FEEDING GREECE:

THE FUTURE OF DISTRIBUTION AND LOGISITCS

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Feeding Greece:
The Future of Distribution and Logistics

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ABSTRACT

Working with Perrotis College, this project focused on understanding the state of the food distribution and logistics sector in Greece to identify stakeholder attitudes toward innovations within the food supply chain. The team conducted interviews with various-sized food distribution firms and faculty with expertise in agriculture and determined that interest in technology is limited within the sector. From these findings, the team outlined potential technologies that have benefitted the system globally and may benefit the Greek system by improving food security and safety while reducing costs and environmental impacts. This research has the potential to be used by Perrotis College for the education of the future workforce in the Greek agribusiness industry.

EXECUTIVE SUMMARY

Food supply chains are complex systems that include food production, processing, distribution, and consumption. Each sector of the supply chain faces its own unique challenges, however, the interconnectivity between them means these challenges impact the system as a whole. The distribution and logistics sector is beginning to implement new solutions in the form of information technology (IT). These are in response to the challenges imposed on the system by climate change, consumer interests, and food safety concerns.

Food systems globally are facing a sustainability crisis due to various social, economic, and environmental factors. Researchers emphasize the need for changes in the food system to address equity, environmental degradation, and consumer interests (FAO, 2018). Since distribution and logistics are the link between producers and consumers, the food distribution system faces challenges that are impacted by both groups.

Globally there is specific technology being applied to the distribution sector such as enterprise resource planning (ERP), radio frequency identification (RFID) technology, and warehouse management systems (WMS) (Chen et al., 2013; Smadi, 2016; Tija, 2023). These software help distribution firms deal with challenges they experience, but there are still discrepancies amongst the global food industry regarding the implementation of such technology.

Project Goals and Research Methods

Our project assessed the state of the distribution and logistics sector in Greece and analyzed stakeholder attitudes toward current and future innovations. We achieved this goal through the research method of key informant interviews with stakeholders who we felt represented the types of distribution firms within the country. Our interview strategies followed semi-structured interview formats that centered around topics of interest derived from our broader objectives written out below;

Identify how the current food distribution networks in Greece operate and what challenges stakeholders experience;

Investigate what motivates stakeholders to implement new technologies in their practices to improve distribution systems;

Explore how stakeholders' attitudes towards current technology influences their willingness to innovate;

Identify the current and most promising innovations related to the food distribution system and how these will affect the entire food supply chain in the future.

Insights and Implications from Stakeholder Interviews

From our interviews with several different stakeholders the compiled and briefed outcomes are listed below;

Trends in Greece's Distribution: reliance on roads and trucks for transportation, peaks of demand in summer months due to high amounts of tourists, industry preference of long food supply chains over short food supply chains, dichotomy of small and large firms working within different sub-markets, vertical integration of large corporations.

Challenges Firms Face: Regulation compliance within practices, weather and traffic patterns affect roads efficiency, meeting demand and having accurate supply ready for orders, current manual entry is not accurate for future predictions, tourism places extra strain on accurate anticipation of changing demand.

Information Technology (IT) application: Distributors use IT to improve operations in three areas: traceability, organization, and adherence to regulations, ERP systems and software like SAP, RFID, and Aberon were used for traceability, implementation or upgrading of already used technology is not always feasible for companies of any size due to several barriers.

Barriers to IT in the Sector: Firms are satisfied with the IT systems they have in place and are hesitant to explore newer technologies because of challenges regarding cost, employee training, and accuracy of the systems, concerns from companies on how well new software would work for their company, firms only upgrade their IT systems when they are no longer sufficient in meeting the needs of the market, despite the traditional nature of the agriculture industry some larger companies with the help from researchers and universities are implementing new technologies.

Proposed Opportunities for Future Research

Through the project several other topics came to light, but because of the timeline of this project such areas of research were not fully uncovered through our work. These topics could have an effect on the future of the food supply chain and came up during our research of journals and articles that have similar interests in the food supply chain or during our interviews with stakeholders. The topics are the socioeconomic impacts of AI on food systems, future food supply chain trends, traceability in food supply chains, and consumer interests. The importance of such topics center around the future of the sector as a whole and when one sector changes the other sectors in the supply chain are also expected to change.

Socioeconomic Impacts of AI on Food Systems

In Greece AI has not reached its full potential within the agri-food sector. Future research on AI in the food system may focus more on the socioeconomic impacts of total automation of the food supply chain with the use of AI. Our project researched some of the benefits of AI, but implementation of this technology throughout the agri-food sector may come at the cost of lost jobs and businesses for producers, processors, distributors, and retailers that do not have the expertise or money to implement such systems in their businesses.

Future food supply chain trends

The growing trend of vertical integration in the food sector is a new and complicated business model shift. Further research could be done to understand the specifics of this trend, including the rate at which it's happening, the motivations to pursue vertical integration, the ways in which companies achieve vertical integration, and the financial power these vertically integrated companies wield within the Greek food supply chain. In addition, consideration should be given to how these companies affect the other businesses in the food supply chain that can't or don't attempt to vertically integrate as well as the effect on the end consumer.

Traceability in Food Supply Chains

An area that future projects could explore is traceability specifically in relation to recalls to understand how companies address such a challenge and what technological applications they implement to prevent or be better prepared for a recall. We recommend interviewing companies that have previously had a recall in order to understand their experience and consider possible areas for innovation in traceability technologies. Future projects could develop a more narrow scope on traceability technologies and how companies apply them to avoid loss of profit, time, and product.

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MEET THE TEAM

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INTRODUCTION

CHAPTER 1.
INTRODUCTION

Food supply chains are complex systems that include food production, processing, distribution, retail, and consumption. A successful food supply chain is one that provides "safe and nutritious food for all" (FAO, 2018). In 2022, the Food and Agriculture Organization of the United Nations (FAO) published *The State of Food Security and Nutrition in the World*, detailing the failures of the global food supply chain that led to a 1.8% increase in undernourishment since 2019, which is when a person's daily food consumption cannot provide the required energy to maintain a healthy, active lifestyle (FAO, 2022). The FAO attributes this to a lack of government financial support to agrifood systems, increasing food prices due to monopolization of the agrifood industry by large companies, and lack of agricultural production in low-income countries (FAO, 2022).

In order to achieve the UN Sustainable Development Goal (SDG) of zero hunger, food security, improved nutrition, and sustainable agriculture by 2030, researchers and companies in the global food system are investing in the power of modern technology to explore pathways towards a more successful and sustainable food system (*Goal 2*, n.d.).

