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DIGITALIZATION WITHIN FOOD SUPPLY CHAINS TO PREVENT FOOD WASTE. DRIVERS, BARRIERS AND COLLABORATION PRACTICES.

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Abstract

Food supply chains increasingly rely on big-data management solutions to foster collaboration across the food supply chain and improve business performance. However, little is known about collaboration practices that actors on the digital food supply chain adopt to solve problems such as food waste, or about the drivers and barriers related to the digital transformation of the food supply chain. Most of food waste studies rely on quantitative analysis, which cannot reveal relevant details about the tensions and dynamics of collaboration. We conducted a qualitative study drawing on eighteen in-depth interviews - of managers of large multinational and local organizations covering different and relevant roles on the digital food supply chain - to investigate how organizational and food supply chain processes are affected by the digitalization of the operations along the food supply chain. By triangulating emerging findings with literature on supply chain management we discuss different views about collaborative practices for food waste prevention in the food supply chain and provide insights on how supply chain design and firms' operations have been re-conceptualized with the usage of digital technologies and on the institutional forces both limiting (barriers) and fostering (drivers) the diffusion of the digital food supply chain.

Keywords: food waste management; big-data management; food supply chain, digital supply chain integration; in-depth interview approach.

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1. INTRODUCTION

Food waste may be described as the food lost during any of the four main phases of the food supply chain, from upstream to downstream, involving the following actors: producers, processors, retailers, and consumers (Bellemare et al., 2017). More specifically, as defined by the Food and Agricultural Organization of the United Nations (2016), "Food waste is part of food loss and refers to discarding or alternative (nonfood) use of food that is safe and nutritious for human consumption along the entire food supply chain, from primary production to end household consumer level" (FAO 2016). Another definition is offered by EU Fusion (2016): "Food waste is any food, and inedible parts of food, removed from the food supply chain to be recovered or disposed (including composed [sic], crops ploughed in/not harvested, anaerobic digestion, bio-energy production, co-generation, incineration, disposal to sewer, landfill or discarded to sea)". Despite differences in how various organizations define food waste, current food waste estimates demand action by governmental and non-governmental bodies. Indeed, each year, about 30% of production is wasted within the food supply chain, reflecting the high level of its inefficiency (Gustavsson, 2011). Recent data confirm that 88 million tons of food produced and destined to human consumption annually in Europe is wasted along the food supply chain (FUSIONS, 2016). In the same year, food waste in the US amounted to about 35 million tons (U.S. Environmental Protection Agency 2016). In developed countries, consumers waste from about 173 kg to 290 kg [1] per capita annually. However, it should be pointed out that given the varied definitions of food waste in literature, as well as the limited availability of data and lack of heterogeneity, it is difficult to accurately gauge the amount of food waste at each phase of the supply chain; it is also difficult to estimate how much food is wasted by each actor (Bellemare et al.,2017; FUSIONS, 2016).

[1] Consumers' shopping behaviors such as purchasing, stocking, and preparing too much food are the main drivers of food waste in addition to the consumer's inability to reuse leftovers. Consumers living in a larger household and having higher incomes are more likely than others to waste more food (for an extensive review of consumer related factors affecting food waste, please see Stancu et al.'s (2016) work) .

As a consequence of this widespread interest in decreasing food waste, national authorities, non-governmental organizations, and the food industry have settled multi-stakeholder strategies to increase sustainability of primary resources reducing their use upstream, as well as reducing food waste across the food supply chain. Specifically, the European Union and the United Nations aim to halve the amount of food wasted by 2030, as a policy goal listed in the Sustainable Development Goals (SDG) document (Gustavsson et al., 2011). Additionally, one stricter new economic paradigm has emerged in the form of circular-economy principles meant to encourage countries to comply with "a new approach to sustainability" (Murray et al., 2017, p. 370) while the ReFED study group of the Rockefeller Foundation (2016) has come up with a number of solutions to reduce food waste.

This broad interest in reducing food waste has made this a burgeoning topic of research for scholars. Past studies have mostly focused on measuring the food waste generated across the various food supply chains (see, for example, Gustavsson et al., 2011; Parfitt et al., 2010; Lebersorger and Schneider, 2014) as well as on exploring the reasons of food waste, both from theoretical and empirical standpoints. Some conceptual frameworks have been developed to offer guidance to food business professionals and practitioners on how to prevent, and deal with the waste produced within the company as well as across the food supply chain (Wolsink, 2010; Kemp and Van Lente, 2011; Papargyropoulou et al., 2014; Eriksson and Spångberg, 2017).

Research studies have also started to analyze aspects of collaboration along the food supply chain to create conditions for sustainable food consumption and production. Specifically, Govidan (2018) illustrates the barriers and possible solutions for coordinating the diverse actors of the food supply chain to realize sustainable production and consumption of food. Additionally, Mangla et al., (2018) identify the crucial challenges and drivers impacting on the potential enactment of a circular food supply chain with the implementation of principles of reuse, recycling, and remanufacturing. Gaitán-Cremaschi et al. (2019) have focused on agent-based modeling (referring to the work of Matthews et al. 2007; Van Dam et al. 2012; Utomo et al. 2018) combined with approaches mainly design-oriented (relying on the results of Ballantyne-Brodie & Telalbasic, 2017) as a means for information integration and for achieving a transition to sustainability (Govindan, 2018; Mangla et al., 2018; Hennchen et al., 2019).

However, the above studies did not consider the increasing integration of digital technologies into food supply chain processes in order to deal with perishable products. Adopting digital

technologies in food supply chains entails that the involved stakeholders devote major efforts to overcome potential challenges that may range from technical problems (for example connection problems or storage needs) to problems related to ensuring privacy and preserving sensitive data (Jagtap & Duong, 209; Astill et al., 2019;). Nonetheless, current studies have not analyzed organizational and managerial perspectives and have not explored synergies and practices enabling coordination along the digital food supply chain (Jabbour et al., 2020). Moreover, just a small set of qualitative research on food waste, such as Goonan et al. (2014) have embraced the process view of the food supply chain, allowing the focus to shift from actor-centered analysis (especially as it pertains to the deliberate decisions made by actors) to practice, offering a more contextualized understanding of practices and their context of usage.

Therefore, research studies have failed to (1) provide guidance for the adoption and usage of digital technologies within food supply chain, (2) offer a model addressing food supply chain problems in a digital environment and (3) to discuss barriers and drivers to the implementation of digital technologies from a managerial perspective (Ben-Daya et al 2017, Ben-Daya et al. 2019).

This study explores the collaboration practices used by actors along digitally connected food supply chains, to prevent food waste both within their own companies and across the supply chain. In addition, the study explores the level of embeddedness of digital solutions devoted to preventing food waste also by looking at institutional drivers fostering implementation of digital technologies as well as by analyzing the barriers experienced by supply chain actors.

The paper is organized as follows: we first describe the theoretical background from food supply chain literature, we then describe the research model and methodology, followed by a presentation and discussion of the findings. The last section is the conclusion.

