introduction, UN stated three dimensions of the environment sustainability: climate change, water and sanitation, and food security and safety (UNEP, 2015), therefore, the United Nations have acknowledged the interrelation of food industry and the environmental sustainability challenge. To further showcase that proximity, authors will examine every aspect mentioned by the UN. Because this research has Indonesia as a focus area, authors will analyse the environmental issues existent in the Indonesia's FSCs.

The first dimension is climate change. As previously mentioned, new lengthy FSC involve more stakeholders; this leads to increased CO2 emissions; according to Gharehgozli et al. (2017) and Long, Blok, & Poldner (2016) digitalization can be effective in tackling this issue. The climate challenge is a significant one in Indonesia, because due to the archipelagic state of Indonesia and the poor state of the infrastructure within the country, Indonesia is the sixth country in the world with the most CO2 emission per year, generating around 1.98 billion tons emissions per year (Nurdiawansyah & Lindrianasari, 2018). Additionally, the poor

development and lack of economic capabilities within some industries are triggering actors to disregard the issue of CO2 emissions, and to prioritize profits over anything else (Abdullah, Musriani, Alim, & Hanafie, 2020). Digitalization can be a life saver in this situation; traceability, optimalization, and integration between all the stakeholders, will enable supply chain management to cut down unnecessary activities, and thus, to decrease the amount of CO2 emitted (Gharehgozli et al., 2017).

Second dimension of environmental sustainability raised by UN is water and sanitation issue. It is a significant challenge in Indonesia as well as the climate challenge; this is due to the bad infrastructure and the economic state the population of the country (Purba, 2018). If the food companies do not evaluate the manufacturing and production procedures within their supply chains, it might cause water pollution in the surrounding areas. It is of increased importance to control water pollution from manufacturing and production sites, as statistics shows that 18% of Indonesian depend on their water usage from the surface water sources which are prone to industrial contamination (Tanjung & Hamuna, 2019). Furthermore, FSC should control their operations to avoid the increase of the issue, as according to statistics, the number of villages in Indonesia that have experienced water pollution has almost doubled between 2014 and 2018, reaching 16.847 villages in 2018 (BPS.go.id, 2021a). Hence, it is necessary for food industry to evaluate their Good Manufacturing Process (GMP) and the Sanitation Standard Operating Procedure (SSOP) to reduce the water pollution which leads to water scarcity (Sucipto, Sumbayak, & Perdani, 2020).

The last dimension is food and agriculture. This element is most closely connected to the food industry. Industry food waste comprises the food that was produced but reduced as waste throughout the FSC before it reached the end consumer; this is ultimately caused by the inefficient FSCs (Annosi et al., 2021). Indonesia is among the countries with the largest among of food waste generated per year by each person, this number amounts to 300 kg and makes Indonesia sixth in the world (Iswara,2020). Food waste creates a significant negative impact towards the environmental sustainability, this is due to the necessity to dispose and landfill vast amount of food, while its manufacturing exploits and decreasing natural resources (Devin & Richards, 2018; Foley et al., 2011). This indicates that the inefficiency of current FSC model and demands for a shift towards improved digital FSC (Annosi et al., 2021; Bellemare, Çakir, Peterson, Novak, & Rudi, 2017). Moreover, Indonesia, previously equipped with more

traditional FSC, encounter the issue of generating large amounts of food waste because of the lack of proper infrastructure (Widodo, 2018).

The amount of food wasted also creates a threat towards food security, as it indicates that less food is available for the world's population (Gustavsson et al., 2011; Ojo et al., 2018). In case of Indonesia, where a big part of the population suffers from poverty, food security challenge is even greater (Paramashanti, 2020; Soma, 2017, 2020). Therefore, the need for efficient FSC is heightened in Indonesia. Integration created by digitalization of the FSC, could create more accurate food supply and demand, also an improved distribution system could lessen the amount of food wasted within the FSC, and could minimize the use of unnecessary natural resources (Gustavsson et al., 2011). Therefore, according to Tan, Ali, Makhbul, and Ismail (2017) the creation of supply chain integration (SCI) which acts as a closed loop, and the added resilience, will ensure the integrity of food throughout the FSCs and will eradicate the issue of food waste, water scarcity, and carbon emission (Sgarbossa & Russo, 2017; Stella, 2019).

Chapter 3. Methodology

This chapter has explained the methods, processes, and rationale followed in writing this thesis. The chapter is divided into six subchapters following the order in which the study was conducted. First, the theoretical framework and the research process behind it are stated. Second, the use of the grounded theory (GT) for data collection and analysis is presented. Third, the primary data collection tool, semi-structured interviews, and the process of sampling are clarified. Fourth, the steps followed in the data analysis process according to GT are outlined. The chapter is concluded with the data quality and ethical considerations being established.

A qualitative study was chosen for this research paper as there is a lack of studies that would concentrate on understanding the actual practices of the real companies, as opposed to the often-used experimental studies applied in the supply chain management field to discover new methods and technologies. Qualitative research effectively understands the perspectives, knowledge, and practices of the studied participants (Flick, 2009; Mello & Flint, 2009). In this research, the authors aspire to take the participants' viewpoints and get an in-depth understanding of how practitioners from FSCs in Indonesia view and interpret the interrelation of digitalization and environmental sustainability trends within their industry; therefore, the aim of the research is exploratory. The authors took an interpretive approach. The life-worlds of the respondents were researched while authors strived to distance themselves maximally; the respondents' perspective constitutes the knowledge, and authors strived to mirror as accurately as possible this knowledge in the research. Therefore, the knowledge base is derived from the everyday life experiences of the professionals who were interviewed.

Moreover, the research is exploratory in nature because the interconnection of the digitalization, sustainability, and supply chain management concepts has seen superficial to no research before; theory had to be developed from the ground due to insufficient previous knowledge (Goulding, 2002; Mello & Flint, 2009). Grounded theory (GT) has been a leading approach in qualitative studies since the 1960s (Flick, An introduction to qualitative research., 2009). Moreover, Mello & Flint (2009) state that the supply chain management field particularly can benefit from the value of the GT approach. Also, GT facilitates the generation of research with increased reliability and validity compared to the traditional approaches towards qualitative methods; this is due to the rigorous guidelines, and the systematic approach

applied (Mello & Flint, 2009). For these reasons, the GT approach towards qualitative research was chosen for this thesis.

3.1 Literature review

In order to address the sensitivity of the topic of the paper and to establish the existing knowledge gap, it was necessary first to study the existing literature on FSCs, digitalization, and environmental sustainability. The process also helped to define the research question. Within GT, the researchers must have a clear mind and avoid bringing to the field preconceptions and assumptions based on previous research, yet, reading before starting the data collection process is an essential part of GT (Goulding, 2002). The literature search helps to narrow down the context and establish the focus of the topic that is chosen to be studied.

To enhance the reliability of the study, only peer-reviewed journals were included, and official government websites for general data about Indonesia. However, because the Indonesian market was studied, papers written in both English and Indonesian were studied. However, due to the multilateral aspect of the research, no restrictions on the field of study, geographical area, or publication date were included. The relevant articles were analysed with a critical approach. They were used to position this study, refine the contribution, and assess previous studies (Charmaz, 2006).

3.2 Grounded Theory

According to Hood (2007), GT has several vital components (See Flick, 2009). GT is composed of multiple "cycles of data collection, coding, analysis, writing, design, theoretical categorization, and data collection" (Flick, An introduction to qualitative research., 2009, p. 428). It is a continual comparison of the cases with one another and with the created theoretical categorizations, where the codes are developed from the gathered data rather than enforced from previous studies. Moreover, within GT, the information is collected until the authors achieve theoretical saturation; that no more new knowledge is obtained from the new cases; thus, it is not necessary to calculate a demographic representation. Theory formed through the GT is not tested and verified by data; it is instead developed through inductive reasoning and through a continual process of checking and improving the theory with the help of the gathered data. Formulation of a new theory is the ultimate purpose of the GT (Flick, An introduction to qualitative research., 2009).

3.3 Data collection

This thesis is done using the qualitative studies to which a Grounded Theory approach was applied. According to Goulding (2002), the most common type of interview within the GT approach is the semi-structured one. Moreover, after some considerations, semi-structured interviews were most appropriate and chosen for this research.

3.3.1 Semi-structured interviews

As stated by Bryman (2012), semi-structured interviews with open-ended questions allow the participants to reflect on their experiences and allow interviewers to get a good understanding of the life-worlds of the participants through an inductive approach. Because of their flexibility, semi-structured interviews create the possibility for the participants and researchers to explore topics and steer the conversation in new directions. At the same time, these interviews are easier to compare, generalize, and obtain validity (May 2011). Therefore, the researchers came to the interviews with a pre-determined set of open-ended questions to manage the conversation flow.

As per the GT approach, the interviews were transcribed and analysed right after. This has permitted the authors to improve and shape the interview guide, and the questions differentiated slightly between the interviews. Additionally, due to geographical distance, the interviews were conducted online, via various communication platforms, including Microsoft Teams, Zoom, Google Meet. The platforms were chosen based on the convenience of the respondents. Each interview was recorded via a mobile app, with the consent of the interviewees. The tasks of the researchers were divided; one person was asking the question from the interview guide and was keeping the conversation going, while the second person was taking notes and was asking follow-up questions for the elaboration of the topic when needed. After the interview, a first version of the transcript was done automatically by the application Otter.ai, after which the authors manually transformed speaking language to written language (for example: excluded all the filler words), and slightly corrected the language grammar when needed as English was not the mother-tongue language of the respondents.

3.3.2 Sampling

Non-probability sampling was applied to this research (May, 2011). Authors contacted people from their network in Indonesia who work for companies from the food industry and use digital

software within the supply chain. This ensured that relevant information was taken from relevant people. After that, snowball sampling was employed; this ensured finding more companies and maintaining the relevance. Finally, maximum variation sampling was applied to ensure that as many types of FSCs as possible are included in the research (Bryman, 2012). In the process of selection of the companies, their corporate websites, corporate social responsibility reports and annual reports were analysed to ensure the right selection. Following the GT, the interviews continued until theoretical saturation was achieved (Goulding, 2002). Moreover, to get additional information or clarifications of the data received during the interviews, follow-up emails were done when it was deemed necessary.

Initially, participants were contacted by email. The authors presented themselves and outlined the aim of the study and the approximate time and duration for the interview. Additionally, such details as confidentiality and anonymity were explained. After the interviews, consent forms that ensured respondents that they will remain anonymous were sent and signed by the interviewers and interviewees (Appendix, anonymous consent form). To collect the necessary empirical data, eight interviews were conducted with ten respondents from eight companies between 2nd April 2021 and 11th May 2021. Respondents were selected based on their scientific or experiential knowledge in supply chain management and digitalization. The duration of the recordings varied between 40 minutes and 75 minutes. During the interviews, the entire stretch of the supply chain was discussed and analysed, except for the supply chain segments that are outside Indonesia in the case of multinational companies.

Below are presented the profiles of the interviewed eight companies in tables and short descriptions:

Company A:

A multinational food and drink processing company, operating in the fast-moving consumer goods (FMCG) industry. Has been in the business for over 50 years, though has been using digital tools for just two and three years accordingly for two different tools. The company is only partially digitalized, and the tools are not incorporated one with the other; thus, it has a fragmented digitalization. (By multinational company, author mean a company that has its operational sites (plant or production or manufacturing) in multiple countries and exports products to multiple countries around the world.)