The newest innovations in the food supply chain build upon previous technologies to help meet the challenges experienced by the global food supply chain. Artificial Intelligence (AI), mobile apps for farmers and consumers, drone technology, GPS tracking devices, automation of warehouse processes, and augmented reality are applied throughout the agrifood system to improve crop management and communication between farmers, buyers, and consumers (AeoLogic, 2022).

These technological innovations are found within all sectors of the food supply chain, but there are some being specifically applied to the distribution sector such as enterprise resource planning (ERP), radio frequency identification (RFID) technology, and warehouse management systems (WMS) (Chen et al., 2013; Smadi, 2016; Tija, 2023). These softwares help distribution firms deal with challenges they experience, but there are still discrepancies amongst the global food industry regarding the implementation of such technology.

Perrotis College is a division of the American Farm School (AFS) in Thessaloniki, Greece. The college provides undergraduate and graduate studies programs specializing in agriculture and food science. Researchers at Perrotis College intend to synthesize a detailed review of the food system sectors in Greece: production, processing, distribution, and marketing, to anticipate the direction of the system in the future. With this understanding, Perrotis College will develop new curriculum and learning outcomes for their students to promote success in the evolving food system.

The goals for our project were to identify trends in the food distribution system in Greece, the pressures, challenges, and innovations that are likely to affect the food system in the future. Our objectives are as follows;

- **Identify how the current food distribution networks in Greece operate and what challenges stakeholders experience;**
- **Investigate what motivates stakeholders to implement new technologies in their practices to improve distribution systems;**
- **Explain how stakeholder's attitudes towards current technology related to improvements influences their willingness to innovate;**
- **Identify the most promising innovations related to the food distribution system and how these will affect the entire food supply chain in the future.**

Our field research to meet these objectives consisted of semi-structured interviews with stakeholders within the food distribution sector of Greece where questions were derived from information gathered by archival research. Through interviews with companies in the food distribution sector, we gained insight into information about stakeholder perspectives on the status of the market, what parameters they feel act as limitations, their motivation for change, and how they see technology fitting into the food distribution sector.

BACKGROUND

CHAPTER 2.
BACKGROUND

MODELING THE FOOD DISTRIBUTION SYSTEM

Modern food supply chains link the production of food products to the end consumer. Figure 1 below provides a flow chart for the many stakeholders of a food supply chain. Food products and information travel from the farm to the consumer represented by the blue arrows. While consumer information, like market demand and preferences, travel from the consumer back to producers represented by red arrows moving through the organizations within the system (A Framework for Assessing Effects of the Food System, 2015). The solid arrows represent the main flow, known as the long food supply chain (LFSC) while the dashed arrows represent a common but less prevalent pathway for food to pass from producer to consumer, known as the short food supply chain (SFSC) (A Framework for Assessing Effects of the Food System, 2015; Kalfagianni & Skordili, 2018; Reina-Usuga et al., 2022). The long food supply chain passes through numerous organizations within the supply chain (i.e. processing, distribution, retail) while the short food supply chain only moves food through a minimal number of organizations, usually consisting of the producer selling directly to the consumer (Kalfagianni & Skordili, 2018; Reina-Usuga et al., 2022).

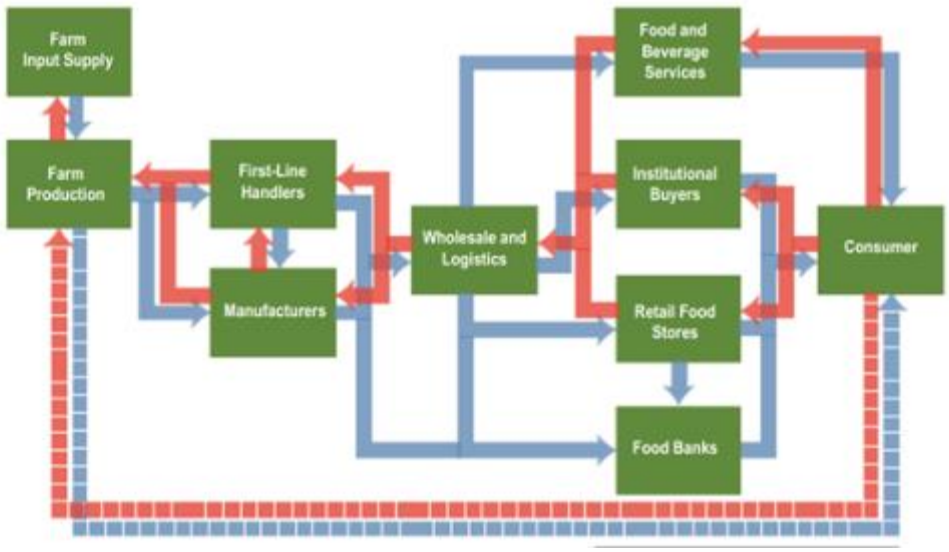


Figure 1. **Representation of the Food Supply Chain Organized by Flow of Goods and Information (A Framework for Assessing Effects of the Food System, 2015)**

The track food products take through the supply chain starts with farm production, known also as producers; these are farmers, fishers, and ranchers who use their resources to grow, catch, or raise raw agricultural commodities like crops or livestock (A Framework for Assessing Effects of the Food System, 2015). The raw agricultural commodities then travel to first-line handlers or manufacturers. First-line handlers buy the raw material from many producers to wash, wax, wrap, and package for use in the manufacturing industry or directly for sale as finished food products (A Framework for Assessing Effects of the Food System, 2015). Manufacturers, also known as processors, purchase from either producers or first-line handlers to turn the raw or handled commodities into higher-value manufactured food products. This sector includes companies like meat packers and bakeries who produce food products not sold in the raw, unprocessed, form it left the farm production sector in. (A Framework for Assessing Effects of the Food System, 2015). The next stage of the supply chain is wholesale and logistics, also known as the distribution sector. Wholesalers purchase handled or processed food products to store and transport to retailers using their network of warehouses and freight transportation vehicles. Throughout this stage logistical considerations like inventory coordination and predictions of demand are made to efficiently distribute food products. (A Framework for Assessing Effects of the Food System, 2015). The last sector of the food supply chain before the end consumer is the retail sector. This sector consists of anywhere the consumer can purchase food products or the service of prepared food. These are stores like supermarkets and convenience stores, institutional buyers like cafeterias and vending machines and food and beverage services like restaurants (A Framework for Assessing Effects of the Food System, 2015).