2. THEORETHICAL BACKGROUND

2.1. Literature on food waste management

Studies on food waste management have flourished over the last ten years and mostly focus on quantifying the food waste generated in the various food supply chains, as well as how much each actor has contributed to causing the problem. Indeed, food waste at the consumer level represents between 46% to 65% of the total food waste generated by the food supply chain (FUSIONS 2016; van Holsteijn et al., 2017) with the remaining part attributable to

other areas of the food supply chain, such as agriculture, production, and distribution (Monier et al., 2010; FUSIONS, 2016; van Holsteijn et al., 2017; Tisserant et al., 2017).

Literature indicates that food waste is mainly caused by overproduction of food as compared to actual market demand. Indeed, each food business operating in the food supply chain overproduces food or ingredients to cover the uncertain demand of the respective downstream actors, diminishing the risk of incurring shortage costs (Mena et al., 2011; Gustavsson et al., 2011). Additionally, food waste production is greater in supply chains in which actors are limited in their ability to communicate and coordinate operational activities (e.g., product production, handling, transportation, storage condition, packaging and transferring the goods from and to other companies); this also has to do with the context in which they market food products with a relatively short shelf-life, for instance, refrigerated products (Mena et al., 2011; Corrado and Sala, 2018).

Researchers have suggested that avoiding surplus food generation from production to consumption is the most desirable strategy in terms of efficacy and effectiveness (Papargyropoulou et al., 2014). Food waste prevention actions implemented so far in the supply chain include a set of practices, aimed at i) redistributing food for human consumption and animal feed; ii) educating consumers in order to prevent food waste in the home; iii) improving supply chain efficiency by enhancing collaboration among those working in the supply chain; and iv) implementing governance actions for food waste prevention, including voluntary agreements, national food waste prevention programs, and regulatory frameworks (Papargyropoulou et al., 2014; FUSIONS, 2016).

Of the actions listed above, the best solutions seem to be redistributing food for human consumption and animal feed, along with programs aimed at educating consumers. Strategies that aim to increase efficiency throughout the supply chain may potentially be more effective, but they are still limited in implementation (FUSIONS, 2016). Digital supply chain initiatives as customer-centric platforms have been recently conceived to collect and optimize the usage of real-time information from different sources placed along the supply chain (Rakowski, 2015) in order to achieve efficiency.

However, in order to understand why certain practices are – or are not – implemented, we must go beyond individual actors and their deliberate decisions and take a wider view of overall organizational processes to better explain the structure and behavior of each organization (Tsoukas & Chia, 2002) in the supply chain. Analyzing processes means looking

at events or actions by considering that they are connected and may account for a course of actions, so that sequence, and history, matter.
Previous studies (e.g. Goonan et al., 2014) have, nonetheless, only limited their analyses within the boundaries of individual organizations but have neglected to explore processes involving diverse actors across the food supply chain. We follow van der Vorst (2004) in using a process view by looking at the food supply chain in terms of sequences of different processes, enacted by actors at different stages, put in place to satisfy end-customer needs.

We use a process view because, if food waste occurs throughout the entire food chain (because products are not incorporated into the supply chain for management reasons), the conversion into waste could be avoided (Cane and Parra, 2020) if the supply chain were to enact strategies and practices to prevent inefficiencies. Therefore, we want to have a better understanding of what single organizations - producers and retailers - do to prevent food waste while also looking at the course of action and the sequence of practices developed by the various actors in the supply chain.

2.2. Digital solutions in the food supply chain

Digital technologies encompass a wide set of tools such as data mobile and big data analytics, blockchain technology, Internet of Things (IoT), and cloud computing. Those technologies have reshaped the operations of most companies, improving collaboration and fostering the development of new business models aiming at improving firm profitability (Cane and Parra, 2020; Santoro et al., 2018).

More specifically, the use of digital solutions serves to store and share different types of information facilitating networking, through contact and information sharing among companies as well as mediating transactions of goods and services between firms. Thus, digital solutions work as market intermediation (Thomas et al., 2014) able to "store, transmit, process, […] display" data gathered from mixed sources (Yoo et al., 2010). They include the usage of big data, facilitating connectivity across firms, offering high-quality information for sharing (Ojala et al., 2018). The connectivity offered by the digital solutions promotes the coordination of organizations in the food supply chain, improving "the alignment, linkage and coordination of people, processes, information, knowledge, and strategies across the supply chain between all points of contact and influence to facilitate the efficient and effective flows of material, money, information, and knowledge in response to customer

needs" (Stevens and Johnson, 2016). Thus, digital technologies can ensure the information sharing needed to control and manage issues, such as the timely transfer of foods/ingredients across the supply chain, as well as the safety of food products along the supply chain securing an adequate shelf life for the end-user (Mena, 2011). Also, digital solutions facilitate producers in supplying the exact amount of products so that retailers can more easily meet customers' demand by preventing food overproduction (Tromp et al., 2016; Choi et al., 2013; Corallo et al., 2020).

The adoption of digital solutions may even promote the creation of a digital ecosystem, leading to greater coordination among companies, including external partners, with which develop collaborative inter-organizational practices, strategies, and processes, as well as synchronizing production processes (Barratt, 2004; Flynn et al., 2010; Zhou et al., 2014). Additionally, a higher degree of supply chain integration – while allowing an increase in the financial performances for each actor along the supply chain – can be also beneficial for the environmental sustainability of the food supply chain itself contributing to lowering both the carbon footprint of the entire chain as well as waste production (Evans and Laskin, 1994; Bosona and Gebresenbet, 2011; Siddh et al., 2018; Gokarn and Kuthambalayan, 2019; Zhou et al., 2019; Kamble et al., 2020).

In the same vein, Ciulli et al.,(2019) theoretically discusses how platform organizations contribute to food waste recovery, by focusing on the multiple brokerage roles that these organization can play for the waste recovery.

The availability and the analysis of big data, despite difficulties (see Gandomi and Haider, 2015), creates conditions for achieving greater accuracy in sales forecasts as well as increasing efficiency in managing sales and promotions by better aligning retailers with suppliers (Einav and Levin, 2014; Bradlow et al., 2017; Grewal, Roggeveen, and Nordfält, 2017). For instance, retailers like Walmart and Target collect and analyze big data (e.g., consumer spending, wholesale prices, inventory levels, product price, state of the economy, demographics, and weather data) to determine the variety of products to offer in specific stores as well as to decide the right time for price markdowns (Einav and Levin, 2014; Bradlow et al., 2017). Using of big data to forecast consumer demand/purchases and promotions, fostering coordination across operators, has been subject to extensive studies (Capps Jr., 1989; Cooper et al., 1999; Leeflang and Wittink, 2000; Wedel and Kannan, 2016). However, few studies have empirically proven the contribution big data can make in terms of the efficiency and sustainability of the food supply chain (Kache and Seuring, 2017).

Due to the relatively recent emergence of the digital economy, there is a general lack of evidence about the organizational practices undertaken through digital solutions to increase the sustainability of food supply chains, preventing food waste generation (Kache and Seuring, 2017). This is surprising considering that the digital supply chain is not "about whether the products or services are physical or digital, it is the way the supply chain is managed" (Büyüközkan & Göçer, 2018). The implementation of a digitally connected supply chain requires proper management in order to have optimized performance and reduced risks (Büyüközkan & Göçer, 2018)

Furthermore, barriers and drivers behind the adoption of digital solutions across the food supply chain are still unexplored comprehensively and little is known about the impact of the integration of digital technologies into the supply chain, especially in terms of what they bring to the firms and how they shape collaborative practices between actors over the supply chain (Ben-Daya et al 2017, Ben-Daya et al. 2019; Jabbour et al. 2020).