The respondent works as a supply chain development specialist, having engineering education and almost a decade of experience in the operational optimization of the company's supply chain.

Company B:

A multinational consumer goods company, operating in the FMCG industry. The cold food supply chain is analysed. Company B has been in the business for over 50 years; however, it has been using the two digital tools for the shortest time, six months and less for both tools. The company is partially digitalized, and it is a fragmented digitalization.

The respondent works as a regional sales manager, has recent engineering education and experience in the management of entire business operations in several areas in Indonesia.

Company C:

A commodity trading company, having tea as a commodity. Operates nationally with companies from the FMCG industry. It is a start-up, has been in business for two years, and uses digital tools from day one. It is partially digitalized and has fragmented digitalization.

Respondent C is a business development manager. He has education in economics and experiential knowledge in business optimisation.

Company D:

An E-commerce business operating in the fresh and frozen fish industry. It is an international start-up company. It has existed for five years but has launched its in-house built digital tools only two years ago. It is end-to-end digitalized now and has all the systems integrated with one another. (By international company, the authors mean a company that has all its operational sites within Indonesia, but exports products to multiple countries around the world.

The respondent currently works as a head of strategic project management and has previous experience in business development within logistics companies, and education in business administration and strategy execution.

Company E:

A fresh fruit and beverages business operating in 2 large regions in Indonesia. It is a start-up company that has been in business for two years and has used digital tools from day one. It is only partially digitalized, but the existing tools are all integrated.

Respondent E is a business development manager at the company E and has previous experience in research development.

Company F:

A multinational agribusiness and food business that manufactures and trades palm-oil-based products. It has been in business for over 20 years and has embarked on the digitalization process six years ago. It is already end-to-end digitalized, and all its systems are integrated.

Respondent F current position is director of supply chain. He has extensive experiential knowledge in the digital transformation of the supply chains, working in business development and logistics engineering from multiple international and multinational organizations.

Company G:

An E-commerce agribusiness operating with fresh fruit and vegetables. It is a start-up company that made its appearance five years ago and started using in-house built and integrated digital tools right away. Company G works within several regions in Indonesia.

The respondent G is a chief operating officer. She has engineering education and extensive work experience in digitalization field. She is also one of the developers of Company G in-house build integrated digital system.

Company H:

Company H is an international nutrition and food manufacturing and trading company that has been in business for over 50 years. It has used digital software for the longest time from all the interviewed companies; from three to twelve years, depending on the tool. It is almost entirely digitalized, and all the tools are integrated with one another.

Three persons were interviewed at this company. First respondent is the head of external plant; he has decades of experience in managing efficient supply chain operations in Indonesia and abroad. Second respondent works as supervisor of quality assurance SC and uses intensively digital tools in his job to eradicate waste and ensure food safety. Third respondent works as

manufacturing development and planning and while having a decade of experience, is responsible for the digital transformation of the manufacturing sites of the company.

More details on the analysed companies:

		Digital tools used in the supply chain	Respondent
1	**Company A**	data analytics tool	Supply chain development specialist
2	**Company B**	delivery optimization app; app for digital order taking	Regional sales manager
3	**Company C**	cloud storage; cloud platform for invoice tracking; platform supporting traceability of the goods movement	Business development manager
4	**Company D**	application tracing transactions; Blockchain; application tracking location of the ships; cloud-based solution for storage; ERP system	Business development manager
5	**Company E**	data analytics tool; POS (Point of Sale); crowdsourcing digital logistics platform for B2B; crowdsourcing digital logistics platform for B2C	Business development manager
6	**Company F**	RFID tags; WMS; MES; TMS; OMS; demand planning system; network optimization software; cloud-based ERP system; Blockchain	Supply chain director
7	**Company G**	operations support system; app for digital order taking; platform connecting digital tools; cloud storage; WMS	Chief operating officer
8	**Company H**	ERP system; WMS; business intelligence software; data analytics tool; ML; SQL; supply chain platform	Waste management & quality control manager Digital transformation manager Operations manager

Table 1: Interviewed companies' profile, part I; (Authors, 2021)

		Supply chain type	Company type	Corporate level Environmental goals	Exact digital roadmap or in the planning process
1	**Company A**	FSC	FMCG	yes	digital roadmap
2	**Company B**	Cold FSC	FMCG	yes	digital roadmap
3	**Company C**	FSC	Comodity trading	no but has sustainably certified operations	planning
4	**Company D**	Fresh & Cold FSC	E-commerce	yes	digital roadmap
5	**Company E**	Fresh FSC	Food & beverage business	no, but has sustainability at its core	planning
6	**Company F**	FSC	Agribusiness and Food Business	yes	digital roadmap
7	**Company G**	Fresh FSC	E-commerce	no, but has sustainability at its core	digital roadmap
8	**Company H**	FSC	Nutritionals and food manufacturing and trading	yes	digital roadmap

Table 2: Interviewed companies' profile, part II; (Authors, 2021)

		Years in business	Market size	Nr. of years using digital tools	Digital tools: acquired vs in-house built	Degree of digitalization
1	**Company A**	50+ years	Multinational	2 & 3 years	acquired	partial digitalization & fragmented
2	**Company B**	50+ years	Multinational, but only regional is analysed	6 months & implementation stage	acquired	partial digitalization & fragmented
3	**Company C**	Start-up 2 years	National	2 years	acquired	partial digitalization & fragmented
4	**Company D**	Start-up 5 years	International	2 & 1 year	in-house built	end-to-end digitalized & integrated
5	**Company E**	Start-up 2 years	Regional	2 years	acquired	partial digitalization & integrated
6	**Company F**	20+ years	Multinational	6 years	acquired	end-to-end digitalized & integrated
7	**Company G**	Start-up 5 years	Regional	5 years	in-house built + cloud storage	partial digitalization & integrated
8	**Company H**	50+ years	International	12 & 3 years	acquired	partial digitalization & integrated

Table 3: Interviewed companies' profile, part III; (Authors, 2021)

3.4 Data analysis

According to Goulding (2002), GT was developed by the collaboration of two scientists: Glaser and Strauss; they created it in aspiration "to develop a more defined and systematic procedure for collecting and analysing qualitative data" (p. 40). However, after its development in 1967, GT was divided into two camps of the initial authors. In the data analysis step of this study, a combination of both schools was used. From the Glaserian approach, creativity and openness while analysing the data were taken, and from the Straussian approach, a formal approach towards the analysis of data was taken (the three steps of coding) (Mello & Flint, 2009).

Step 1: Open Coding

According to the GT approach, the analysis of the gathered data has started early on. The first stage of analysis is open coding. "Open coding is the process of breaking down the data into distinct units of meaning" (Goulding, 2002, p. 76). This is an early development stage where analysis usually lacks focus and starts gaining clarity the more interviews are conducted. Each interview was transcribed, and each line was analysed thoroughly before proceeding with the

following interview. The authors tried to pinpoint chunks of texts that belonged to various concepts researched in this thesis. At the same time, the authors tried to stay open towards new concepts that were identified throughout the new interviews. Multiple codes emerged throughout the interviews, and when a relationship between the codes was found, these codes were merged into groups of codes; thus, a relationship between the gathered information was established (Goulding, 2002). A various number of codes emerged from each interview; the most significant amount going up to 135 codes from one interview.

Step 2: Axial Coding

Goulding (2002) explains that axial coding is a movement towards more abstract thinking. With the help of constant comparison, similarities are identified, and more general categories are built that show the interconnections of the codes. Axial coding is the one that forms the core of the future theory. Thus, the authors went constantly back and forth between the interviews and the data analysis to compare and identify patterns and relationships. This is an abductive process of theory development. Abductive reasoning is particular to GT development (Charmaz, 2006).

Step 3: Selective Coding

This is the last step of coding. After the constant comparison and identification of the relationships between the categories, the degree of relationship has to be identified. It is done to recognize the main categories around which the "storyline" evolves (Borgatti, 1996). The axial coding and selective coding with the analytical inputs are presented in the fourth chapter, analysing the empirical data.

3.5 Research quality

The paper gains external validity thanks to the fact that data from the interviews was gathered and sent to the "centre of calculation" and was "translated" into codes and segments with the help of GT; these were later categorized and incorporated into tables; it makes the data mobile, stable, and shuffable (Latour, 1987). After that, it was possible to generalize the findings, and this type of data can also be used again in future research within new studies or to replicate the current study without distorting the data. When it comes to internal validity, (Yin 2014) states that it does not have as much importance for the research in descriptive or exploratory studies.

The paper gained reliability thanks to its intertextuality; rich referencing to previous research is present in the literature review. Additionally, the paper acts on distances (Corvellec, Ek, Zapata, & Zapata Campos, 2018). While looking at the interrelation of three fields of study, bridges are created to reduce the distance between the fields and the knowledge, and new relationships between previously detached fields are created. Moreover, the whole research process was documented; the interviews were recorded and transcribed, which increases the reliability of the qualitative research (Flick, An introduction to qualitative research., 2009).

3.6 Critique for the chosen method

It is essential to mention that authors acknowledge the existing drawbacks of the chosen method, interviews. Data acquired this way can be subjective. Respondents understand that they represent their company, and they might feel the pressure and strive to showcase it from the best angles. This is one reason why the authors decided to focus only on the benefits to environmental sustainability rather than any positive and negative effects. Additionally, all the knowledge created as a result of the interviews was perceived as truthful 100%, though authors understand that it might not be the case all the time.

Moreover, seven interviews were conducted in English while the mother tongue of the interviewees is Indonesian. Thus, the respondents often could not express themselves clearly or fully and limited themselves to short, brisk answers. At the same time, one interview was conducted in the Indonesian language and later translated by one of the authors. Important notions and meanings might have been lost in translation. Additionally, when it comes to the GT, interviews should be done at least one week apart to ensure a thorough analysis of each interview before proceeding to the following one (Goulding, 2002). However, it was not always possible. Authors collaborated with large companies and busy people, so often dates for the interviews were dictated by the companies and were not negotiable.

3.7 Ethical considerations

Qualitative research is unavoidably linked to people in the subject; thus, it is crucial to consider ethics (Silverman, 2013). Therefore, ethical considerations have been followed throughout the entire research process. According to Silverman (2013), the main ethical principles are "voluntary participation and the right to withdraw; protection of research participants; assessment of potential benefits and risks to participants; obtaining informed consent; not doing

harm" (p.162). In order to follow these principles, several actions have been taken. As discussed above, the research topic is a sensitive one, so the authors strived to use neutral language, avoid criticism, and not offend the interview participants. The purpose of the interview was explained to the interviewees in advance. Consent was taken for the recording of the interview, and the reasons for recording were explained. Moreover, participants were given to sign a form where their anonymity was reinstated, and they were given the right to withdraw from the research at any point should they desire that as well as they could choose if they agree or not to the extracts from the interview to be quoted and published.

Lastly, during the data collection and analysis process, the authors strived to hold a high level of integrity and objectivity. The researchers are aware of their own life experiences, and to their best abilities, try to avoid the interference of their preconceptions into the study findings in order to preserve the accuracy of the research.