Food Supply Chain Management or Logistics

Logistics of the food supply chain refers to the strategies and methods employed by organizations to facilitate the efficient flow of food products (Zhong et al., 2017). Organizations within the food supply chain must concern themselves with properly managing their resources. Factors such as storage facilities, trucks, transportation routes, employees, labor hours, and product shelf life must all be balanced by proper logistical considerations in order to avoid the waste of time, money, and food (Nunes et al., 2022; Zhong et al., 2017). Optimizing the supply chain's logistics is an incredibly important task due to the perishability of food products and the failure to deliver on time decreases the quality and safety of the food for consumers (Zhong et al., 2017). To this end, the flow of information through the supply chain is necessary to inform the logistical predictions organizations make, like what is produced, manufactured, and where it is distributed. These are all linked to the accurate understanding of market demands and consumer trends (A Framework for Assessing Effects of the Food System, 2015).

CHALLENGES TO THE GLOBAL FOOD SYSTEM

Food systems globally are facing a sustainability crisis due to various social, economic, and environmental factors. Researchers emphasize the need for changes in the food system to address equity, environmental degradation, and consumer interests (FAO, 2018). Since distribution and logistics are the link between producers and consumers, the food distribution system faces challenges that are impacted by both groups. Major stressors of the food distribution system fall under three major categories: changing consumer demands, trends in market structure, and climate change.

Changing Consumer Demands

The current food distribution system faces growing demand in regards to population size, changing dietary preferences, and traceability concerns from consumers. Global population growth increasingly stresses the food system with respect to population and distribution. The United Nations projects that the global population will be 9.7 billion by 2050, a 32% increase from 7.3 billion in 2015. As the population rises, so will the global need for food (FAO, 2018).

Growth in the global economy and per capita annual income has led to an increase in food demand, specifically for resource intensive goods like dairy, meat, and fish (FAO, 2018). Researchers attribute this trend to the rise of the Western diet in place of the Mediterranean diet, not just in the U.S. but globally (Saez-Almendros et al., 2013). While Mediterranean diets prioritize fruits, vegetables, grains, and a small amount of white meat, the Western diet is characterized by low-cost, high processed foods and a preference for red meat, chicken, and pork (See Figure 2)(Saez-Almendros et al., 2013, Vega Mejia et al., 2018). Meat products in particular have a significant negative environmental impact; livestock contributes 14.5% of total greenhouse gas (GHG) emissions (Shabir et al., 2023).

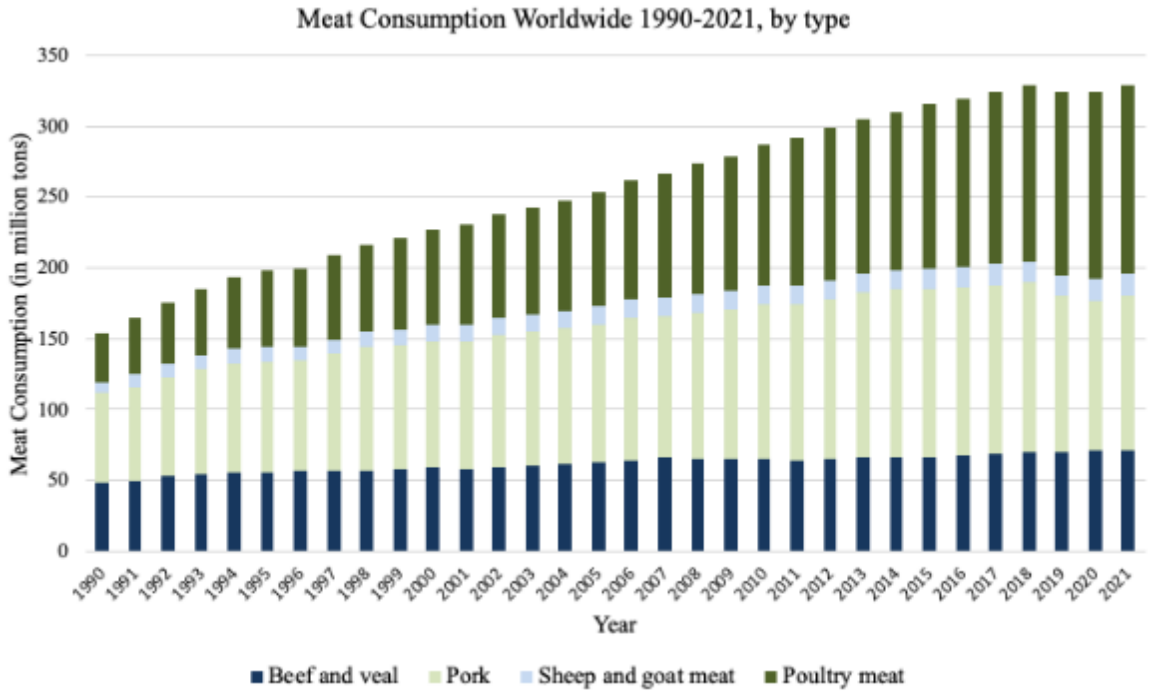


Figure 2. **Meat Consumption from 1990-2021 (OECD, 2022)**

The beef and poultry industry emits GHGs during production (land-use, methane from livestock, water consumption), feed processing, and transportation (vehicle emissions, refrigerated trucks) (See Figure 3)(Shabir et al., 2023). These products require more resources throughout the food supply chain, in this case specifically called the cold-chain, including refrigeration and time efficiency during distribution to preserve freshness (James and James, 2010). Overall, this shift in consumer preferences causes increased demand in both the production and distribution systems of the food chain (Vermeulen et al., 2019, Godfray et al., 2010).

Due to various foodborne illness outbreaks in recent years such as the bovine spongiform encephalopathy epidemic that led to over 200 deaths in Europe in the 1990s, there is increased consumer and government attention on food safety (Swire and Colchester, 2023, Hannstein, 2014). Consumers expect food to travel through the stages of production, processing, and distribution without contamination. Ensuring food safety relies on transparency throughout the whole food system from production to retail (Elliot, 2014). For producers and distributors, food contamination can be costly and damage or ruin company reputations. From a consumer perspective, contamination can become a major health threat (Dong et al., 2023). For example, a recall of Ferrero Rocher chocolates in 2022 stemming from salmonella contamination during production resulted in over 450 consumers becoming sick and "tens of millions of Euros" in losses for the company (Desk, 2023). Food safety is established through traceability, which is "the ability to track any food, feed, food-producing animal or substance that will be used for consumption, through all stages of production, processing, and distribution" (European Commission, 2007, 1). As the link between producers, processors, and retailers, the distribution industry must comply with government regulations of "one step forward and one step back" information that identifies the supplier of the product and where it was next sent, as well as consumer interest in traceability (European Council, n.d., Hannstein, 2014).