Our study informs about how new technologies are used to prevent food waste throughout the food supply chain as well as within each company, also exploring the barriers to the diffusion of digital supply chain and the institutional drivers creating conditions for its larger adoption.

3. METHODS

To analyze how food waste management practices are deployed throughout the food supply chain network and favored by the usage of digital technologies and to identify the drivers behind the diffusion of the digital food supply chain (together with the barriers to entering into it), we enlisted the help of eighteen organizations. These organizations work in the food industry in Greece or within Greek branches of large, global and multinational companies (the sample is described in table 1). In line with past studies, these organizations have the most incentive for preventing food waste and are, therefore, more likely to take the initiative in reducing food waste throughout the entire supply chain (Carter and Jennings, 2002; Kleindorfer et al., 2005; Seuring and Müller, 2008). Each organization included in the study had actively participated in industry-wide supply chain sustainability efforts and had adopted a series of digital tools, which we report in the table 1, and come up with a sustainability strategy in order to expand their own standards. They had all been under pressure from the environment to achieve sustainability goals, therefore, they had a strong incentive to prevent food waste. To understand the relationships among food waste management, the use of digital

solutions, supply chain integration, and information sharing, we decided to use a multiple case-study approach and in-depth interviews, involving one manager for each of the organizations involved.
Through the analysis of their cases, we were able to understand which practices they currently use, which barriers they face and the drivers they feel are required to accelerate the adoption of digital technologies; we were also able to get an idea of the network they have built around those practices.

3.1 Data collection

We collected data from July to September 2020. We conducted eighteen semi-structured interviews with customer logistics managers, supply chain directors, distribution managers and warehouse coordinators who were working in the food industry in Greece or in Greek branches of large, global and multinational companies.
Almost all interviews were conducted through Skype. Participants were willing to participate in a personal interview via the Internet due to the COVID-19 outbreak. Only in one case the interview was conducted offline – specifically in the office of the participant.

We selected organizations in Greece because the industry presents some interesting characteristics (PWC, 2018). First of all, it has historically been made up of many SMEs, but as the industry evolves, larger companies are emerging, fostering a process of concentration. To remain competitive, players are thus encouraged to aggregate and/or collaborate to achieve efficiency and increase performance. Second, the food industry plays a major role in the Greek economy, accounting for about 25% of the country's GDP. Due to the strong role maintained by agri-food firms within communities, organizations are pressured to organize their productions for a more sustainable use of resources and to prevent food waste.
Table 1 summarizes the profiles of all participating companies and interviewees and the list of technologies they adopted.
We gathered data from two diverse sources, with the aim of increasing the rigor of our research (Gioia et al., 2013): (1) semi-structured interviews to collect information on the usage of digital technologies and food waste related initiatives within each firm, and among firms within the supply chain; (2) archival data, gathered throughout available news sources, databases and reports. Using different sources allowed us to triangulate the information regarding digital technology usage, food waste initiatives and the status of supply chain integration and worked as the basis for inductive-theory development, an approach seen as

particularly suitable to understanding how the practices related to the management of food waste evolve and use big-data technology

Table 1 here

3.1.1 Semi-structured interviews

We conducted eighteen interviews. During interviews, we raised open questions, placing emphasis on understanding the cognitive reactions and deep motivational reasons behind decisions made by the organizations related to the use of digital technologies in preventing food waste and the strategy of food waste prevention across the supply chain and within the company. Interviews lasted approximately 25-40 minutes and were based on an interview guide, which included certain areas of discussion However, participants were free to express their views in other issues that were relevant to the discussed topic and were not mentioned in the guide. More specifically, questions were organized into eight areas of investigation: (i) the types of digital application firms in their supply chain networks (ii) their familiarity with such technologies; (iii) the benefits of digital supply chain applications, as well as their contribution to improving overall performance; (iv) the main limitations of digital supply chain applications, (v) the degree of adoption of digital supply chain applications; (vi) of the association between digital supply chain application usage and implementation of relationship marketing strategies; (vii) how organizations promoted a sustainable approach to businesses; and finally (viii) how to enhance the usage of digital supply chain applications in their firm (see the interview protocol in Appendix A). We also had follow-up meetings with informants to validate information gathered and to complete missing data. Each interview was recorded with the informant's permission. Interviews were then transcribed and translated into English.

3.1.2 Data analysis

For a grounded theoretical model, we followed the approach described in Gioia et al. (2013), which has three steps. To start, we identified first-order categories in the data, which, when maintained during the interviews, emerged as a consistent pattern in the data to reveal food waste management practices across the supply chain and within each single organization. The barriers to and drivers of digital solutions were also observed and reported. All first-order practices were named using the informant's language (Strauss and Corbin, 1990). We then

grouped these first-order categories into second-order categories, which we further organized into four aggregate analytical dimensions. This data structure served as the basis for creating the general framework representing the practices of food waste management across the supply chain and within the single organization. To ensure the validity of the findings, two researchers independently coded the interview data. Discrepancies in coding were discussed every time before reaching a consensus. This process enabled us to develop a theory for how food waste management can be accomplished across the supply chain and how it can be facilitated through the adoption of digital solutions.

Consequently, the resulting framework answers the call for theory (expressed in Mena et al., 2011; 2014; FAO, 2018; Gaitán-Cremaschi et al. 2019) and provides useful insights for both theory and practice. In the next section, we present our findings and the comprehensive grounded research model.

4. RESULTS

This study of the attempted transformation in organizational practices to prevent food waste involved a number of complicated phenomena, which entered into the management of operations within each single organization. There is also an impact at the inter-firm level in the food supply chain implying the usage of new digital solutions. Table 2 describes the emergent data structure. The phrases in the boxes on the right side show the supporting evidence and include the related informant justifying the first-order concepts (placed at the center of the table), which have been assembled into second-order analytical/theoretical themes (on the left side of the table). Table 2 is relevant since it provides a static view of the main practices involved at the level of firm and on supply chain. It also provides the bridge between our method, our data and the grounded theory (discussed in the discussion section). We hereby present the results obtained from the interviews on the issues of big-data management, supply chain integration, information sharing, and food waste management.

Table 2 here

From our interviews, multiple factors supporting (see drivers below) or limiting (see the section on barriers) the introduction of digital technology on the food supply chain emerged as being important for food waste prevention. We also discuss the collaboration practices

among different actors with the firm and along the supply chain aiming to prevent food waste.

4.1 Barriers to the integration and usage of digital technologies across the food supply chain

Interviewees reported difficulties in coordinating with small and medium enterprises (SMEs). Many of them have not developed a clear business case justifying possible investments in new technologies, which they might also not know much about. SMEs tend to innovate in ways that best suit their interests and limited capabilities, working quite independently and preferring simpler and less effective methods, but the risk is they will waste food products. This has created a barrier for the integration of these companies' businesses into the digital food supply chain..