Chapter 4. Results

In this chapter, the authors present a thorough analysis of the empirical data gathered from eight companies from the food industry in Indonesia through in-depth semi-structured interviews. The aim of the chapter is to answer the two RQs of this thesis. It is essential to keep in mind that the analysis and the results are presented from the perspective of the managers working in the Indonesia's FSC. However, in order to place this paper in the broader context of the existing research literature and to create intertextuality, the results are compared to previous studies and knowledge within the field when possible. Moreover, comments and direct quotations from the respondents will be written to offer readers references to the empirical data which has been the basis for various findings. The reader must be aware that all the concepts and findings obtained in this study are grounded; hence, they are not yet proven to be generalized and are presented as substantive theory. Therefore, the empirical study presented is only suggested from the analysis done by the authors to answer the RQs which motivate this study. Additionally, to facilitate the reader's comprehension of the chapter, authors have divided it into two sub-chapters answering a RQ each. First sub-chapter comprises the analysis of the findings regarding the benefits for the environmental sustainability of the companies generated by the FSC digitalization in Indonesia. The second sub-chapter encompasses the results from the analysis of the factors influencing the digital transformation of the Indonesian FSCs and their classification.

4.1 Benefits for the environmental sustainability of Indonesia's food supply chains from the digitalization process

Below are presented the findings coming from the last step of GT, axial coding, to answer *RQ1: How does digitalization benefit the environmental sustainability of the food supply chains in Indonesia?* After a lengthy and thorough analysis of the interviews, the multiple generated codes have fallen into three prominent families, which in turn each lead to a more environmentally sustainable FSC. Three dimensions that have been identified are optimization, traceability, and visibility (Figure 1). Each of the dimensions has several subdimensions or sub-categories that help eradicate at least one of the three environmental challenges stated by the UN Global Compact: climate change, water and sanitation, or food and agriculture. It is to be mentioned that during the course of the interviews, it was established that managers believe

that evidence of these perceived benefits exists and even can be evaluated, though most of the time, concrete numbers were not disclosed to the authors.

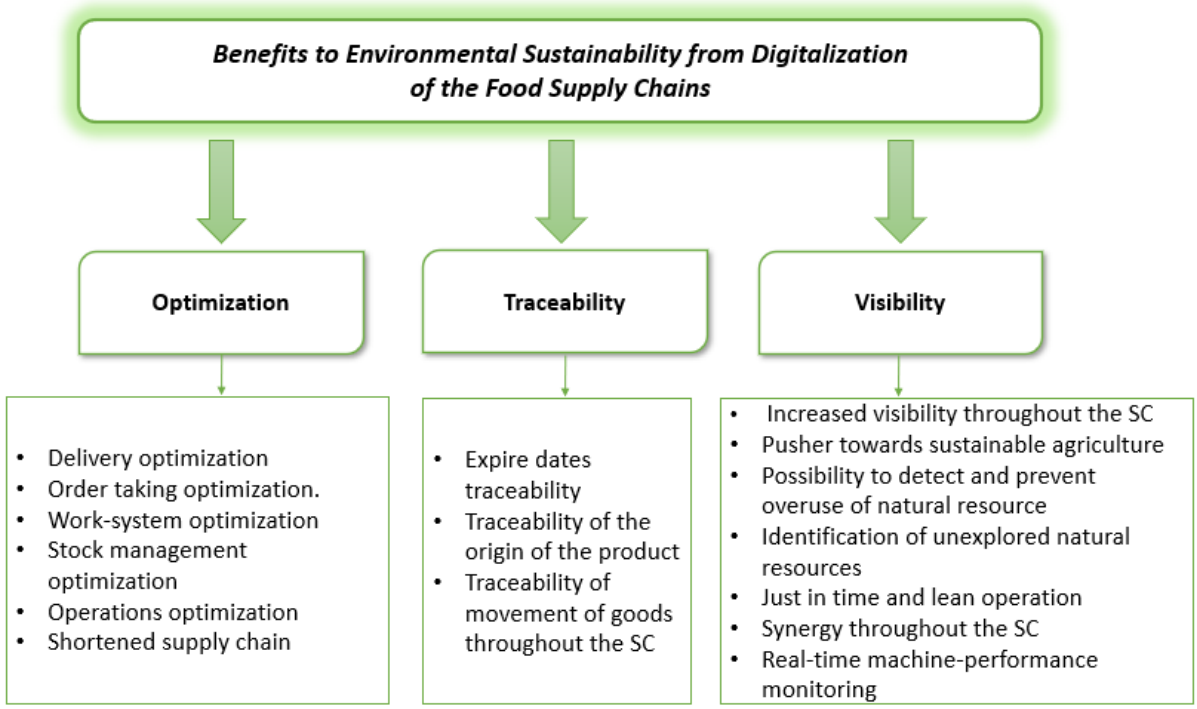

Figure 1: Benefits from the digitalization of the food supply chains that lead to the eradication of the environmental challenges; (Authors, 2021)

4.1.1 Optimization of the food supply chains

Optimization of the FSC with the help of digital tools and significant benefits for the environmental sustainability coming from the FSC optimization has been discussed most often and in-depth by the respondents. It was identified that there are a wide range of factors that can be optimized through the digitalization process. Those factors have been gathered into six sub-categories of optimization: delivery optimization, order-taking optimization, work-system optimization, stock management optimization, operations optimization, and the optimized length of the FSC (Figure 2).

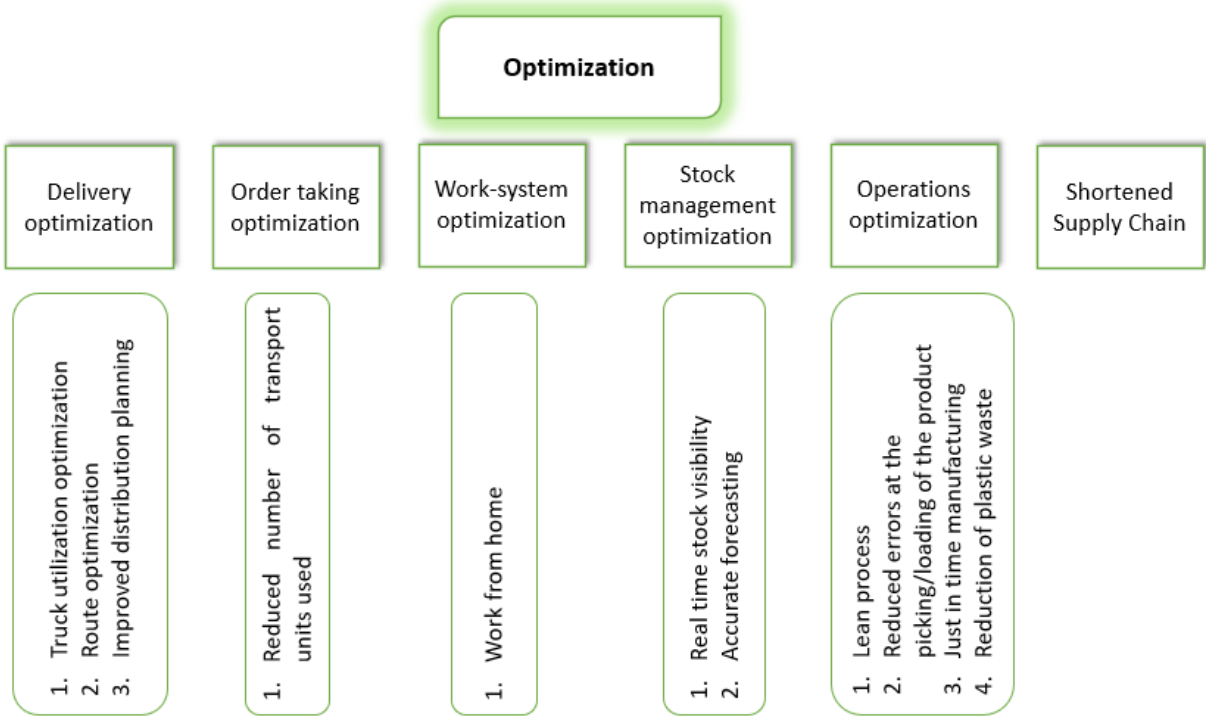

Figure 2: Benefits from the optimization of the food supply chains that lead to the eradication of the environmental challenges; (Authors, 2021)

Three components together make up the delivery optimization sub-category. These are truck utilization optimization, route optimization, and improved distribution planning. Six out of eight companies have stated that they could do some type of truck utilization optimization thanks to the implementation of various digital tools. Companies A, E, F were able to increase the truck fill rate. Company A has stated that it has reduced the number of trucks used for delivery by 9.4% thanks to load optimization. Two companies have achieved optimal selection of the trucks; now, the digital system matches the size of the loads to be delivered with the required size of the truck. This all is leading to reduced CO2 emissions because of fewer half-empty trucks on the roads. Company H has concluded that digitalization has helped to increase the quality of the trucks in use, as well as the time efficiency; now, there is no need for additional inspections of the trucks; this leads to food safety achieved through less contamination during the transportation phase and reduced food waste especially for the time-critical products due to time efficiency.

"Under transportation, we use system analytics to calculate the optimal utilization of each truck, because if we are only following the supply or the order from the customer, then we will be having non-optimized trucks [capacity]. Say we want to have 100% utilization of the truck,

but at the end of the day, if we are only following [the orders] and not doing the improvement, we are only sending them with 60% of utilization and it leads to a bigger number of trucks. […] The digital tool is giving us the opportunity for the fast improvement in regard to the utilization of the trucks. And as a result, we are having a reduced number of trucks. And therefore, reduced carbon dioxide and other things." (Company A)

The second component of the delivery optimization is route optimization. Half of the companies interviewed use some type of software or algorithm for this purpose. Both old and new, international and national companies see the benefits towards environmental sustainability from route optimization. However, the tool is used differently; most of the companies use it on a daily basis, but Company F, for example, uses it only every quarter to optimize the fixed routes. Several benefits from route optimization have been identified. Company B has seen that now one truck can be used for more dropping points; thus, fewer trucks are needed and hence, decongested urban area; the fuel consumption was reduced by as much as 50% for selected routes, so, fewer natural resources are consumed. All four companies have seen that the time and distance of the delivery have been reduced, leading to reduced CO2 emissions. The efficiency of the delivery for Company G has grown from 80% to 90%. For Company F, the distribution system is now integrated with the warehouse system; therefore, it cuts unnecessary time-wasting within the distribution.

"In transport, we use what you normally call transport management system. This is basically used to link sales orders with truck planning. This will help us make sure that we improve our truck availability, even for last minute order. When we use this system, our information accuracy is improving much, much better than before […] And once the trucks arrive at our plant, immediately, our system will call this truck and our WMS, the warehouse management system, will pick up the goods from the warehouse. So, the truck will no longer need to wait for too long before the goods are loaded into the trucks." (Company F)

The last component of delivery optimization is improved distribution planning. Company E stated that their software enables them to plan ahead and to be able to track the whole distribution. This has dramatically improved the relationship with the distribution partners, but most importantly, it has made them more time-efficient, and time is a critical factor in reducing the food waste in the fresh FSCs. As mentioned by company B, E, F, G and H, time-efficiency is an essential matter in the distribution because some of the commodity being distributed is

time-critical products, which if not handled properly, or lacking efficient distribution may degrade the quality of the products or turn the products into waste in the process.

"So, if we are talking about supply chain in our product category, it will be very time critical. And we will plan ahead before we implement that. And especially for fresh product and live product, because we are also selling live product, we will plan ahead 24 hours or 48 hours before we can send the product. We need to know every supply chain." (Company D)

Order-taking optimization is the second sub-category derived from the optimization dimension. Company B has developed its own software to reduce the salesmen workload in one of the underdeveloped areas of Indonesia. An online platform was created for the local store owners to place their orders via a mobile application. This reduces the carbon footprints of the salesmen as they do not need to go from store to store on a weekly basis. Earlier, salesmen were going to up to 180 stores weekly by motorcycle to collect the orders.