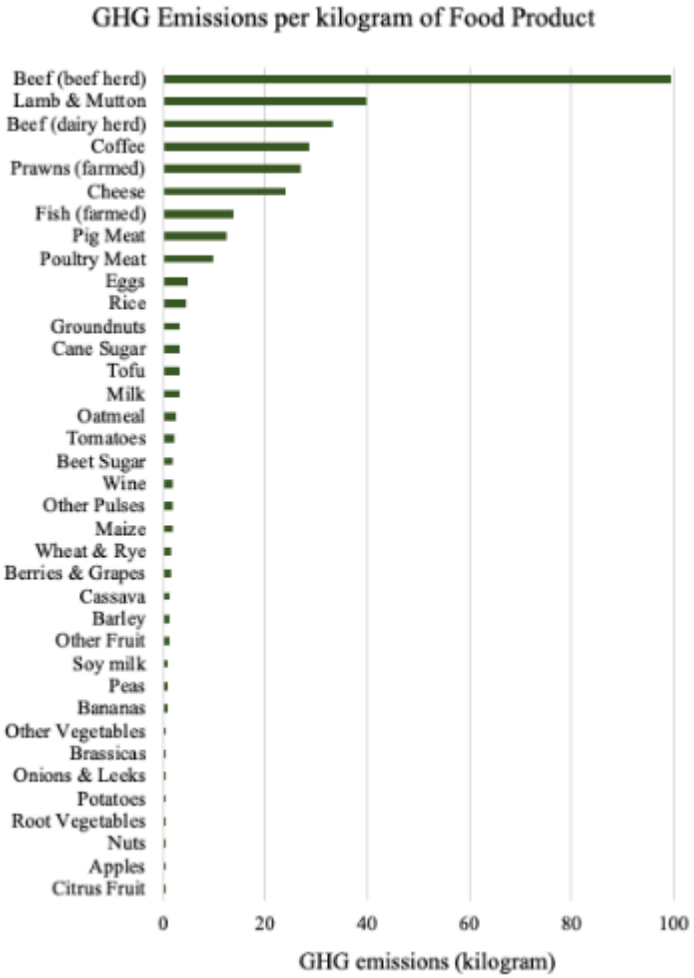


Figure 3. **GHG Emissions by Food Product (OWID, n.d.)**

Trends in Market Structure

Global economic growth trends lead to increased stress and demand on the food system, which has resulted in a centralized food distribution network where processors and distributors control the market power for large groups of independent farmers and independent consumers (See Figure 4) (Brinkley, 2018, Patel, 2007). With this type of market structure, which exists in other industries besides just food and agriculture, power is concentrated to large distributors, giving consumers and suppliers less control over the prices at which they buy and sell their products (Clapp et al., 2021, IPES, 2017). Distributors influence how food is grown, the price that farmers and retailers sell their goods, processing methods, and marketing methods (Clapp et al, 2021). This concentration of market power makes changes to the food distribution system more difficult since producers and consumers have very few other options if they are interested in traceability, environmental sustainability, or local agriculture, and these options often come at a significantly higher price (Howard, 2016, Clapp and Fuchs, 2009).

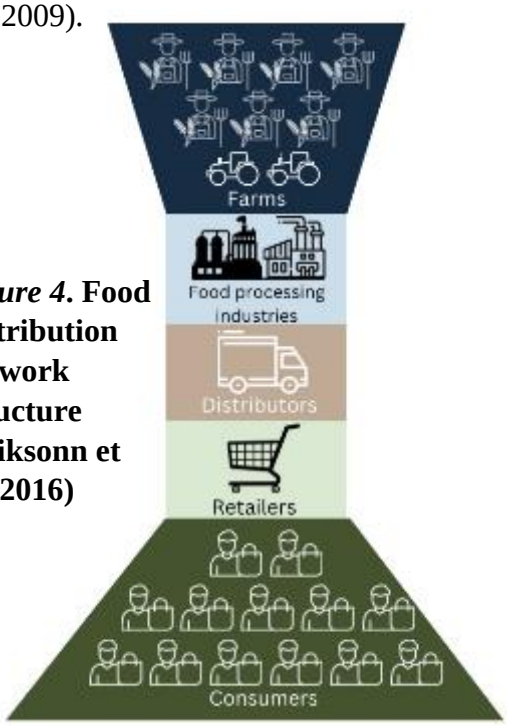


Figure 4. **Food Distribution Network Structure (Eriksonn et al., 2016)**

Environmental Concerns for a Growing Food System

In the face of climate change and natural resource depletion, researchers emphasize the need for a more sustainable and environmentally conscious food system (FAO, 2018). The European Climate Law (EU 2021/1119) targets, set a legally binding target of net zero GHG emissions by 2050. This will require a 90% reduction in GHG emissions from the transportation sector (European Council, 2022).

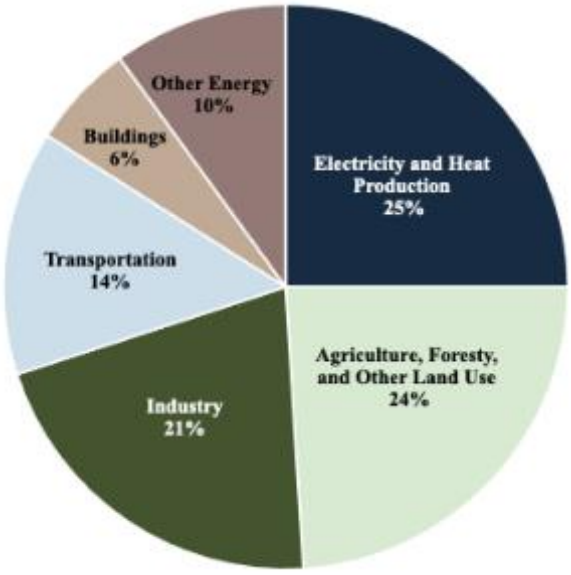


Figure 5. **Food System Greenhouse Gas Emissions by Sector (Watson, 2020)**

Within the food system, the transportation of food products contributes between 14% and 20% of total GHG emissions (See Figure 5)(Watson, 2020, Li et al., 2022). GHG emissions can be reduced by decreasing the total food miles of a product. Food miles are a measurement of the total distance a product travels from producer to consumer, and they also take into account the emissions produced by the mode of transportation (Kissinger, 2012). The primary modes currently used in the

food distribution industry are trucks, trains, ships, and airplanes, of which air transport has the most GHG emissions (Chen et al., 2021). From the share of global food miles, 58.97% is water transport, 30.97% is road transport, 9.9% is rail transport, and 0.16% is air transport (Poore and Nemecek, 2018).