> *All of the big companies have adopted the most up-to-date model of surveillance, which gives them a big competitive advantage of both quality and cost of the services they provide. (...) is not as familiar, informed and modernized and tries to organize the distribution network with more economical and simple methods of surveillance witch does not offer all of the benefits that all the new models of surveillance and insurance of the quality because of technology offer, in wasting time, money and the quality of their products.* (interviewee 15)

Interviewees also mentioned that companies lack awareness about the effects of their operations on the environment. And this is one of the main barriers inhibiting their investment in digital tools as well as their lack of skill in terms of how digital solutions can mitigate such affects, including the impact on food waste

> *A lot of companies lack the knowledge of how their operational procedure affects the environment.(...) For example, predictive data analysis can consolidate shipments and avoid the empty container scenario and the fossil fuel consumption (...) which reduce the waste, it promotes the consumer knowledge in how the product is manufactured and distributed by enhancing process transparency and much more. (interviewee 9)*

Another problem that emerged for SMEs was their lack of resources for developing training programs and to have skilled people allocated to the management of digital technology and for overseeing the transition to the digital technologies as it demands the knowledge about the existing operations involved and about the application of old technologies. There is also the issue of running basic operations along the digital supply chain because they require the intervention of humans.

> *Smaller firms that do not have such expertise can outsource their R&D as well as training of staff to external firms that are specialized in this.* (interviewee 7)

The main limitations of digital supply chain applications are value due to investment in new platforms ,the combination of complex processing models data , the education of the employees in these compound programs which is something that is time consuming and demands a lot of time in order to be more familiar and a serious limitation is the incapable staff. The staff needs to be capable to respond in the new data. (interviewee 15)

Raw data and huge amount of uncategorized inputs could destroy the potential solid outcome of a Digital Supply Chain framework. The internal training of the human capital (eg. Key users), is of tremendous importance, in order organization develop the specific infrastructure in terms of human capabilities that leads to an efficient data analysis management (interviewee 3)

These applications basically depend on big amount of data to be inserted and frequently maintained in the system which requires manual work from the final users (interviewee 12)

Individual resistance was also mentioned as an obstacle to the transition, highlighting the conflicting interests of actors along the supply chain getting benefits from the traditional communication with the others and the fear of the unknown was diffused.

People have become very used to how things were done and are scared/unwilling to change. The human factor and personal communication have traditionally been very important in building relationships within the shipping and logistics industry and losing this factor is scary for traders. Digital solutions reduce or eliminate the human factor in many cases. (interviewee 11)

Resistance of large organizations was mostly due to their higher sensitivity towards new sources of technological risks that they identified such as the possibility to lose the satellite coverage with the risk to damage customers or the need build a secure (against cyber attacks) data storage, and so on.

Loss of satellite coverage may result to data loss or anomalies that may frighten the customers. Backup plans are required if any of the digital solutions fail. Top-notch cyber-security is required to prevent malicious attacks. (interviewee 11)

Lack of trust can also represent, for actors on the supply chain, a relevant obstacle to the information sharing, perceived as a fundamental element to secure in order to foster the collaboration among actors leading to the maximization of company goals and the reduction of food waste

Digital Supply Chain applications can work effectively only when a food retailer decides to trust its stakeholders or customers to share crucial information and technologies in order to maximize the company's' performance. So, trust and knowledge are the backbone of a stable long-term relationship between retailers - suppliers or customers, representing probably the only way that can lead a company to prosperity and its own success story. (interviewee 6)

4.2 Driving forces behind the degree of integration of digital technologies into food supply chain processes

The first issue that was raised by interviewees is that incumbent large organizations tend to use and leverage the digital food supply chain also to preserve their established assets, such as e.g. their brand reputation and collaborations among functions along the chain. In the food industry, the incumbent large players also use the digitalization of the food supply chain as a means to minimize costs. These are all relevant levers to accelerating the integration of digital technology for preventing food waste along the food supply chain

> *All of this data and information supports the collaboration among functions, brand reputation, elimination of costs, prevention of loss.* (interview 1)

By expanding the use of digital technologies in the food sector, information transparency – defined as the degree to which supplier- and market-related information within the institutional environment can be readily obtained, interpreted, and verified – constitutes a new emerging demand to satisfy both the B2C and B2B markets. Interviewees have indicated that information transparency appears to be a relevant institutional force that influences the speed of digital transformation along the food supply chain.

> *It requires huge information and data to be integrated in order to satisfy our B2B & B2C customers regarding the quality of our products, time of delivery, inventory accuracy, detailed forecasting, promotion productivity of our activations in the market and etc. (interviewee 1)*

Interviewees also emphasized that a well designed digital food supply chain had two main goals, reducing CO2 by improving logistics performance but also preserving food quality and environmental sustainability with less food waste.

> *The two main goals of digitalizing the supply chain are to reduce food waste/loss and carbon emissions.* (interviewee 11)

From our interviews, it emerged that large firms are more and more attentive to apply new technologies to safeguard their long-term competitive advantage, enabling them to adapt to a dynamic environment.

> *Companies need to adjust their operations to the proper digital supply chain model in order to maximize their performance. It is a fact that Greek food retailers that do not quickly apply digitalization in their supply chain operations are doomed to survive and run behind other companies.* (interviewee 6)

Our data also confirms that, given the level of interconnectedness among organization in a sector, there is the tendency to conform to new developing institutional norms foreseeing the application of new technology and creating some structural similarities in the field.

> *The Greek food industry is observing the developments in the digital transformation of the northern European food industry and is starting to understand the benefits that come with it. (interviewee 11)*

> *There are a few companies that have already deployed digital tools in their supply chain, others that are in the first steps or looking to initiate a digital transformation strategy and a lot that either refuse to change or are waiting to hear more success stories. The reality is that larger companies are paving the way and pushing the competition towards realizing the value of digital supply chain applications and initiating change.* (interviewee 11*)*

Our interviewees appear to be aware of another driving factor accelerating the transition to the digitalized food supply chain: the latent need Greek companies have to expand their business by penetrating foreign markets. To carry out this strategy and achieve globalization, they need to manage business transactions across borders in a faster, cheaper and more efficient way also to better compete in these markets. Therefore, they might find that digitization is a relevant condition for remaining in these new markets.

> *Yes digitalization in the supply chain will play a significant role in the future in the Greek food industry, especially when we all realize that the real development will not come from the domestic market but only from exports. The adaptation of digitalization is a strong tool that will pave the way towards this one-way road of successful development*. (interviewee 16)

> *Even though the majority of companies use a tool to monitor the process (mostly a tool to monitor a single process and not in combination with the rest of the departments or addressees e.g. supplier-> customer, production->warehouse), the need to combine data between departments and destinations is much more crucial now, especially if we take into consideration the globalization and the already existing intra-European business practices (interviewee 9)*

4.3 Practices and digital means for preventing food waste within the firm

Several interviewees suggested practices and digital technologies used in their firms to prevent food waste. Interviewees also emphasized different aspects of digitalization contributing to food waste prevention. Regarding the main technologies used to support food waste prevention, the following were mentioned: digital traceability tools, big data analytics, internet of thing (IoT), Robotics Process Automation (RPA).

More specifically interviewee 1, in his role of logistics manager in a large multinational bottling company, explained that the usage of digital applications allows for tracing a product

from its production until reading the end consumer, reducing fines and defective products and the consequent damage to the company's image. He also mentioned the adoption of data analytics, which was an outsourced activity difficult to carry out in-house, also used as an outsource activity since very few companies can support it as an in-house technology.