Moreover, digital integration obtained due to digital tools' implementation helps companies optimize their work-system, the third sub-category. Ultimately during this COVID-19 pandemic, the help of an integrated cloud system makes it easier for companies to enable the back-end office workers to work from home while the data integration is still connected and will not affect the outcome of the work. The integration of the work system will also decrease and may even eradicate errors as everyone works within the same cloud system. Further, it reduces the natural resources used by the employees to get to the office and at the office itself. Every interviewee implements the cloud system; it shows how important this is for the continuity of the work.

The fourth sub-category, stock management optimization, can be expressed through two significant gains: real-time stock, visibility, and accurate forecasting. This sub-category benefits companies' warehouse system the most, as stock management reduces high inventory holding costs; thus, less space for storage is needed, and minimum to no amount of expired product is achieved. This sector became one of the most crucial parts for company F, which is the most digitalized company that the authors have interviewed. Additionally, implementing visible stock management and accurate forecasting in order to prevent food loss and waste is significant towards the sustainability challenge in Indonesia. Out of the eight companies interviewed, only three of them did not achieve this optimization, and it shows the relevance towards Indonesia's current condition of food loss and waste, as the economic sectors come

into play in which there might be less and less food for the poor if the issue of food loss is not tackled properly (Soma, 2017). This shows that Indonesia's food industries are stressing the issue of food waste, as a lot of lower-class Indonesian having the inability to get food (Soma, 2017).

"[…] we are now implementing the integrated demand and supply planning system. This is basically to maintain our supply and demand accuracy at the highest level, and to reduce the waste or inventory holding, the excess inventory holding at our plant. Now, with this demand and supply planning system, we procure only when we need it. So, we reduce the BOI, base of inventory, in the warehouse for both raw material and finished goods. So, the machine inside the barn is optimized to produce only what the market needs at that particular time." (Company F)

The fifth sub-category identified is operations optimization. Company F, G, and H, the only three companies using digital tools for more than five years, have seen enhanced environmental sustainability obtained from operations optimization. Respondents have stated that through digitalization, companies were able to accomplish a leaner process, just-in-time manufacturing, as well as reduced errors at the picking and loading of the products, which all lead to the reduction of food waste. According to Labs (2019), it is true that considerably food loss and waste can be reduced or even prevented with the help of lean and just-in-time operations (Labs, 2019). Additionally, Company G, a start-up E-commerce company with in-house built software, has found a way to reduce plastic usage in their activity with the aid of digitalization. They source fresh fruits and vegetables from farmers and distribute them directly to the consumers after the sorting at the fulfilment centre. Through the application, consumers can choose to have plastic-free orders; thus, the use of plastic is avoided even at the fulfilment centre.

The final sub-category from this dimension is the optimized length of the FSC. Company D and G are e-commerce companies, and they were able to create a maximally short supply chain through digitalization. They were able to cut the number of middlemen substantially. Both companies do not have any manufacturing needed to be done within their FSCs, but since company D works under the fishery industry and company G works under fresh agri-food industry, the commodity they offer is time-critical, and due to the lack of infrastructure in Indonesia (Faturay et al., 2017), there are many middlemen within the older FSCs. They create unfair trading environments for the fishermen and farmers. Hence, shortening the FSC will

bring benefits towards environmental sustainability, and it will also benefit the lower-class social and economic sustainability of Indonesia. Vanishree & Sendhil (2018), in their research, also claim that shortening the lengthy FSC reduces the environmental impact of the companies.

4.1.2 Traceability of the food supply chains

The second dimension identified by the authors and obtained through the digitalization of the FSCs, which leads to more environmentally sustainable FSCs is traceability. This dimension is separated into only three sub-categories: expiry dates traceability, traceability of product origins, as well as traceability of the movements within the FSC (Figure 3). However, it is still of great significance to the findings as all the eight companies interviewed have recognized this enhanced dimension after embarking onto the digitalization process.

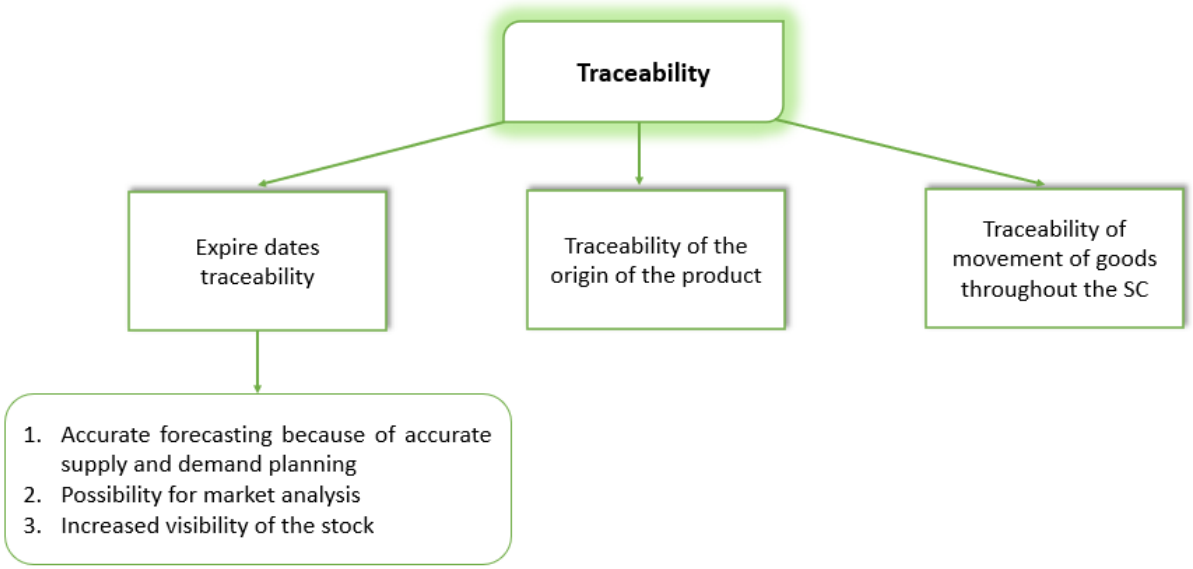

Figure 3: Benefits from the traceability of the food supply chains that lead the eradication of the environmental challenges; (Authors, 2021)

It is stated within the literature review that 30% of food loss and waste happens before it reaches the consumer's hands (Gustavsson, Cederberg, Sonesson, Van Otterdijk, & Meybeck, 2011). This shows that even during the manufacturing of the product, companies tend to not check on their product expire-dates, thus having a significant loss in food and profit. Five out of eight of the companies interviewed are stressing over this issue and are using their own take to reduce the food loss caused by expired products. The expire date traceability is enhanced by having better market analysis, more accurate forecasting, and improved stock visibility, which are all

possible thanks to digitalization. Companies have stated that the possibility of tracing the expiration dates of the products has helped them avoid overproduction and make use of the near-expire goods before these become a waste.

"The second goal is to reduce the bad goods in order to reduce food waste. We are doing expiry date traceability […]. By having this kind of visibility, it is giving us transparency and is helping to ensure that we are committed to the environmental focus." (Company A)

The second and third sub-categories of the traceability dimension are quite interrelated. In order to ensure food safety and security, five companies use digital software to trace the movement of goods throughout the entire supply chain. They state that it also helps to maintain the quality of the product and to reduce waste. This is in line with the research done by Roth, Tsay, Pullman, and Gray (2008), which shows improved food safety and quality due to enhanced traceability. Company C, D, and G, which are companies that work within the fresh commodity industry, take it to the next level; they trace the origin of the commodities. Tracing the origin of the product is also being pushed by the demand of the market in which today's consumers are more aware of a better quality of the products and the impact towards the sustainability matter (Ghadge, Er Kara, Mogale, Choudhary, & Dani, 2020).

"To manage those forms of certifications, there are tools created by the Rainforest Alliance for its certified members. So, for that documentation administration proposes we are utilizing their tools. The tools also function as traceability tools for the teas that we are sourcing and selling. So, within that website and that platform, we can track the teas that we are selling to our customer; we can have the footprint from where it was planted, from where it is sourced, and to where it is sold." (Company C)

4.1.3 Visibility of the food supply chains

Visibility of the FSC gained from using the digital tools is the third and last dimension identified that helps towards the environmental sustainability of the FSC in Indonesia. Visibility dimension is formed by seven sub-categories that are possible due to the digitalization process: increased visibility throughout the entire FSC, synergy throughout the FSC, possibility to detect and prevent overuse of natural resources, identification of the unexplored natural resources, just-in-time and lean operation, add a real-time machine performance monitoring, and a more sustainable agriculture (Figure 4).

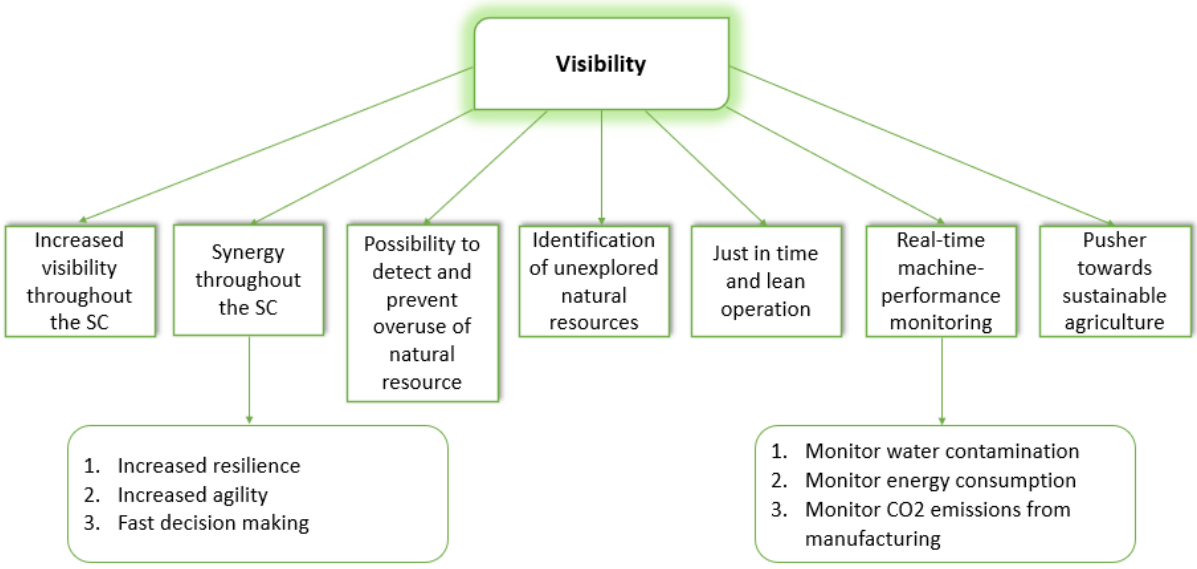

Figure 4: Benefits from the visibility of the food supply chains that lead the eradication of the environmental challenges; (Authors, 2021)

The first sub-category of the visibility dimension is increased visibility not just in one or several elements of the SC but throughout the entire FSC. Four out of eight companies interviewed have stated that they have gained this added value after their digital transformation. This was true both to small and large companies, and to partially and fully integrated ones; though naturally, to different degrees.