In addition to transportation emissions, food waste produces GHG emissions either when rotting in landfills or being incinerated (Buzby, 2022). Worldwide food waste contributes 8% of total GHG emissions (UN, 2020). Within the total food system, up to 50% of waste comes from post-harvest activities which represent unnecessary use of natural resources including land, water, minerals, and genetic resources (i.e. plants and animals) that were depleted in food production (Westhoek et al., 2016, Balaji and Arshinder, 2016, Hertog et al., 2014). EU 2018/851 aims to reduce supply chain food waste through the implementation of educational programs, landfill charges for food waste disposal, and food donation (EUR-Lex).

INNOVATION AS A MEANS FOR IMPROVING THE FOOD DISTRIBUTION SYSTEM

Food Integrity and Traceability in the Distribution Sector

Distribution firms in the supply chain produce food waste when they overstock a product, which means buying more than they are able to sell. Warehouse Management Systems not only take into account how much product should be in stock but also consider the shelf-life of perishable goods to ensure the customer receives their order in the highest possible quality. In cold chains specifically, first-in-first-out (FIFO) is an industry-standard practice for many distribution firms to avoid capital loss due to food waste or recalls. A cold chain consists of the steps of the supply chain specifically for items that must remain refrigerated or frozen, i.e. they are temperature and time-sensitive (Mercier et al., 2019). Due to the sensitivity of such products, FIFO is the standard practice in making sure the first products to enter the warehouse are the first ones to leave. Implementing this standard is a helpful organizational tool for warehouses in tracking products and promoting food integrity (Tija, 2023). Food loss, especially in regard to cold chain items, is a result of improper refrigeration and tracking, resulting in inedible products and a monetary loss in sales (Tsang et al., 2018). The use of temperature sensors in refrigerated vehicles also reconciles food loss during transportation and is an application of Distribution Management Systems (DMS).

To improve delivery timing and therefore decrease the risk of food spoilage, a simple solution is shortening the route of transportation. While shortening transit routes may work for goods with longer shelf lives, experts in the supply chain express that is not a feasible solution for perishable items, so proper refrigeration is necessary (Tsang et al., 2018). Using refrigerated trucks as a type of DMS to adequately transport perishable products is not a new innovation, but new technologies have been implemented to address rising challenges. One of the largest challenges is temperature control, as opening doors during transit increases the temperature in the refrigerators, affecting the shelf life of the products. To manage the temperature of the products during transportation distribution firms are implementing sensors to track the temperature of products throughout the whole food supply chain. In addition, they are working to create refrigeration systems that are quick to bounce back to the

appropriate temperature (Fallman et al., 2022).

The implementation of RFID technology reduces the number of miscommunications and allows for better organization of warehouses so FIFO can be facilitated properly and food integrity and traceability are not jeopardized (Chen et al., 2013). RFIDs function in a similar manner to barcode systems, where there is an RFID chip that contains all necessary information and an RFID scanner that decodes the information. An important advantage that RFIDs have over barcode systems is long-range and instant communication access (Kumari et al., 2015). RFID technology tracks products throughout the supply chain and contains information regarding dates, times, and locations of when a product has left and arrived at its intended destination including where the product has come from or where it is going. This technology also has the ability to monitor in real time the environmental sensing for temperature and humidity (Kumari et al., 2015). The newest innovative application of RFID is their use in conjunction with temperature sensors that monitor and record the temperature of the product from farm to fork to be certain it is of high quality (Renko et al., 2019).

Supply chain management is the management of businesses, finances, and the flow of products throughout all sectors of the food supply chain and has been improved through the use of Enterprise Resource Planning (ERP) over the past 50 years. Although this management method has been around for decades, improvements are being made and new software is being applied to work in unison with these systems. ERPs represent centralized systems in which data is shared with the other sectors of the system in a timely manner (Cardoso et al., 2015).

Figure 6. **Functions of ERP System (Precise Business, n.d.)**

One benefit of implementing ERPs in food systems is reducing the costs of communication, meeting, delivery, and traveling [or transportation] (Smadi, 2016). This gives firms a competitive advantage by improving delivery time by increasing effective communication through the use of the software's ability to work in real-time (Madanhire and Mbohwa, 2016). A drawback of this system is the inability to connect with certain softwares, however of all the companies that have implemented ERP systems 49% reported that their business process overall had improved and 93% reported their ERP implementation as a success (Biel, 2022). Additionally, ERP software is used to make projections on consumer trends that estimate the future supply and demand of products so distribution firms can understand buying trends. This improves organization and preparation to minimize monetary and product loss (Daleo, 2022).

More recently, researchers have used AI, a computer program designed to

complete tasks that normally require human intelligence, for supply and demand prediction that can give distributors a competitive advantage. A sales manager for an ERP software firm, Pete Zimmerman, is using his expertise in the field to create the mechanism he refers to as "suggestive purchasing" where an AI program is able to inform the distributor of the quantity, timing, and the storage of the order. In addition, the software considers how much stock is available in order to prevent overstocking and therefore prevent jeopardizing food integrity. Assuming distributors are unable to obtain a certain product, the system will suggest a similar product as a substitute for the consumer and can inform customers about when to order products that are only stocked upon request (Daleo, 2022).

Environmental Sustainability in Distribution

The optimization of transportation routes has proven to be one of the best solutions to decrease food miles in long food supply chains (Aliotte and Oliveira, 2022, Coley et al., 2009). Specific to distribution, a form of AI known as digital twin modeling is being applied to improve transportation (AIFS, n.d.). Digital twin modeling is a very accurate virtual representation of a real entity. Transportation in the food system is represented by a digital version of the system with real data connecting the two. The graphic below explains this technology in a simple manner.

Digital twin serves as a simulation of a real structure by visualizing certain scenarios digitally first helps companies with cost savings and process improvements (Khajavi et al., 2019). In simulating transportation systems in food distribution companies can optimize routes, improve refrigeration and energy consumption to ensure the highest quality of products are delivered every time.

Figure 7. **A Simple Depiction of Digital Twin Modeling (Essex, n.d.)**

CRITICAL TRENDS IN THE GREEK MARKET

In Greece, the main form of transportation of goods consists of roads; the EU's paper, *Research for TRAN Committee*, goes on to say "The dominance of the road transport is partly due to the characteristics of the country's terrain and inadequate railway infrastructure" (EU, 2018, section 2. General Information on Transport). The geography of Greece is 80% mountains and forests in addition to many populated islands, leading to the limited transportation infrastructure of the country (EU, 2018).