> *Traceability is really important in order to track the path of products from production to customer and then to shopper. We want to guarantee high TQM standards, avoiding fines, customs fines or bad brand reputation. Another element we use is data analytics, which is an outsourced activity. Very few companies are doing it in house.* (interviewee 1)

Interviewees also included the usage of big data as a performance optimization tool, that acts as a prevention measure to avoid weak points in the production process. The usage of big data aimed to diminish any potentially defective products and therefore reduce or eliminate food waste. The historical analysis of data allowed us to identify relevant actions to embrace proactively in order to prevent deficient production and food waste.

> *Performance tracking apps like PowerBi are a daily part of my job as a supply chain optimization consultant. Fetching production, logistics and overall supply chain data is extremely useful to understand the weak points in the performance which, in turn, helps me to develop workshop activities to support our dairies.* (interviewee 8)

> *These technologies lead to more accurate reporting and performance* (interviewee 11)

Interviewee 11 added the usage of big data, IoT and Robotics Process Automation (RPA) as tracking tools along the food supply chain. Indeed, large companies perform a more advanced usage of the abovementioned technologies, being able to monitor the whole route of the product throughout the supply chain reducing the reliance on human work. The safety of the whole manufacturing process is, thus, ensured, reducing manual errors that cause food waste in the long run.

> *We take advantage of Internet of Things (IoT) solutions to track and monitor shipments of refrigerated products. We use Robotics Process Automation (RPA) to automate steps in a shipping transaction that do not require manual human intervention and ensure consistency in paperwork (customs declarations, safety certificates, etc.)" (interviewee 11)*

Finally, managers emphasized the importance of digitalization as a trigger to changing the organization as a whole and providing benefits on different levels. Specifically, using digital technology in the planning and forecasting of demand within the firm eventually leads to food waste prevention.

> *By digitizing supply chain operations, an organization will reflect an integrated set up, which will benefit the structure as a whole. Specifically, customer service, order*

management and supply/demand planning outputs will be leveraged by this end-to-end transparent process. (interviewee 3)

Digital applications are used for the insight planning in order to see all the open orders for each supplier and check pending quantities for each order; find the expected arrival date and the actual arrival date; see the actuals sales compare to forecast sale. For the specific program you can export data for further analysis such as delays of the arrival of orders, missing quantities, over-shipment. (interviewee 4)

4.4 Practices of food waste prevention along the food supply chain

According to interviewees, food waste prevention can be successfully achieved with the integration of digital systems, not only within the firm but also across the whole food supply chain by investing in communication among systems from different companies. For instance, they indicated that during the production and transportation processes, digital tracking systems provide necessary information among suppliers and customers allowing for the creation of more predictable and optimal processes. They also mentioned that B2B interfaces lead to improved communication among all the involved parties, also reducing risks in terms of overproduction and food waste. Specifically, the distribution manager of a large, multinational food and beverage company explains that wide-scale, intensive use of track-and-trace systems has been implemented to co-evolve with B2B interfaces with suppliers and customers, contributing to food waste prevention:

Primary logistics / transportation offer a more extensive capability of supply chain technologies that can be utilized, at least around the EMEA region. Full track-and-trace systems through central control towers and remote temperature control applications are the major activities monitored extensively for the last three years, and twelve years in total, as a traceability tool. B2B interfaces are also used as a communications tool with suppliers (mainly) and customers. (interviewee 14)

Moreover, another interviewee added that technology is integrated within the distribution structure in order to secure transportation processes of food products along the supply chain and prevent food waste. They mentioned that the relationship between suppliers and producers is vital for production planning and it can be made easier by using the appropriate digital systems, bringing together information from the two different parties, exchanging information along the chain and helping to plan the schedule for all the production and transportation processes. This also helps in improving planning and forecasting, preventing the generation of food waste.

Digital applications improve accuracy in planning and forecasting, Find the gaps between planning, marketing and sales, Better inventory management, Reduced process time, Reliable data, Optimized lead times.(…) You can prepare your order according to supplier restrictions, such as lead time, minimum order quantities, order pallet factor, volume requirements of containers and provide purchase forecast for the next months. Also, by giving the order on time, supplier can prepare the order on time and thus any out of stock or over-production issues are avoided (interviewee 4)

Interviewees emphasize the relevance of sustainable food supply chain to reach different other goals complementing the reduction of food waste. More specifically, managers said that digital applications in the distribution process assist firms of the food industry to follow the principles of sustainable development by allowing the enactment of environmentally and financially viable practices. They also helped customers have more detailed information about the product.

Since a lot of documentations are in electronically version this contribute to the reduction of waste. Also supply chain impacts the environment because if you deliver products more efficiently it can reduce the carbon footprint on the environment (interviewee 4)

Focusing on the transportation sector, as digital supply chain applications lead to optimisation in the processes of a firm, this leads to a reduction in carbon emissions and food waste which contribute to a more eco-friendly approach and sustainable process (interviewee 7)

Absolutely, the entrance of (DSC) applications and the use of many different technological instruments, such as RFIDs, GPS, PDAs, Scanners etc. has replaced the traditional paper – based documents, reducing carbon footprints and promoting eco-friendly approach to businesses (interviewee 6).

Finally, interviewee 1 gave a more spherical view, linking the adoption of an eco-friendly approach with corporate social responsibility that has also as a goal of preventing and reducing the food waste within the company and along the whole supply chain:

With the new norm that of Supply Chain Digitalization the back-end operations can acquire transparent inputs in order to navigate and manipulate the raw data leading to a concrete form of decision-making output for the front end and top management departments. By digitizing Supply Chain operations, an organization will reflect an integrated set up, which will benefit the structure as a whole. Especially, customer service, order management and supply/demand planning outputs will be leveraged by this end to end transparent process. In this way, the operation will be advanced to an effective and agile one, enhancing the entire framework of Operational Strategy in the end of the day.(…) The Digitalization of every industry could provide eco-friendly, sustainable and efficient operational framework. The improvements occurred of an operational revamp like this, could drive agility

regarding day to day tasks saving money, time, profitability and food waste as the resources (human & machines) can operate in their optimal capacity. (interviewee 3)

Digital supply chain applications assist firms in the food industry in creating strategic partnerships and developing and sustaining long-term profitable relationships with suppliers and customers. Digital technology is used as the vehicle for creating qualitative and profitable relationships with partners, as the most important advantage of digital technology is that enhances transparency in the flow of information, resulting in the creation of a feeling of trust among the trading partners. This leads to better planning and forecasting, which results in food waste prevention.

Moreover, digital supply chain applications promote an eco-friendly approach to business as well as helping industry firms follow the principles of sustainability. Digital supply chain applications help firms reduce carbon emissions, b) reduce hard copy usage, c) reduce waste in all stages of the distribution process and d) allow for energy savings. All the above-mentioned actions eventually lead to food waste prevention and even reduction.

5. DISCUSSION AND CONCLUSION

Our findings contribute to the investigation of how producers and retailers in the food supply chain can cooperate to prevent food waste, which can also be facilitated by the availability of digital technologies. We have adopted a process view because our aim was to provide an in-depth look at the phenomenon and to go beyond the investigation of practices enacted by the single organizations in the food supply chain – producers and retailers – to prevent food waste.