"…information is visible to all parties as it happens. So, quick decision can be made should anything happen." (Company F)

The two companies that use digital tools for the longest period have the most significant number of integrated tools and have claimed that they have achieved synergy throughout the entire supply chain: second sub-category. Thanks to this, Company F and H have gained increased resilience and agility. They are able to act fast and make quick decisions when unexpected challenges occur. According to Bajželj, Quested, Röös, and Swannell (2020); Stella (2019), added resilience helps to reduce or prevent food waste throughout the FSCs.

Companies C, F, and G have seen that digitalization and particularly enhanced visibility are pushing their companies towards sustainable agriculture. Company F, for instance, has all the trees at the palm tree plantations incorporated with RFID tags. According to the supply chain director, this helps to identify the optimal time for harvesting while avoiding waste, and it also helps to monitor the usage of water and fertilizers at the plantation. Moreover, increased

visibility has helped Company F to promote continues sustainable agriculture. Previously, workers at the plantations were doing things "right" only before the audits, but now that anyone from the management can monitor the work at any given moment, employees have learned to implement sustainable agriculture continuously.

"[…] the issue with those audits sometimes is that people have to prepare a lot. They prepare prior to the audit. In the time before the audit, they don't really care much about the situation. Now, with this digitalization, they have to care about it every day because the management can actually look at it anytime. So, this has helped shape the behaviour of the people on the ground (at the execution level). And with this, it reduces waste, it reduces loss and pollutions, that people without digitalization would actually do. So, it is shaping a new behaviour of the people on the ground." (Company F)

Furthermore, company D has seen benefits from using the digital tools that have formed two more subcategories of the visibility dimension. Company D operates within the Indonesia's fish industry. Thanks to the in-house developed digital tools, Company D has full visibility over its supply chain, including the exact locations where fish is caught. This has greatly helped the company to fulfil its mission of sustaining a healthy sea ecosystem. By constantly monitoring the location of the fishermen, it is possible to prevent overfishing, which is an overuse of natural resources; additionally, it is possible to find locations that still hold unexplored resources and are underfished. Visibility created by Company D is beneficial for the sea ecosystem, and management hopes to further improve the sea ecosystem in the future.

"[…] *by using our system in our fishermen communities, we can track the trend of the product, and we can see whether our fishermen community is overfishing or underfishing. We can see the trend and we can distribute that area that is still underfishing, so we can maximize the capacity without overfishing." (Company D)*

Likewise, within the visibility dimension is the real-time machine-performance monitoring category. Company H has the most digitalized manufacturing sites. The company's digital transformation manager stated that it helps them to have truly sustainable operations. All the machines' performance on the sites is monitored, and data is stored to be analysed afterwards through various software. It helps the company to cut down on energy consumption by singling out inefficient machines and replacing them. It also helps to monitor water consumption as well as water pollution. Additionally, it was the only company that stated that it monitors the

CO2 emissions from the whole manufacturing site and has checked that the digital transformation of the manufacturing sites has not caused added CO2 emission.

Finally, increased visibility leads to leaner operations. It is interconnected with the benefits that have already been discussed within the optimization dimension.

4.2 Factors influencing implementation of digitalization in food supply chains in Indonesia

The previous sub-chapter presented benefits towards the environmental sustainability of the FSCs acquired through the digitalization process as seen by the respondents from the eight FSC companies from Indonesia. It is consequential that in order to achieve those benefits, companies must first embark into the digitalization process. So, it is crucial to take a step back and look at the bigger picture. To answer *RQ2: What factors influence the digitalization process of the food supply chains in Indonesia?* Authors have investigated four factors influencing the digitalization process of the FSCs: obstacles, pushers, opportunities, and challenges, as these factors can give an in-depth understanding of the past, present, and future hopes for the digitalization process. *Pushers* are the elements that are out of the company's control and somewhat force the management team to adopt digitalization. *Opportunities* are attractive elements that are seen as desired things, future aspirations that can be achieved only through the digitalization process. *Obstacles* are the elements that are stopping companies from adopting digitalization or are slowing them down. Finally, *challenges* are the issues that the companies face throughout the implementation process of digitalization, already after embarking on the process.

First, the obstacles are analysed; or barriers that stop businesses from transitioning from manual operations towards a digitalized supply chain. Indonesia is still at an early stage of the digitalization process, as seen from the literature review. The companies interviewed have embarked on the digitalization process quite recently from 6 months to 6 years ago, and only one company started the digital journey 12 years ago. This is despite the fact that half of the interviewed companies have been in the business for 20+ and 50+ years already. So, investigating the obstacles might bring some light onto the question of the late adoption of digital tools in Indonesia compared to many developed countries. Pushers are the factors that forced the businesses to finally adopt digitalization despite their resistance. These are the factors that were out of the companies' control. Opportunities are the positive elements, future

goals that companies hoped to achieve after adopting the digital tools. Moreover, finally, challenges are the issues faced by the business throughout the digitalization process, throughout their transition towards having a digitalized FSC. Thus, the section will focus on the mentioned four factors. For better visualization, see table 4.

	Factors Influencing the Digitalization Process of the Food Supply Chains in Indonesia			
	Obstacles	**Pushers**	**Challenges**	**Opportunities**
1.	Cost of acquisition	Need to be remain competitive	Time-consuming R&D of digitalization process	Increase of business efficiency
2.	Resistance to change	Digitalization is enforced by the global team	Employee training	Food waste reduction
3.	Challenging process of digitalization	Need to eradicate the errors derived from the manual work	Poor technological skills at the operational level	Cost optimization
4.	Complexity of the operational process	Customer demand	Time-consuming implementation process	Added resilience
5.	No clear guidelines for digitalization process	Nature of the product	Complexity of the digitalization process	Market acquisition
6.	Misperception of the new technology	Nature of the business	Various digitalization level in multinational organizations	Shortened supply chain
7.	Need for collaborations	Nature of the industry	Poor technological skills within the B2B customers	Social sustainability
8.		Poor infrastructure	Lack of clear communication between the global and the local team	Market disruption
9.			The process of knowledge transfer	Identification of product seasonality
10.			Large size of the business	Support for the governmental goals
11.			Poor infrastructure	Time efficiency
12.			Process of finding the best fitting digital solution	Reliability and accuracy
13.				Convenience for employees
14.				Competitive advantage
15.				Increased food safety and security

Table 4: Factors influencing the digitalization process of the food supply chains in Indonesia; (Authors, 2021)

4.2.1 Obstacles for food supply chains digitalization

After the communication with ten managers from 8 companies, seven main obstacles for digitalization were identified: resistance to change, misperception of the new technology, cost of acquisition, complexity of the operational process, lack of clear guidelines for the digitalization process, digitalization as a challenging process in general, and need for collaborations (Figure 5).

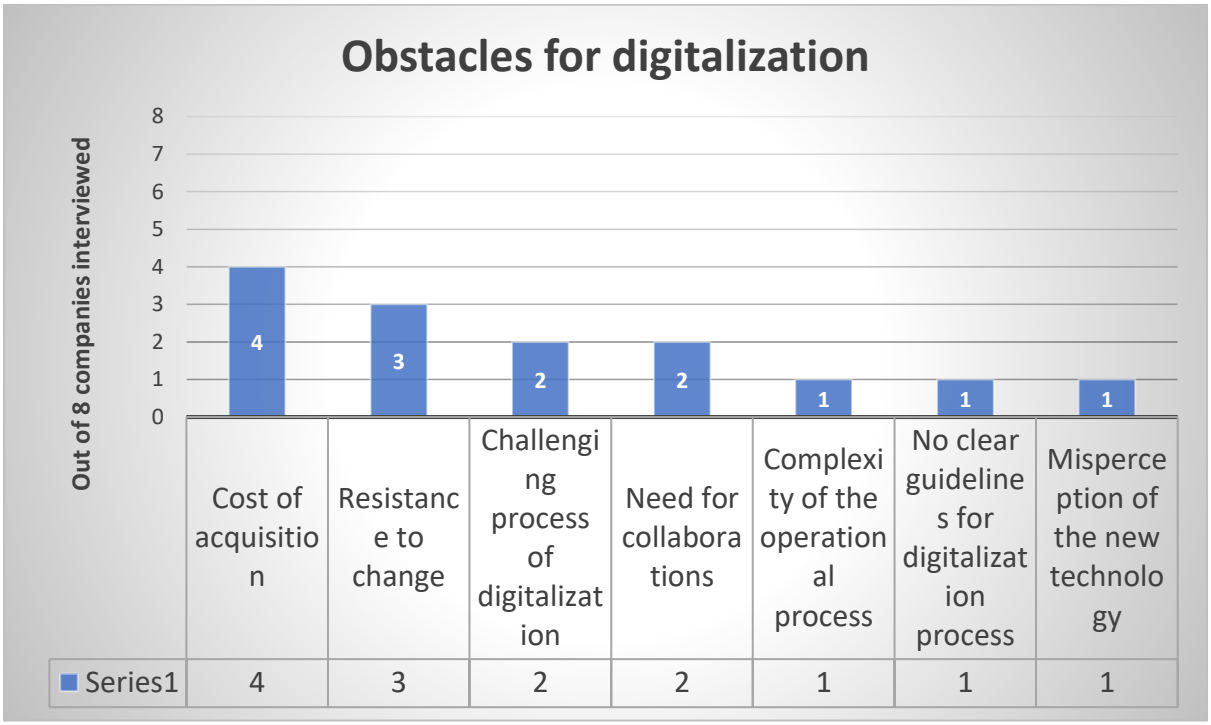

Figure 5: Obstacles for digitalization of FSCs in Indonesia; (Authors, 2021)

The main obstacle identified is the high cost of the acquisition of digital tools. Substantial investment is required, and this is stopping or has delayed companies from faster adoption of the digital tools. This was found to be true for all types of companies: new start-ups operating regionally, multinational companies, as well as both: companies that chose to acquire the tools and those that chose to build the tool in-house, specifically for their needs. Four out of eight companies have faced this obstacle.

"In terms of costs, some of them [experts in FSCs] will say:" Well, it's bloody expensive. We already have all the tools we need to do the work today, so why do we need to have these additional things?" […] And when you need to upgrade it (the software) without having the (annual) license, it probably cost you a fortune as well." (Company F)

Resistance to change is another significant obstacle identified. A particularity was the fact that only old companies which have been in business for decades have mentioned this factor. Three out of four old established companies interviewed have seen resistance to change as an obstacle, while start-up companies have not mentioned this.

"People will ask: "[…] Is this only some hype that will pass and be forgotten? And then some will ask: Why do I need to do this? I'm fine with the current process that we do today." […] I see that people in general resist to change. So, the question is, how can we bring these tools, digitalization, despite the resistance? How do we deal with the people when their work changes? (Company F)

Resistance to change is also closely related to another obstacle found: misperception of the new technology. As explained by Company B, which does the distribution of the goods within a cold FSC for many years, retailers used to benefit from personal service; an employee would visit around 180 stores on a weekly basis by motorcycle and would take the orders personally for the following week; when the company decided to switch to a digital tool for order taking, which would mean that one person would now be able to serve around 250 stores weekly without ever leaving the office, Company B met massive resistance from its customers because they saw it as a decline and a complication of a service that used to be very easy and convenient.

The two most digitalized companies. Company F and Company H, which have fully integrated systems with the most significant number of digital tools, nine and eight tools each, both have stated that the lack of collaborations is an obstacle, and partner companies are required before fully embarking onto the digitalization process. These can be business partners or consultancy companies who will be there throughout the entire process, especially during the first year of the implementation when everyone is still adopting the new systems, and the processes have to be stabilized. The same two companies acknowledge that digitalization is a very challenging process, and this is yet another obstacle. Company F has compared the process of digitalization with a complex equation that must be solved beforehand. It is so complicated that pilot programs should be implemented first before making a final decision about the adoption of one tool or another.