Almost all businesses in Greece can be categorized as Small Medium Enterprises (SMEs) and within the agricultural sector this is seen by most farms in Greece being small, 7 hectares or less (OECD 2020, EuroStat 2022). Data from PricewaterhouseCoopers (PwC) shows that 90% of Greece's food production businesses are small family-owned farms with less than 10 employees as small- and medium-sized companies with 10 to 50 employees account

for 19% of the industry's entire turnover (GIG, 2020). It has been recently documented that food prices in Greece have seen an upward trend which is affected by higher demand and global food prices affecting the food supply chain's profitability (Alpha Bank, 2020).

An important factor in the food sector is consumer buying trends, which affect the demand for products. Changing consumer wants can affect competitiveness amongst sellers. A study in 2004 looked at Greek consumers' evaluations towards certain quality cues. These were product certification, geographic association, and traceability, and such cues were perceived as highly important by consumers of specific socioeconomic and demographic characteristics (Dimara & Skuras, 2004). Although not all consumers value the same qualities in such regards, it shows the possibility for these factors to have larger effects on the sector within certain socioeconomic and demographic clusters.

An Overview of The Food Sector in Greece

In Greece, the food products produced in the country consist of corn (maize), wheat, barley, sugar beets, peaches, tomatoes, cotton (of which Greece is the only EU producer), and tobacco (Britannica, 2023). To understand the Greek Agrifood sector's role in the larger picture of the EU, the graphs below illustrate which products are exported and imported into Greece.

The majority of products exported from Greece are (from largest to smallest quantity) processed fruits and vegetables, dairy and cheese products, fiber crops, fish products, and oils. It is important to look at which products are being exported as the methods to transport all agricultural products are not the same. Perishable products like dairy, fish, and meat must be refrigerated, causing the distribution of such products to differ from that of non-refrigerated goods.

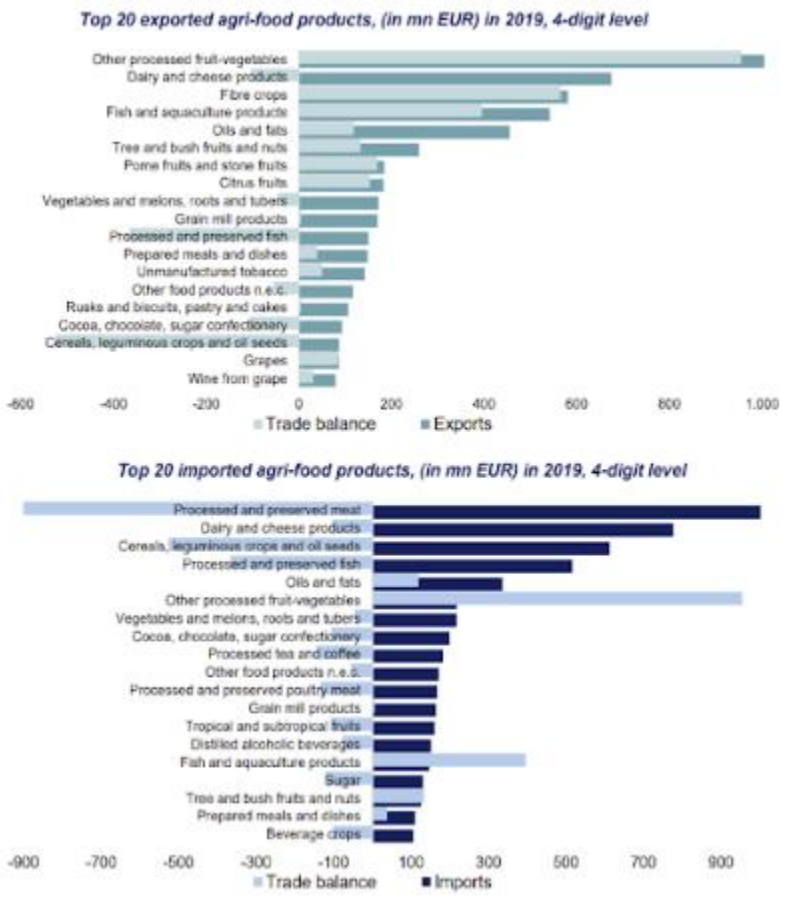


Figure 8.
Top Exported and Imported Products of Greece (Eurostat, 2020)

Agricultural farms in Greece are located throughout the country, however Greece has a limited amount of farmable land as seen in 2020 the total farmable land was 2,131,930 hectares (Macrotrends, 2020). The Greek agrifood sector consists of about 700,000 farms, which are rather small in physical size with the average farm being 7 hectares; more than 70% of Greece's farms consist of less than 5 hectares (European Commission, 2022). The highest concentration of farms are located in the surrounding areas of the two largest cities in Greece, Athens in the southern region of the country and Thessaloniki in the northern region of the country. 11.6% of the population in Greece in 2019 worked in the agriculture sector, accounting for approximately 1.2 million jobs (Statista, 2023). The agricultural sector accounts for about 4% of Greece's Gross Domestic Product (GDP) but acts as an input for other industries such as Food & Beverage (Agriculture and Rural development, 2021, European Commission, 2023).

PERROTIS COLLEGE INITIATIVE

The food distribution system in Greece faces similar challenges to the global food distribution system and some that are due to the country's combination of unique factors. Researchers at Perrotis College are interested in forming strategies to improve logistics in the food supply chain. The Greek economy depends on agriculture, fishing, food and beverage production, and tourism services, so the food system and specifically food distribution play a vital role in economic success in Greece (Tsekeris, 2017). Perrotis College researchers are developing an overview of the current state of the entire food system, innovations being implemented, and what challenges will arise in the future with these new strategies.

METHODS

CHAPTER 3.

METHODS

The goal of our project was to identify trends in the food distribution system as well as stakeholder perspectives on factors, challenges, and innovations that are likely to impact the system in the future. Our project was one of many research initiatives at Perrotis College investigating the food supply chain; production, processing, distribution, and marketing as a basis of research to build Perrotis' future curriculum and research initiatives. Our objectives were as follows:

- Identify how the current food distribution networks in Greece operate and what challenges stakeholders experience;
- Investigate what motivates stakeholders to implement new technologies in their practices to improve distribution systems;
- Explore how stakeholders' attitudes towards current technology influences their willingness to innovate;
- Identify the current and most promising innovations related to the food distribution system and how these will affect the entire food supply chain in the future.