Our results show different barriers and drivers for collaborative practices aimed at food waste prevention in the food supply chain, and provide insights on how the supply chain design and company operations have been re-conceptualized via the usage of digital technologies.

By doing so, we also help answer the emerging need to study the practices and mechanisms of coordination throughout the food supply chain (see Govindan et al , 2018), since recent research works have claimed that a good level of communication and solid cooperation practices among the relevant actors in the food supply chain are vital for preventing food waste (Richter et al, 2016; Girotto et al, 2015). However, most food waste studies rely on quantitative analysis (Newenhouse and Schmit, 2000) which, by its nature, cannot reveal relevant details about the tensions and dynamics of collaboration emerging among the actors in the food supply chain. Instead, the small set of qualitative food waste research on food

service have discussed operations (Goonan et al., 2014; Ofei et al.,2015) or have provided a very detailed analysis of the practices of one single actor in the food supply chain (Hennchen et al 2019). Additionally, we contribute to building a deeper understanding of the managerial implications and inferences digital supply chains might have for company operations by highlighting barriers and drivers to the usage of digital technologies along the food supply chain. We also identify new forms of collaborative practices enacted within the firms and along the supply chain after the introduction of new digital technologies.

More specifically, we were able to identify four pivotal, overarching aspects combining past knowledge, and the experiences of large multinational and local firms on the food supply chain, gained after the adoption of digital technologies and helping in conceptualizing the organizational and managerial implications derived from the adoption of digital technologies along the supply chain : Barriers to the integration and usage of digital technologies across the food supply chain; driving forces behind the degree of integration of digital technologies into food supply chain processes; practices and digital means to prevent food waste within the firm; practices of food waste prevention along the food supply chain.
Regarding the barriers to the integration and usage of digital technologies across the food supply chain for food waste prevention, interviewees reported difficulties to coordinate with partners that were different in size (for example, with small and medium enterprises), digital mindset, resources, competencies and involvement, as well as risk propensity and risk awareness. Some particularly interesting findings include the highlighted need to balance diversity in size and priorities, in partnering with firms with compatible digital mindsets, the critical activity of joint decision-making, and the importance of trust among partners.
Indeed, literature highlights these factors are key for successful collaboration. Following our findings, we agree with Cao et al. (2010), starting with the idea that congruence in goals is required by supply chain partners. Congruence can be related to the degree of agreement on the target, on the fit among partners and, as it appears more evident in this case, on the compatibility among involved firms. The interviewees also highlighted a problem of diverse decision synchronization (Cao et al., 2010), described by a difference in decision rights and expertise. What is more important, is that in order to reach congruence, an alignment among practices and values among partners needs to be present.

One factor that emerged more than once was the need for big companies to find ways to collaborate with SMEs. Differences among these actors did not simply occur in terms of size, but also in strategic choices, business models, technological and digital readiness, resources and competencies. Horvath and Szabó. (2019) emphasize that SMEs tend to be less constrained by market conditions, but pressured by their quest for competitiveness in fragmented markets leading to strategic choices which are often reactive (rather than proactive) and driven by end market needs. Within this context, SMES often struggle to plan ahead when it comes to innovation management, find the right competencies in markets that are limited as compared to those of MNCs, or dispose of abundant financial resources.

Thus, MNCs and SMEs may struggle to work with those collaboration principles, communal decision-making, ease of communication, shared technology and vision, that members of an integrated supply chain should possess to realize a precise and timely exchange of goods and services, money, knowledge, and processes to offer the greatest value with the lowest costs and time, increasing efficiency and efficacy (Frohlich and Westbrook, 2001; Bowersox et al., 1999;). Joint decision / goal making is key to achieving proper supply chain integration (Seuring & Müller, 2008). It is defined as "the extent to which partners have beliefs in common about what behaviors, values, and policies are important or unimportant, appropriate or inappropriate, and right or wrong" (Morgan and Hunt, 1994, p. 25). Achieving proper integration among partners could also lead to the virtuous set of trust among actors, because common behavioral norms are set. Undeniably, trust is essential for fostering a resource-sharing mechanism, that is essential for the effectiveness of collaboration and food waste prevention. While this has been emphasized as a potential risk in the analysis, the actors embedded in such related context (in terms of similar institutions, relations, logics and culture) might have a higher likelihood of fine information exchange as well as joint problem-solving arrangements (Uzzi, 1997).

On the other hand, our study pointed out to driving forces behind the degree of integration of digital technologies into food supply processes. Issues raised by interviewees were related to the need to increase competitiveness (e.g., by working on brand, cost reduction, performance increase) or to being driven by institutional elements arising from the environment, such as the need to gain information transparency, meet sustainability requirements (e.g. CO2), enter or expand into foreign markets and follow the behavior of other companies in the industry.

Undoubtedly, the quest for higher competitiveness is a major factor driving integration, which may even facilitate collaboration in spite of differences in market focus, size, or role within the network. For such motivated partners, the focus on shared goals, like those related to sustainability, sharing information on prices and products, or production timing, has a positive impact on the adoption of digital technologies and on food waste prevention. Nonetheless, another interesting finding emerges from the interviews, that is the role of external forces and the formal and informal institutional environment, via regulatory or normative pressures, thus highlighting that organizational choices can be determined by the extent of alignment with the environment, imposing a set of constraints influencing their behavior. Indeed, we find that companies can be driven by the need to comply with formal rules, such as meeting CO2 reduction targets or being in line with international standards and practices. They may also be driven by normative or social pressures, for example by imitating others in digitalization processes or waiting to hear success stories before embracing transformation. This recalls the existence of homogenization processes to take into consideration, which can be described by the concept of isomorphism (DiMaggio and Powell, 1983): that happens when one component in a population is forced to look like other components facing the same environment (Hawley, 1968). Thus, as the industry evolves these processes may drive further the integration of digital solutions in food supply chain and impact on food waste prevention.

The third aspect identified is related to the actual practices and digital means used to prevent food waste within the single firms. Big data emerged as a leading means for performance optimization and for traceability. More interestingly, digitalization was often depicted as a trigger for a deeper change in the organization as a whole. Big data analytics allow for focusing on consumer behavior and sales history, which optimizes promotions and forecasted demand (Mena et al., 2011), ultimately leading to better food waste management. Through big-data management and the use of digital technology, relevant information is shared, and better interaction, planning and control are possible. The use of big data is a trigger for change as it requires companies to rethink their operations, controls, and coordination of activities. Still, most organizations are using big data as either a descriptive or diagnostic tool, and are lacking expertise in their use as predictive or prescriptive tool, which is still in development. Positioned at the base of the knowledge pyramid (Rowley, 2007), data is essential, but context must be given in order to extract information. This requires specific skills, not simply technical – such as extracting data – but also managerial, like being able to interpret data in relation to the organization's goals. Indeed, digital tools and big data

represent new systems of knowledge and modify how we understand phenomena and relationships. However, the lack of specific analytical skills, and/or time constraints might hinder the whole data-management process.