"We do pilot projects before fully adopting the new software. We have a pilot project in machine learning to study the activity at the manufacturing site and to make some real-time

monitoring. We also just started a pilot to study about steam or gas consumption from several machineries. And another pilot for artificial-intelligence-based tools." (*Company H)*

Another obstacle met by Company F was the fact that there is no clear guidance for the digitalization process in the industry. Respondent F, a supply chain director who has worked with multiple FSCs throughout his career, states that many fellow experts from the field are confused and do not know how to tackle the digitalization process, and this is a huge obstacle.

"Today, I also talked to several people that need help or need clarifications in the digitization. And there are a lot of obstacles that they see when it comes to digitization. […] First and foremost, people will ask: How do I start? What kind of beast is this digitalization? […] And some would say, it's too complicated; we don't really have the time for this nonsense. […] Are we ready to embark this? Do we need a specific thing just to handle this digitalization? Because no one really knows." (Company F)

Finally, Company D, a start-up operating internationally, stated that the complexity of the operations, and specifically the distribution leg of the cold FSC is too complex and too time-critical to be handled efficiently by software; therefore, it would be disadvantageous to move this from manual work to a route optimization algorithm. This conclusion is quite contradictory to the existent literature stating that digitalization brings efficiency to the SCs (Ehie & Ferreira, 2019; Ntabe, LeBel, Munson, & Santa-Eulalia, 2015). However, the authors acknowledge that this might be due to the novelty and inexperience of the business; the start-up has operated for five years and has been using the digital tools just during the past two years. Additionally, this may be connected to the obstacle mentioned above of misperception of the new technology.

4.2.2 Pushers for food supply chains digitalization

The analysis of the communication with eight companies has led to the identification of eight pushers for FSC digitalization in Indonesia: need to remain competitive, the global team enforces digitalization, need to eradicate errors derived from manual work, customer demand, nature of the product, nature of the business, nature of the industry, and poor infrastructure. However, the numbers are pretty dispersed, and no major pusher for digitalization has been identified (Figure 6).

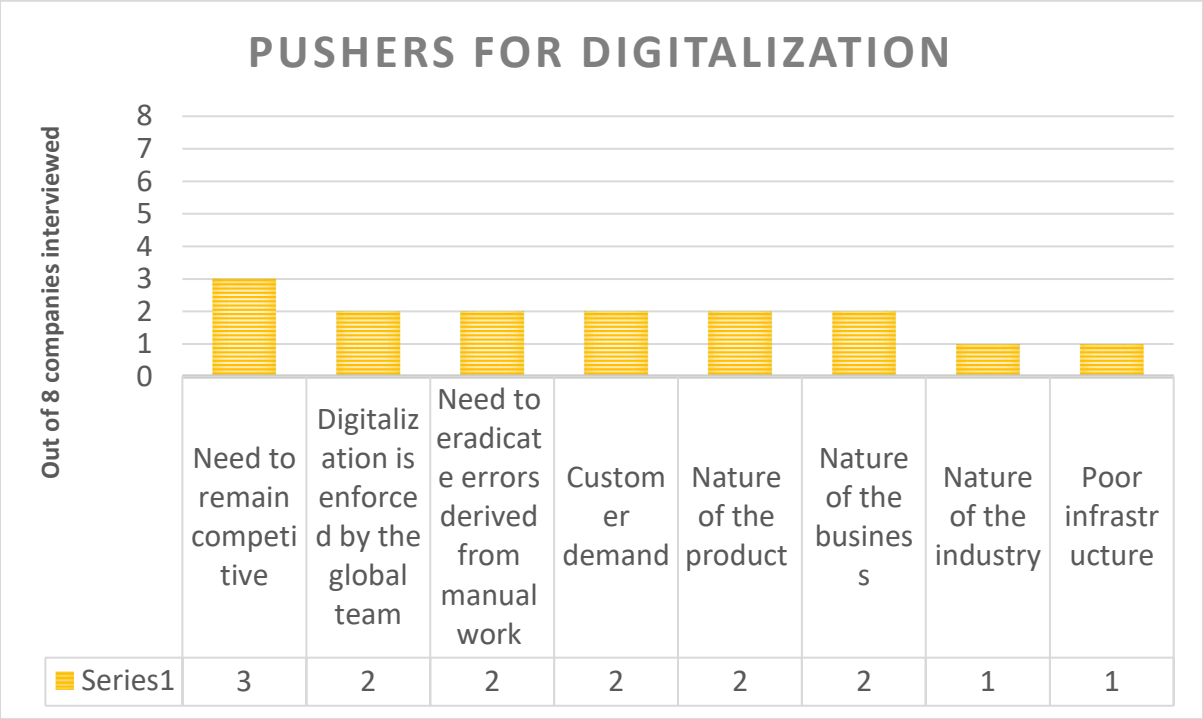

Figure 6: Pushers for digitalization of FSCs in Indonesia; (Authors, 2021)

Three companies, all of varies in size: regional, national and multinational, and various times in business: two start-ups and a 20+ years company, have associated with this pusher. It was derived from the threat to become obsolete while more and more businesses go digital and gain new competitive advantages. Then businesses have no other choice but to adopt this new reality and look for ways to go digital as well.

"If we are still operating our business in the old ways, and if we are not changing, there will be another business or the competitors that will bit [surpass] us with the new technology. So, I would say, that by keeping up with the current pace, by being digitalized, it is one way to be able to stay relevant in the market, as well as the opportunity to be able to disrupt the market itself." (Company C)

A lot of leaders actually are a bit worried. Because when they spend time to think and wait, it might be too late for them. Yeah, what if the competition is already ahead of them? (Company F)

Only two companies from the interviewed ones, Company A and Company B, have global operations and the headquarters are outside of Indonesia. Both have stated that digitalization was enforced upon them by the headquarters, by the global team who has decided on new

strategies for the two companies worldwide, and the local teams had to implement those no matter their opinion on the issue.

"Frankly, speaking, most of the digitalization here in Indonesia comes from two sides. But looking at the pusher, the first one, may be the top-down from the global team. The main department communicates that in the global we are having this type of project, for the example the transportation hub. They are setting how these tools would help us reduce the number of trucks, to reduce the emissions, to reduce the cost as well. They are setting the plan, they are analysing it, and they are expanding it to each of the markets." (*Company A)*

Another pusher pinpointed was the need to eradicate errors derived from the manual work. Company C and company G have stated this, and they are both relatively new start-ups, 2 and 5 years respectively. These companies were already created in the generation of Industry 4.0. The respondents, co-founders of the two companies, understand the added value that digitalization can offer instead of manual work.

"First is to ensure that the operations can run efficiently. As compared with the manual processes where some of the activities are repetitive, we can build some sort of system to support those activities, so that those activities can be done faster. So, basically it is to ease the job of the people who run the day-to-day activities. And then the second one is about reliability and accuracy. If we would be using tools like a pen and paper, we would have to aggregate all the orders manually, of course, and there would be a huge margin of error." (*Company G)*

Moreover, from four businesses operating at a global scale, two have stated that the nature of the business has pushed them towards adopting digitalization in their daily operations to achieve fully integrated systems. This is in line with Sarkis, Kouhizadeh, and Zhu (2021), who claim that digitalization enables the integration of global FSCs. Company F has several production plants around Asia and exports goods worldwide, and Company H has multiple manufacturing sites around Indonesia and exports worldwide as well, hence both have claimed that complete visibility throughout all the international departments, simultaneous traceability, and instantaneous communication is crucial for efficient, resilient business operations. Those can be achieved only through digitalization. Astill et al. (2019) stated that digitalization enhances the process of information sharing between numerous actors thanks to the added

connectivity and visibility. Furthermore, according to Wehberg et al. (2017), real-time information allows the company to be flexible and make fast decisions.

"We really need information in a short time that can be used for taking decision in the whole business, so I think digitalization is quite an important part" (Company H)

"I think one of the reasons, and this is one of the big reasons, is because we don't operate just in Indonesia, we operate in multiple countries, and a lot of this processes in our industry is the same. And a lot of information is coming in from the plants. You know, in Indonesia itself we have several plants, also in China, India, and so on. So, some of the information needs to be centralized so that the management can see what is going on and make decisions faster based on the input they get from all these factories. […] So, I think size of the company is something that matters for us, and information from all of these plants needs to come faster for us to make a quick decision." (Company F)

Additionally, two out of four start-up companies have indicated customer demand (B2B) as a pusher towards the digitalization of the SC. Company D has seen a growing demand from the customers to track every transaction and the quality of the product. While for Company C, it was a matter of choice: adopting digitalization or going out of the business. 80% of the revenue of Company C is generated from trading commodity goods with a large multinational business; this business demands all its suppliers to use specific software to track all the transactions and movements of the goods from the origin and all the way until it arrives in the business factory sites. In this case, the multinational business has the bargaining power.

Three interviewed companies operate with fresh foods and have a fresh FSC. Two of these companies are E-commerce businesses, and they both have found that the nature of the product is an essential factor that pushes towards the digitalization of their supply chains. The companies operate with time-critical products: fresh fruits (Company G) and fresh fishery products (Company D). The respondents argue that their products are time-sensitive and lose quality very quickly, so there was a need to find tools to track the quality and speed up operations. Consequently, Company D, for example, has adopted blockchain technology which is effective in reducing the time for tracking the products (Kamath, 2018).

The nature of the industry is one more factor identified. Company C operates with tea as a commodity. Tea is the third commodity after coffee and cocoa, whose demand for sustainable production is growing according to the International Institute for sustainable development

(Voora, Bermúdez, & Larrea, 2019). One of the largest organisations in Indonesia to give a sustainability certification is Rainforest Alliance. In order to get the certification, companies must operate with the digital traceability tool and the platform enforced by the alliance. Only one company operating with tea as a commodity was analysed; thus, only one respondent stated that pusher.

The last factor in this list is the poor infrastructure. As written before, Indonesia is made up of 17.000 islands, making the country's infrastructure a nightmare for businesses operating nation-wide. It is an increased obstacle and a factor that pushes towards digitalization, as digitalization allows the connectivity of numerous stakeholders (Astill et al., 2019). Company D is a business that has 20.000 fishermen nation-wide as suppliers and many more national and international stakeholders. Therefore, for them, digitalization was a way to overcome the poor infrastructure.

4.2.3 Challenges of the digitalization process implementation in food supply chains

As seen from the literature review, Indonesia has only recently entered the Industry 4.0 era. Businesses are still struggling to adapt to this new reality. Therefore, authors have seen it crucial to research the first-hand experience through the manager's lenses, people working in the field in their day-to-day life, and to analyse the main challenges that these managers encounter while applying new software into the FSCs. Numerous and varied challenges have been identified, which will be discussed below (Figure 7).