STAKEHOLDER INTRODUCTIONS

The stakeholders we chose to interview consisted of food distribution firms and Perrotis College faculty. In selecting stakeholders to interview, we were interested in gathering a range of perspectives including a large distribution firm, a small distribution firm, and a vertically integrated company, which refers to a business that operates in multiple sectors of the supply chain, such as production, processing, and distribution. See the figure below for profiles on each interviewee.

Figure 9. **Profiles on Companies and Industry Experts Interviewed**

INTERVIEW STRATEGIES

Based upon the stakeholders we selected and interviewed, two types of interviews were used: (1) unstructured interviews and (2) semi-structured interviews as described by *Interviewing for Research* (Easwaramoorthy and Zarinpoush, 2006). The decision to use both types comes from the format of the interview.

In our interviews with Perrotis College faculty, we wanted to use their expertise as an introduction to the whole agrifood sector in Greece and learn about relevant factors that impact the food supply chain. To do this, we conducted unstructured interviews. Since these key informants have extensive knowledge in the agrifood sector and in the Greek culture as a whole, we left the direction of the discussion open to factors that they saw as most important for our research. In addition to being part of our findings, the results of these interviews were used to generate interview questions for distribution firms.

With distribution firms, we conducted semi-structured interviews for which we prepared a standardized list of questions derived from areas of interest in our archival research which can be found in Appendix B. Semi-structured interviews proved to be the best interview strategy because we were able to ask probing questions and change the direction of the conversation to gain more insight about the most relevant topics. These topics were generated by identifying what information each objective was trying to gain. Each box in the chart to the right represents an objective and the associated topics:

Topics Via Objective	
Objective #1 The scale of their company; The transportation and storage methods they use; If their methods have changed in past years; What retailers they distribute to.	**Objective #2** Challenges companies face while distributing products; Placing priority on specific challenges.
Objective #3 How companies benefit from their current technology systems; Challenges companies face with their current technologies; Circumstances that would lead companies to innovate; Stakeholders' interest in promising technologies such as AI and robotic automation.	**Objective #4** Current technologies being used in various food distribution firms; Technologies stakeholders expect to see breakthrough into the distribution sector; Impacts of these technologies on distribution and other sectors in the future.

Figure 10. **Topics Breakdown by Objective**

DATA ANALYSIS

After we conducted our interviews, we transcribed the recordings to organize our data. We then used thematic coding to identify patterns and trends within the data, as described by the University of Wisconsin researchers in *Analyzing Qualitative Data* (Taylor-Powell and Renner, 2003). Further categorizing our data into relevant sub- and super-categories related to our objectives, we drew connections and relationships between them before beginning our findings and conclusions. This was done by organizing all our findings and specific quotes by the objectives and topics outlined previously. In addition, archival research was used to support the perspectives of the stakeholders we interviewed where possible.

FINDINGS

CHAPTER 4.
FINDINGS

The findings of our research are presented via key questions that were investigated in association with our objectives.

WHAT ARE THE TRENDS IN THE GREEK FOOD DISTRIBUTION SYSTEM?

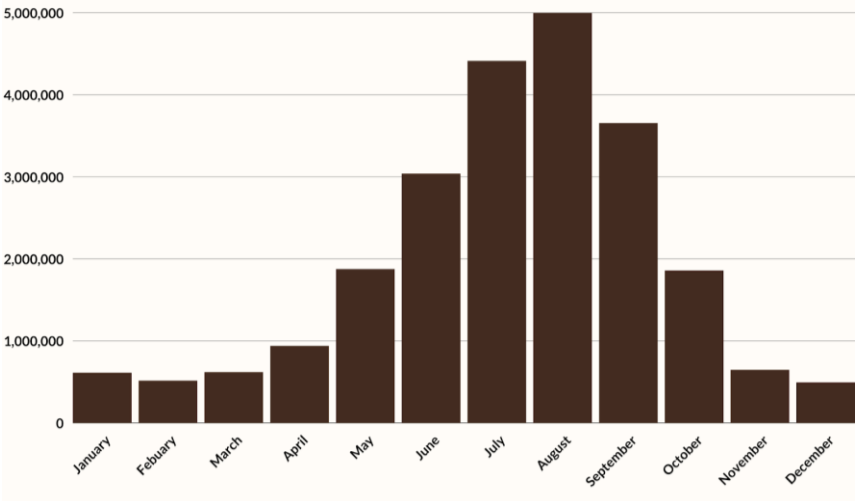
THE GREEK FOOD DISTRIBUTION SYSTEM IS ALMOST ENTIRELY RELIANT ON TRUCKING FOR FREIGHT TRANSPORT

The Greek distribution sector is dependent on trucking to accomplish its transportation of food products. "**Everything is done by trucks**," as both Patricia Forou and Alex Georgiadis remarked. This reliance is caused by the lack of an efficient railway network within Greece as Patricia Forou explained to us, resulting in distribution firms operating their own fleets of trucks. This is consistent with our background research on the Greek agrifood system. As the EU reports, 97% of Greek freight transport is done by road with only 2% by rail (Tuszyńska, 2018, section 2. General Information on Transport). To service the many islands of Greece, distributors must book travel for their trucks on ferries owned by private companies, a system that works but adds another layer of complexity to the task.

TOURISM IN GREECE CONTRIBUTES TO A SIGNIFICANT PEAK IN DEMAND DURING THE SUMMER MONTHS

The Greek market experiences large peaks in demand during the summer months, brought on by Greece's significant tourism industry. With a population of around 10 million, Greece hosted 23.6 million international tourists in 2015, who on average stayed for a little over a week (Bank of Greece, 2023; Stamou, 2016). The total number of tourists grew yearly to around 33.1 million in 2018 before dropping due to COVID-19 (OECD, 2020). As explained by Kostas Rotsios, Greece sees over three times as many tourists as its normal population in a given year. The figure below shows the number of international tourists to arrive in each month of 2015, with significant peaks corresponding to the Greek summer.