Literature also describes big-data as the technical enabling factor for supply chain integration (Kache and Seuring, 2017; Regattieri et al., 2007). This led us to our fourth area of findings, connected to practices of food waste prevention along the food supply chain. Here, we found that digital tools connect suppliers and retailers, allowing them to share a variety of information, especially regarding forecasting and market-intelligence activities. Among these tools, big-data management appears to be the most suitable for such objectives, since multiple types of data can be collected by organizations and shared to improve accuracy, although other digital tools, such as the blockchain were also underlined as a potential tool to trace the entire process. Among these practices, digital tools appear essential to track-and-trace, optimize performance and most importantly for this study, prevent food waste and realize a sustainable supply chain.

5.1 Limitations

Of course, this research presents limitations, especially given the analyzed setting, which is restricted to a sample of firms operating in the Greek food industry, but it is a promising starting point for literature, bringing together supply chain integration, food waste management, digitalization management, and information sharing. A second limitation is that we chose to only interview a set number of people in each organization – the same number of employees per organization to make them comparable. However, this decreases the reliability of the research as other employees might have made different statements. Because this study interviewed people in different roles, heterogeneity in perspectives can also represent a limitation. However, all categories were fully explored over time, meaning that no new information was collected, which indicates that the data gathered was at least mentioned by multiple organizations.

In conclusion, we discuss how firms collaborate for food waste prevention in the food supply chain and provide insights on how digital technologies have impacted the organization of activities within and across firms and how institutional forces are both limiting (barriers) and fostering (drivers) the diffusion of the digital food supply chain. This research contributes to the academic fields of food waste management, big-data management, and supply chain integration of suppliers and retailers in the Greek food supply chain.

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TABLES

Table 1: sample description

Organization name	*Organization role involved.*	*Interview type*	*Technologies*
E1	Customer logistics Manager	Skype	Tracing systems, Data analytics
E2	Logistics Manager	Skype	Smart warehousing, Smart logistics, Tracing systems
E3	Logistics Planner	Skype	Big Data analytics, Power Query, Power BI
E4	Warehouse Manager	Skype	Mantis system, Nodal
E5	Forecast Planner	Skype	Customized forecasting tool, Warehouse Management (WMS), ERP, BIs
E6	Regional Store Manager	Skype	SAP software (Systems, Applications and Products in Data Processing), Enterprise resource planning (ERP),
E7	Production Planner	Skype	Big Data Analytics
E8	Supply Chain Optimization Consultant	Skype	Power BI
E9	HR&Administration Manager	Skype	Sotf1 ERP, SAP, Big Data Analytics, CRM functions, GPS
E10	Global Operations Executive	Skype	SAP software, Power Bi, EXCEL VBA models
E11	Project Manager - Performance Analyst	Skype	IoT, RPA
E12	Regional Supervisor Premium Spirits Planning,	Skype	ERP, APO system, Inventory Tool, VMI, WH solutions
E13	Continuous Improvement Supervisor	Skype	3D Printing, Fused Deposition Modeling (FDM), CAD, IoT, QR coding
E14	Distribution Manager Se Europe&Emea	Skype	Track-and-trace systems, B2B interfaces
E15	CEO	Skype	Cloud computing, GPS
E16	Total Quality (SHEQA), Food Safety And Dairy Affairs Manager	F2F	SAP system, Chem watch (MSDS), PPM (Portfolio project management), Horizon, Foqus Supplier Quality Management (SQM)
E17	Distribution Supevisor	Skype	Big Data Analytics, Mobile DSD, EDI ordering & invoicing, VMI, Vision Picking
E18	Supply Chain Director	Skype	SAP, BW, Horizon, ThinClient. MS Teams

Table 2. Data structure

2nd-order Themes	1st-order Categories	Quotations
Barriers to the integration and usage of digital technologies across the food SC	Collaboration among parties along the supply chain is limited by the capabilities of small and medium firms to advance their system to monitor food products	*All of the big companies have adopted the most up-to-date model of surveillance, which gives them a big competitive advantage of both quality and cost of the services they provide. (...) is not as familiar, informed and modernized and tries to organize the distribution network with more economical and simple methods of surveillance witch does not offer all of the benefits that all the new models of surveillance and insurance of the quality because of technology offer, in wasting time, money and the quality of their products.* (interviewee 15)
	Lack of knowledge about how the digitalization of processes could lead to substantial improvements to the environment also through a reduction of food waste	*A lot of companies lack the knowledge of how their operational procedure affects the environment.(...) For example, predictive data analysis can consolidate shipments and avoid the empty container scenario and the fossil fuel consumption (...) which reduce the waste, it promotes the consumer knowledge in how the product is manufactured and distributed by enhancing process transparency and much more. (interviewee 9)*
	Smaller firms that do not have resources to invest in digitalization such as for training and for their R&D activities	*Smaller firms that do not have such expertise can outsource their R&D as well as training of staff to external firms that are specialized in this. (interviewee 7)*
	Transition to the digital technologies requires the involvement of people being competent both on the new technologies and on the operations firm runs	*The main limitations of digital supply chain applications are value due to investment in new platforms ,the combination of complex processing models data , the education of the employees in these compound programs which is something that is time consuming and demands a lot of time in order to be more familiar and a serious limitation is the incapable staff. The staff needs to be capable to respond in the new data (interviewee 15)*
	Digitalization requires also human intervention and the right personnel appointed with proper competence which is not easy to find	*Raw data and huge amount of uncategorized inputs could destroy the potential solid outcome of a Digital Supply Chain framework. The internal training of the human capital (eg. Key users), is of tremendous importance, in order organization develop the specific infrastructure in terms of human capabilities that leads to an efficient data analysis management (interviewee 3)* *These applications basically depend on big amount of data to be inserted and frequently maintained in the system which requires manual work from the final users (interviewee 12)*
	People tend to resist to the technology which is reducing their level of embeddedness in their social network	*People have become very used to how things were done and are scared/unwilling to change. • The human factor and personal communication have been traditionally very important in building relationships within the shipping and logistics industry and losing this factor is scary for traders. Digital solutions reduce or eliminate the human factor in many cases. (interviewee 11)*
	Perception of new risks potentially affecting stakeholders along the supply chain	*Loss of satellite coverage may result in data loss or anomalies that may frighten customers. • Backup plans are required if any of the digital solutions fail. • Top-notch cyber-security is required to prevent malicious attacks. (interviewee 11),*
	Trust among parties is the crucial element to obtain in order to have data shared along the supply chain	*Digital supply chain applications can work effectively only when a food retailer decides to trust its stakeholders or customers to share crucial information and technologies in order to maximize the company's' performance. So, trust and knowledge are the backbone of a stable long-term relationship between retailers - suppliers or customers, representing probably the only way which can lead a company to prosperity and its own success story* (interviewee 6)
Driving forces behind the degree of integration of digital	Brand reputation, collaboration among functions, elimination of costs are co-specialized assets which incentivize of food waste prevention	*All this data and information supports the collaboration among functions, brand reputation, elimination of costs, prevention of loss* (interviewee 2)