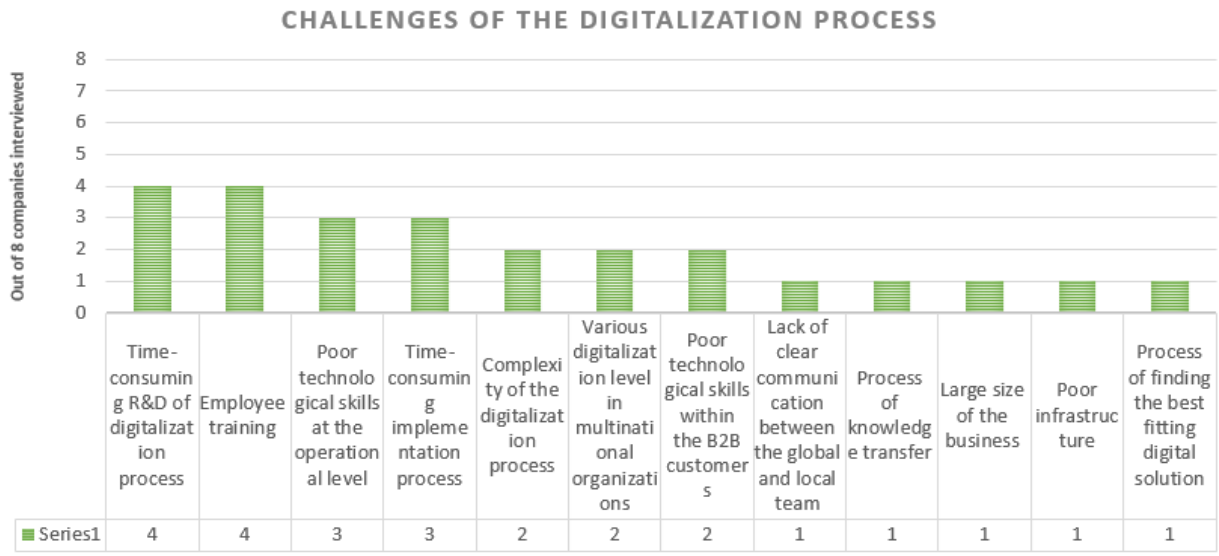

Figure 7: Challenges of the implementation of digitalization process in FSCs in Indonesia; (Authors, 2021)

According to Jiang, Han, and Huo (2020), FSC are complex and differ a lot in their nature; thus, proper research of the existing tools on the market is a must in the first step of the digitalization process: Research and Development (R&D). Half of the interviewed companies have recognized the challenge of the time-consuming R&D process of digitalization. However, it was beneficial, as, from their perspective, proper research was one of the critical factors leading to fully integrated systems with digital tools that are smoothly incorporated one with another. From the eight respondents, five companies have fully integrated systems, from which four have identified this challenging factor. Moreover, connected to this is the challenge of having a time-consuming process in the implementation stage as well already after the R&D stage. Three out of four companies that have mentioned the time-consuming R&D said that implementation is time-consuming as well and have said that digitalization is, in fact, a never-ending process, a continual journey.

That's what we did initially. We gather together as a team from different workgroups, from finance, from operations, from supply chain, and so on, and look at the overall operation and supply chain of our business, and identified the biggest pain points we had. […] So as a result, we built a digitization blueprint for our organization. We looked into our operations from end to end. We looked into different types of systems that are available on the market and those that we can embark in, and which are relevant to our organization. We looked into some kind of timeline here. But all of this is still a work in progress, because we still look into what kind of systems are available, or the best options in the market […]. So, this is a continuous journey for us. (Company F)

Additionally, another reason for a lengthy procedure is the complexity of the digitalization process- one more challenge. This challenge has various aspects and depth to it. For instance, for Company C, complexity is added by the fact that the large B2B customers have a bigger bargaining power than their newly establish start-up company; that leads to more significant customers and sustainability alliances dictating the digital tools to be used within the supply chain, which forces the company to have multiple tools in use which are not integrated with one another, leading to a fragmented digitalization. An extra aspect is explained by Company F: digital software is evolving fast and thus must be upgraded at least annually, so one cannot

just purchase a system and forget about all the troubles. The nature of the software is complex in itself (Long, Blok, & Poldner, 2016).

The process of employee training was identified as a significant challenge by half of the respondents. Company C business development manager stated that considers employee training to be the biggest challenge; it is exponential to make sure that everyone in the company is on the same page and knows the new ways of dealing with the day-to-day activities and can fully benefit from the new software. The co-founder of the E-commerce business has also said that it is essential to make sure that digital tools are used to the optimal capacity by the employees and the B2B customers, and the training is challenging.

Two challenges: poor technological skills at the operational level and poor technological skills within the B2B customers (retailers) are directly related to the previous challenge and, in a way, are partially factors that lead to it. Susilo (2019) argues that only the main island, Java, has a tech-savvy population in Indonesia, while all the other areas lack technological skills. This has been found to be true while analysing the empirical findings as well. For instance, it was identified by Company C that in order to implement a new customer-facing software for order-taking, they had to train the retailers first, as those do not use yet any smart-phones in their daily life, thus are unaware of the way the mobile applications function. More importantly, three out of eight companies mentioned that the adoption of the digital tools was challenging due to lack of technological skills within their employees at the operational level (ex: manufacturing); while the IT department employees had little difficulty adopting, people who are doing the vast majority of the labour at in the operations had to be trained more thoroughly.

The low number of tech-savvy populations in Indonesia also led to the challenge of having various digitalization levels within multinational organizations. Both global companies interviewed, that have the headquarters outside Indonesia, have stated that the different level of digitalization in different markets does not allow for the same digital tools to be used worldwide. Company B also stated that as a result, in order to overcome this challenge, new tools had to be developed specifically for the Indonesian market because, the other tools were in a way irrelevant to the Indonesian market.

The last four challenges have been singled out by one company at a time. For instance, Company A has experienced a lack of communication between the global and the local team in Indonesia; this is particularly challenging during the implementation of digitalization

because company strategies are decided at the global level, however when there is not clear communication, then the decisions and strategies suggested for the other markets as Indonesia, are not fit to their specific needs. Jiang et al. (2020) also suggest that the same digital tools cannot be applied to all the FSC due to their significant differences. Furthermore, linked to the complexity of the digital tools and various FSCs, Company E has identified the process of finding the best fitting digital solution as a challenge. This might be connected to the fact that it is one of the youngest companies interviewed; it has been in business for only two years, so the employees are still figuring out the processes and are researching the existing tools on the market that could be beneficial for their supply chain.

Three final challenges have been stated by an international and a multinational company and are directly related to the size of the business. One company has found it difficult when the process of implementation of digitalization is spread through many countries; the process of knowledge transfer in this situation is challenging. Digitalization is a complex process without having to communicate all its aspects to various markets with different levels of readiness for digitalization. The second company, Company D, is dealing with the Indonesian fishermen community, which is scattered throughout 10.000+ islands; it has to connect through its software a multitude of stakeholders; and so far, 20.000+ fishermen are connected through the application developed in-house. Lastly, according to (Indonesia-Investments.com, 2017), Indonesia lacks good infrastructure. Company D points this out as one of the challenges in the process of adoption of digitalization.

"*First of all, if we are talking about fishery in Indonesia, it is quite unconventional, often it is also quite challenging. If we are talking about the fishermen community in Indonesia, 90% of fisherman community are small fishermen communities in Indonesia. And at the same time, the places or the sites of the fishermen are lacking infrastructure very much. So often, there is no access to a good or stable data, they don't have any internet connection that is stable. Also, they are far away. And even some of them, they don't use Android or Apple devices for communication. Right now, the industry itself is very conventional and there isn't any system that fits our needs. That is why we are doing it internally; we are developing the system in-house." (Company D).*

4.2.4 Opportunities from the digitalization of food supply chain

A lot of research has been done by academia's regarding the potential benefit of digitalization for the FSCs. However, for the authors, it was essential to understand the managers' perspective on the issue. Indonesia as a country is quite new to digitalization, and all the interviewed companies are relatively new to digitalization, having used the digital tools for six months to six years, and only one company has been using them for 12 years. Because of these, it is of particular interest to the authors to analyse what opportunities managers think that digitalization can open for the food business; what are the dreams or goals that are to be achieved with the help of digitalization. The opportunities identified were the most numerous from all the factors (Diagram 4). Readers might notice that some opportunities overlap with the above-discussed benefits; however, authors consider that to be natural as the interviewed companies are at slightly different levels of digitalization. Therefore, some have already fulfilled their expectations and are reaping the benefits, while for others, the same elements are yet to be achieved and are still seen as future opportunities.

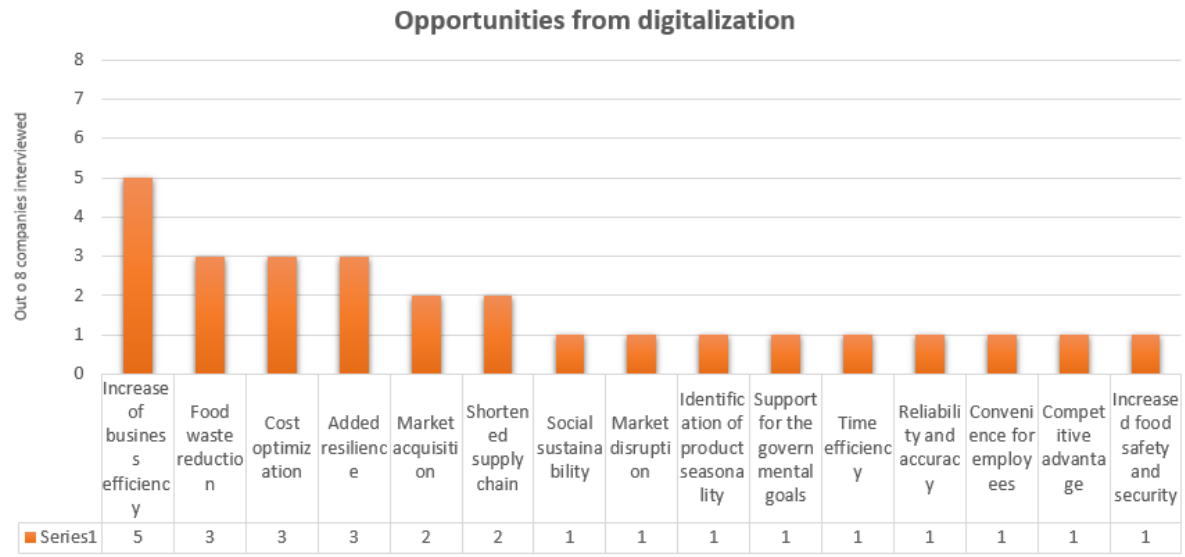

Figure 8: Opportunities of the implementation of digitalization process in FSCs in Indonesia; (Authors, 2021)

After analysing the empirical data, it was identified that most companies, five out of eight, expect digitalization to help them improve business efficiency in general. It was the most often mentioned element. Four out of five companies stated it has all the digital tools integrated and incorporated with one another. At the same time, some companies have more focused goals

within business efficiency. Three companies are looking to obtain cost optimization through digitalization; these are both large and small, old and new players in the business. The other three companies believe that they can achieve added resilience because of the possibility of making fast decisions based on quickly obtained data from the plants and manufacturing sites placed around the country or around the world. Astill et al. (2019) claim that, indeed, resilience can be created through the digitalization of the FSCs.

Furthermore, two companies, which are both start-ups, hope to get market acquisition as digitalization allows for easier reach of new customers. While another start-up company would even like to disrupt the market by gaining abilities that other, older, non-digitalized companies do not yet possess. In the case of Company C, digitalization allows them to be 100% sustainably certified in all the processes (sourcing, manufacturing, distribution), so it is a way to be a leader and to differentiate themselves in a market where only 19% of the tea commodity is sustainable-certified (Voora, Bermúdez, & Larrea, 2019). According to Creinin (2020), digital tools have disruptive potential, especially in the FSC.