technologies into food supply chain processes	B2C and B2B markets constitute institutional sources of forces incentivizing the provision of information	*It requires huge information and data to be integrated in order to satisfy our B2B & B2C customers regarding the quality of our products, time of delivery, inventory accuracy, detailed forecasting, promotion productivity of our activations in the market and etc. (interviewee 1)*
	Food waste and a CO2 reduction are considered among the key factors triggering digitalizing the food supply chain	*the two main goals of digitalizing the supply chain are to reduce food waste/loss and carbon emissions (interviewee 11)*
	Digitalization of company operations is felt by large companies as a mean to remain competitive in the market	*Companies need to adjust their operations to the proper digital supply chain model in order to maximize their performance. It is a fact that Greek food retailers who will not quickly apply digitalization in their supply chain operations are doomed to survive and run behind other companies. (interviewee 6)*
	Imitation is the institutional mechanism guiding the diffusion of digitalization within the Food supply chain	*The Greek food industry is observing the developments in the digital transformation of the northern European food industry and is starting to understand the benefits that come with it. Eventually Greek businesses will adapt and move towards digital supply chain applications.* (interviewee 11)
	The relevance of digitalization increases especially for expanding in foreign market	*Yes digitalization in supply chain will play a significant role in the future in the Greek Food Industry especially when we all realize that the real development will not come from domestic market but only from the exports. The adaptation of digitalization is a strong tool that will pave the way towards this one way road of successful development* (interviewee 16)
	Globalization and existing intra-European business practices are a driver for the adoption of digital technologies	*Even though the majority of companies use a tool to monitor the process (mostly a tool to monitor a single process and not in combination with the rest of the departments or addressees e.g. supplier-> customer, production->warehouse), the need to combine data between departments and destinations is much more crucial now, especially if we take into consideration the globalization and the already existing intra-European business practices* (interviewee 9)
	Many companies are waiting for success stories before embracing the transformation but there is the pressure of large firms	*There are a few companies that have already deployed digital tools in their supply chain, others that are in the first steps or looking to initiate a digital transformation strategy and a lot that either refuse to change or wait to hear more success stories. The reality is that larger companies are paving the way and pushing the competition towards realizing the value of digital supply chain applications and initiating change* (interviewee 11)
Practices and digital means to prevent food waste within the firm	Firms that operate in the food industry use digital applications as a traceability tool	*Traceability is really important in order to track the trip of products from production to customer and then to shopper. We want to guarantee high TQM standards avoiding fines, customs' fines or bad brand reputation. Another element we use is the data analytics, which is an outsource activity. Very few companies doing it in house*. (interviewee 1)
	Big data (are seen mainly) are used as a performance optimization tool	*Performance tracking apps like PowerBi are a daily part of my job as a supply chain optimization consultant. Fetching production, logistics and overall Supply Chain data is extremely useful to understand the weak points in the performance which in turn helps me to develop workshop activities to support our dairies.(interviewee 8)* *These technologies lead to more accurate reporting and performance (interviewee 11)*
	Large companies are doing a more advanced usage of big data and internet of thing to track the shipment of food product along the supply chain	*We take advantage of Internet of Things (IoT) solutions to track and monitor shipments of refrigerated products. We use Robotics Process Automation (RPA) to automate steps in a shipping transaction that do not require manual human intervention and ensure consistency in paperwork (customs declarations, safety certificates, etc.)"*(interviewee 11)
	Companies also see the digitalization of food supply chain as a trigger to change the organization as whole.	*By digitizing supply chain operations, an organization will reflect an integrated set up, which will benefit the structure as a whole. Especially, customer service, order management and supply/demand planning outputs will be leveraged by this end to end transparent process(interviewee 3)* *Digital applications are used for the insight planning in order to see all the open orders for each supplier and check pending*

		quantities for each order; find the expected arrival date and the actual arrival date; see the actuals sales compare to forecast sale. For the specific program you can export data for further analysis such as delays of the arrival of orders, missing quantities, over-shipment. (interviewee 4)
Practices of food waste prevention along the food supply chain	A large and intense use of track-and-trace system is implemented and co-evolve with B2B interfaces with suppliers and customers	*Primary logistics / transportation offer a more extensive capability of supply chain technologies that can be utilized, at least around the EMEA region. Full track-and-trace systems through central control towers and remote temperature control applications are the major activities monitored extensively for the last 3 years and 12 years in total as a traceability tool. B2B interfaces are also used as a communication tool with suppliers (mainly) and customers*(interviewee 14)
	Technology is integrated with the distribution structure in order to secure transportation processes and prevent food waste.	*Digital applications improve accuracy in planning and forecasting, Find the gaps between planning, marketing and sales, Better inventory management, Reduced process time, Reliable data, Optimized lead times.(...) You can prepare your order according to supplier restrictions, such as lead time, minimum order quantities, order pallet factor, volume requirements of containers and provide purchase forecast for the next months. Also, by giving the order on time, supplier can prepare the order on time and thus any out of stock or over-production issues are avoided (interviewee 4)*
	Sustainable supply chain is attending different relevant goals complementing the reduction of food waste	*Since a lot of documentations are in electronically version this contribute to the reduction of waste. Also supply chain impacts the environment because if you deliver products more efficiently it can reduce the carbon footprint on the environment (interviewee 4)* *Focusing on the transportation sector, as digital supply chain applications lead to optimisation in the processes of a firm, this leads to a reduction in carbon emissions and food waste which contribute to a more eco-friendly approach and sustainable process (interviewee 7)* *Absolutely, the entrance of (DSC) applications and the use of many different technological instruments, such as RFIDs, GPS, PDAs, Scanners etc. has replaced the traditional paper – based documents, reducing carbon footprints and promoting eco-friendly approach to businesses (interviewee 6).*
	Blockchain as possibility to make the entire process transparent and safe enabling managers to recognize issue before preventing food waste to happen	*With the new norm that of Supply Chain Digitalization the back-end operations can acquire transparent inputs in order to navigate and manipulate the raw data leading to a concrete form of decision-making output for the front end and top management departments. By digitizing Supply Chain operations, an organization will reflect an integrated set up, which will benefit the structure as a whole. Especially, customer service, order management and supply/demand planning outputs will be leveraged by this end to end transparent process. In this way, the operation will be advanced to an effective and agile one, enhancing the entire framework of Operational Strategy in the end of the day.(...) The Digitalization of every industry could provide eco-friendly, sustainable and efficient operational framework. The improvements occurred of an operational revamp like this, could drive agility regarding day to day tasks saving money, time, profitability and food waste as the resources (human & machines) can operate in their optimal capacity. (interviewee 3)*

APPENDIX A

Interview protocol

1) Which digital applications and/or technologies do you use in the supply chain functions in your firm? (e.g. Big data analytics, Trace and tracing systems, etc.). How many years have you used them? How familiar are you with digital supply chain applications? (please discuss)
2) What are the main benefits of digital supply chain applications? (e.g. better decision-making process, improved response to customer needs, etc.) Do they contribute to the enhancement of the overall performance of your organization? How so? (please discuss)
3) What are the main limitations of digital supply chain applications? (please discuss)
4) To what extent have firms in Greek food industry adopted digital supply chain applications? Do you think that the Greek market is lagging compared to the other developed countries of northern Europe in terms of IT systems usage?
5) Digital supply chain applications assist your firm to develop long term relationships with its customers or/and suppliers? You consider these relationships as an important aspect in your industry? (please discuss)
6) Do you think that digital supply chain applications promote an eco-friendly approach to businesses? (please discuss)
7) What are your recommendations for enhancing the usage of digital supply chain applications in your firm? Do you believe that in the future, digital supply chain applications will play a more crucial role in the Greek food industry? (please discuss)