"I would say, that by keeping up with the current pace, by being digitalized, it is one way to be able to stay relevant in the market, as well as the opportunity to be able to disrupt the market itself." (Company C)

Moreover, few times but the companies still stated opportunities within all the dimensions of sustainability that they hope to gain by adopting digitalization. For instance, Company H hopes to eradicate food contamination and thus increase food safety and security by increasing visibility throughout the supply chain and tracking all the goods' movement. Additionally, they see the opportunity to gain a competitive advantage if they manage to eliminate any contaminations.

When it comes to social sustainability, one company sees the opportunity to make people's work more convenient by replacing repetitive jobs with machines. At the same time, Company D aims to create more social sustainability by eliminating all the middlemen from the SC and paying fairly to the fishermen community.

"…in Indonesia, there are lots of middleman is in terms of supply chains in fishery. So, the pricing of the end-product can be up to 1.000% from the original price from the fisherman." (Company D)

Related to this issue, both E-commerce companies that were interviewed hope to shorten down the FSCs to create direct access to market for the fishermen and farmers and reduce the food waste caused by the lengthy SCs. Moreover, one company sees the opportunity to support the government towards its sustainability goals and identify product seasonality to help fishermen increase their income and create a sustainable maritime ecosystem. Lastly, three companies see that they will be able to reduce food waste with the help of digitalization. Two out of the three companies are start-up companies who have created their business having sustainability at the core of operations. They source only locally and have the strategy of preventing waste rather than reducing it, and they see digitalization as a tool that will aid them in their missions.

Chapter 5. Concluding discussion

In this chapter, the authors present summarized results of the completed research while answering the RQs that motivated this paper. Managerial and theoretical implications are drawn. Limitations of the study are stated, and suggestions for future research are given.

5.1 Summary of results

First, addressing the *RQ1: How does digitalization benefit the environmental sustainability of the food supply chains in Indonesia?*

As a result of the empirical study, three main dimensions obtained through the digitalization of the FSCs in Indonesia, which lead to more environmentally sustainable supply chains, have been identified. These are: optimization, traceability, and visibility. With the help of digitalization, companies operating in the Indonesia's food industry have optimized their operations, delivery, order-taking, work-system, stock management, and have reduced the length of their supply chains. These further led to optimal truck utilization, route optimization, improved distribution planning, real-time stock visibility, a more accurate forecasting, reduced errors from the manual labour, a lean process, just-in-time operations, as well as the possibility to work from home and to educate the end consumer regarding the environmental issue. The second dimension obtained as a result of digitalization is traceability. It was expressed through the gained ability to trace the origin of the products, the movement of goods throughout the entire FSC, and the goods expire dates. This new added value has resulted further in stock visibility, accurate forecasting, and enhanced market analysis. The last dimension identified was visibility. Enhanced visibility from the digitalized FSCs led to the possibility to prevent the overuse of natural resources, to identify unexplored natural resources, and to monitor machine performance in real-time; it also led to the creation of synergetic FSCs and just-in-time and lean operations, while also pushing the companies towards sustainable agriculture.

The respondents have identified many more benefits from the digital transformation of the FSCs, but just the above mentioned, in their perspective, have led to more environmentally sustainable FSC. Thanks to those, now, companies are able to tackle to some degree issues connected to climate change, water and sanitation, and food and agriculture.

Finally, addressing the *RQ2: What factors influence the digitalization process of the food supply chains in Indonesia?*

This study showed that the digital transformation of the FSCs in Indonesia is yet at an early stage. Multiple factors that influence that process have been identified and grouped into four families. Authors have found seven main obstacles for the digital transformation of the FSCs in the country: resistance to change, misperception of the new technology, high cost of acquisition, complexity of the operational process, lack of clear guidelines for the digitalization process, complexity of digitalization, and need for collaborations. Despite the barriers, there are eight factors that drive the adoption of digitalization: need to remain competitive, enforcement from the global team, necessity to eradicate errors from the manual work, customer demand, nature of the product, nature of the business, nature of the industry, and poor infrastructure. But once embarked on the digital journey, companies face multiple challenges; the most significant are time-consuming R&D and implementation, poor technological skills within employees and customers, need for employee training, and difference in the digitalization level. Still, companies choose to go digital because they see future gains from it. Managers have expressed fifteen various opportunities; main being: business efficiency increase, food waste reduction, cost optimization, added resilience, new market acquisition, and shorter FSCs.

5.2 Managerial Implications

At practical level, this study shows that FSC managers are not yet fully aware of all the benefits that companies from the food industry can get through the digitalization of the supply chains towards the environmental sustainability. Authors have taken the data from all companies and compiled them into figures illustrating the benefits from the digitalization process of the FSCs in Indonesia that can help towards the eradication of the environmental challenges. These can serve as a useful tool for the future managers when evaluating the advantages of the FSC digitalization. It can also be used for benchmarking purposes, to see if all the possible benefits are achieved in the process as compared to other players in the food industry, and act accordingly to stay relevant in the business.

Second RQ generates a list and diagrams with factors that influence the digitalization process of the FSC in Indonesia. The diagram comprising challenges experienced by the companies during the digital transformation; this can be useful to have in mind by the new businesses

when doing the R&D and creating the future digital roadmap; because if not addressed properly, these challenges can stop companies from gaining the full potential of the digital tools. The list of opportunities, similarly to the benefits, is to be analysed by the managers when considering the trade-offs of the digital transformation. Furthermore, the list of pushers and obstacles which illustrate drivers and barriers for the adoption of digitalization in the FSC, should be taken into consideration by the government of the country. As seen from the literature review, digitalization can be very efficient in the fight with the environmental challenges as well as in the increase of profits. Food industry plays a crucial role in the Indonesia's economic growth; thus, the government should be interested in the analysis of the factors that are stopping businesses from increasing their productivity in a sustainable manner. For example, it is clear from the research that Indonesia has a poor physical and digital infrastructure, and without help from the government, there is little what businesses can do about it. Also, with the help of this paper government can investigate what motivates business to adopt digitalization and can see the need for legal reinforcement of environmentally sustainable operations, as the current food industry is mostly profit-oriented rather than sustainability-oriented.

5.3 Theoretical Implications

This study contributes to the academia by addressing an empirically unexplored topic. The results of the study reveal the disconnection between managerial understanding and knowledge of the perceived benefits towards environmental sustainability from the digitalization process, comparing to the existing body of literature that is mostly based on experimental research. Furthermore, the study showcases the gap between the scientific literature that focuses on the research of state-of-art digital tools, and the market that is not yet ready for the high-tech technology due to the lack of infrastructure, lack of technological skills, and early stage of development of the digitalized FSCs in Indonesia. A need for the academia to be more in line with the reality of the food industry is found.

5.4 Limitations

This study is an attempt to understand the implementation of digital tools in Indonesia's FSC. It provided valuable insights for both academia and industry; however, there are some limitations to this study that have to be addressed for the reader First, the research has been conveyed in an international context. English is not a primary language for the authors, nor it is for the participants in the interviews; thus, the language barrier could have led to

misinterpretations, yet there was no way around this issue. Second, the data gathered through interviews is bound by respondents' lenses, thus personal understanding and knowledge of the topic are created. Hence, a new research with a different set of respondents can lead to slightly different results. Third, the findings of this study reflect on the FSC industry; a dynamic industry that involves numerous actors along the chain. Therefore, the results of this study need to be carefully interpreted before being implemented in other sectors.

5.5 Future research

For future research, it would be valuable to convey a further quantitative study of the same topic. This type of research will give more depth to the findings while quantifying the level of benefits from different digital tools for various types of companies within the food industry. Additionally, this research was focused on the benefits from the digitalization process, thus in future research it would be relevant to research the adverse sides of digitalization and whether benefits are grater or not. It is important to see all the effects caused the digitalization. Moreover, this research has fully relied on interviews, thus data is subject to personal bias, future research though case-study research design can provide more aspects to the topic. A similar study in another country from the same geographical region and with a similar level of development would create a possibility to generalize the findings to a broader area.

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Appendix

Anonymous Consent Form

I, _____, agree to participate in master's thesis research study on the digitalization of the food supply chains, at Lund University.

The purpose and nature of the study has been explained to me verbally.

I am participating voluntarily.

I give permission for my interview with Alexandra Surdu and Farhan Sitepu to be tape-recorded.

I understand that I can withdraw from the study, without repercussions, at any time, whether before it starts or while I am participating.

I understand that anonymity will be ensured in the write-up by disguising my identity.

I understand that disguised extracts from my interview may be quoted in the thesis if I give permission below:

(Please tick one box:)

I agree to quotation/publication of extracts from my interview […]

I do not agree to quotation/publication of extracts from my interview […]

Signature [Interviewee]……..... Date…….

Signature [Interviewer] Alexandra Surdu …..…….. Date ……

Signature [Interviewer] Farhan Sitepu …..……... Date ……

	Company Name	Supply Chain Type	Company Type	Years in Business	Market Size	Nr. of Years using Digital Tools	Digital Tools: Acquired vs In-house Built	Degree of Digitalization	Corporate Level Environmental Goals	Exact Digital Roadmap or in the Planning Process	Digital Tools used in the Supply Chain	Respondent
1	**Company A**	FSC	FMCG	50+ years	Multinational	2 & 3 years	Acquired	Partial Digitalization & Fragmented	Yes	Digital Roadmap	Data analytics tool	Supply chain development specialist
2	**Company B**	Cold FSC	FMCG	50+ years	Multinational, but only regional is analysed	6 months & implementation stage	Acquired	Partial Digitalization & Fragmented	Yes	Digital Roadmap	Delivery optimization app; app for digital order taking	Regional sales manager
3	**Company C**	FSC	Commodity Trading	Start-up 2 years	National	2 years	Acquired	Partial Digitalization & Fragmented	No but has sustainably certified operations	Planning	Cloud storage; cloud platform for invoice tracking; platform supporting traceability of the goods movement	Business development manager
4	**Company D**	Fresh & Cold FSC	E-commerce	Start-up 5 years	International	2 & 1 year	In-house Built	End-to-end Digitalized & Integrated	Yes	Digital Roadmap	Application tracing transactions; Blockchain; application tracking location of the ships; cloud-based solution for storage; ERP system	Business development manager
5	**Company E**	Fresh FSC	Food & Beverage Business	Start-up 2 years	Regional	2 years	Acquired	Partial Digitalization & Integrated	No, but has sustainability at its core	Planning	Data analytics tool; POS (Point of Sale); crowdsourcing digital logistics platform for B2B; crowdsourcing digital logistics platform for B2C	Business development manager
6	**Company F**	FSC	Agribusiness and Food Business	20+ years	Multinational	6 years	Acquired	End-to-end Digitalized & Integrated	Yes	Pigital Roadmap	RFID tags; WMS; MES; TMS; OMS; demand planning system; network optimization software; cloud-based ERP system; Blockchain	Supply chain director
7	**Company G**	Fresh FSC	E-commerce	Start-up 5 years	Regional	5 years	In-house Built + Cloud Storage	Partial Digitalization & Integrated	No, but has sustainability at its core	Digital Roadmap	Operations support system; app for digital order taking; platform connecting digital tools; cloud storage; WMS	Chief operating officer
8	**Company H**	FSC	Nutritionals and Food Manufacturing and Trading	50+ years	International	12 & 3 years	Acquired	Partial Digitalization & Integrated	Yes	Digital Roadmap	ERP system; WMS; business intelligence software; data analytics tool; ML; SQL; supply chain platform	Waste management & quality control manager Digital transformation manager Operations manager

Interviewed companies' profile; compiled table (Authors, 2021)