Figure 11. **Greek International Tourists by Month During 2015 (Stamou, 2016)**



THE GREEK FOOD SUPPLY CHAIN PREFERS LFSCs WHILE STILL EMPLOYING A NUMBER OF SFSCs

When we asked about preferences for long or short-food supply chains in Greece, it was clear that the long-food supply chain model was the most prevalent. Looking at an analysis of the Greek grocery sector, larger supermarkets combined with smaller grocery and convenience stores account for 81% of the retail sector's total yearly income (Kioses & Doukidis, 2011). These retail methods predominantly rely on the long-food supply chain to operate efficiently due to their scale. Christos Mourtziopoulos also pointed out that "**long-food supply chains are, by far, more environmentally friendly in comparison to the short ones, so industry prefers the long ones**" due to the fact that the actors involved in the supply chain are interested in maximizing efficiency and minimizing carbon dioxide footprint. The remaining 19% of the grocery sector's total yearly income comes from kiosks, liquor stores, bakeries, butchers, greengrocers, fishmongers, and street markets, which are more likely to use the short food supply chain, specifically the butchers, fishmongers, and street markets, who sell raw agricultural commodities they can purchase directly from producers if they themselves are not the producer (Kioses & Doukidis, 2011). According to Kostas Rotsios, farmers' markets will primarily serve the elderly and nonworking since they are only open in the morning, but recently there has been a push to keep them open later so more can utilize this form of food distribution for their shopping

THERE IS A GROWING TREND TOWARDS LARGE CORPORATIONS IN GREECE'S FOOD SUPPLY CHAIN VERTICALLY INTEGRATING

There appears to be an emerging trend toward vertical integration within Greece's food supply chain. By definition vertical integration is the effort by an organization to expand to operate all or most sectors of its supply chain (i.e., production, processing, distribution, and retail). As Ioannis Patounas of the vertically integrated poultry cooperative PINDOS explained, "**As a leader in the market, everybody is following our model**." He also commented that the difficulty in fostering a "**culture of cooperation**" and the financial capital required to run multiple sectors of a supply chain hinders other attempts to vertically integrate. Alex Georgiadis also commented on the recent trend of bigger retailers who "**collect all the goods in their main warehouse and… do the distribution themselves**." This points toward the trend for larger corporations of the Greek food supply chain to vertically integrate into their surrounding supply chain sectors.

THE GREEK FOOD SUPPLY CHAIN EXHIBITS A DICHOTOMY BETWEEN SMALL AND LARGE ORGANIZATIONS

We noticed a trend toward two parallel pathways for food distribution. Split between the size of corporations: small producers sell to small distributors who sell to small retailers, and large producers sell to large distributors who sell to large retailers. Alex Georgiadis of the small firm Nikolaos Georgiadis S.A. explained that "**90% of our business are small stores**" and that they provide an avenue for small producers to reach the market, citing how "**bigger retailers…mostly (buy) from bigger farms**." Ioannis Patounas of the large poultry cooperative PINDOS explained that the majority of their production is distributed to large supermarkets while the rest is split between butchers, restaurants, and minimarts.

WHAT CHALLENGES DO DISTRIBUTORS IN GREECE FACE THAT LIMIT THEIR COMPANY'S PROFITABILITY?

INDUSTRY REGULATIONS RETAILERS WANT FROM SUPPLIERS POSE NEW REQUIREMENTS FOR FIRMS TO ACHIEVE

A challenge consistently brought up in our interviews are the regulations distribution firms are expected to comply with in their practices. The regulations most prominent in our interviews were; HACCP, ISO 22000, and ISO 14001. To understand how they apply to the food supply chain, we discuss them briefly below;

Hazard Analysis and Critical Control Points (HACCP) is a management system where food safety is addressed through all segments of the food industry. This is a certification ensuring that distributors handle food products safely developed by the FDA and is considered an international standard (FDA 2022).

ISO 22000 is a certification that has requirements for a food safety management system that outlines what an organization, no matter its size or position in the food supply chain, needs to do to show its ability to control food safety hazards before receiving such certification (ISO, nd).

ISO 14001 is a certification that has requirements for an environmental management system to provide assurance to company management and employees as well as external stakeholders that environmental impact is being measured and improved before receiving such certification (ISO, nd).

These regulations support standardized practices across the entire sector so distribution firms cannot cut corners and risk jeopardizing the quality of the products they distribute. It is viewed by both large (Elgeka) and small (Nikolaos Georgiadis S.A.) firms as **"another parameter [we] must take into consideration"** when thinking about their distribution methods and company decisions. These regulations and certifications are not obligatory for distribution firms to follow but if they want the certification they must comply. Many companies choose to get such certifications as their customers in the retail sector will not work with them if they do not hold these certifications.

MEETING CONSUMER NEEDS IS CURRENTLY PREDICTED BY MANUAL ENTRY, LEAVING ROOM FOR ERROR

Distributors "act as the middleman" in the food supply chain according to Patricia Forou of Elgeka. In our interviews, companies referred to their customers not as the end consumer of the food but the retailers who buy and sell food products. Elgeka sells to large chain supermarkets within Greece; some but not all include: Sklavenitis, Lidl, Alfa Beta Vassilopoulos, and Metro Aebe, who each see billions of profits annually. They set a new list of challenges in order to meet the demands of such a large customer. There is a balancing act at play of buying enough products to meet the demand while not going over budget and remaining timely in replenishing the supply of products. **"The challenge is timing"** and knowing exactly what decision is to be made based upon multiple factors, as stated by Patricia Forou, as the current

manual entry doesn't provide exact predictions for future orders or take into consideration the season, exact supply quantities, changing buying trends, and more.

It is the same for the small distribution firms, despite distributing to smaller grocery stores, convenience stores and few large supermarkets, they face similar challenges of predicting the right amount of products for their customer and getting it there on time. Currently the orders are fulfilled by workers who manually enter how much the small firm should bring based upon their own previous experiences. As stated by Nikolaos Georgiadis S.A. representatives, **"At the same point, you need to be very careful, so in order not to have outdated products, not to take too many and some of them will expire. So you need to find a balance. I think this is and we think this is the most difficult part of our job: balance"** Distribution firms of all sizes struggle with the logistics of how much product to supply an inexact demand. There is additional concern with the possibility of food waste when such predictions are wrong and the supply put onto trucks doesn't reflect the demand, leaving excess products to go back and become food waste, making both distributors and producers lose money in the process. The repercussions for inaccurate supply for distributors is serious and was a primary focus of both large and small distributors during our interviews.

GREECE'S DISTRIBUTION IS PRIMARILY VIA ROADS, BUT THIS IS EASILY AFFECTED BY WEATHER AND TRAFFIC PATTERNS WITH NO ALTERNATIVE

Many of our interviewees described how the mountainous geography of Greece and the limited rail service negatively affects the transportation of food products. The mountain ranges and forests that cover the country make land transportation methods reliant on roads systems. The most notable geographic features in Greece are the many islands which add to unique challenges distributors face in Greece. Many firms still distribute to the markets on the islands despite boats being the only feasible methods, with "improvements of this at a standstill," according to Elgeka and other transportation committees in Greece. The niche micro-climates of different regions of Greece cause delays in truck transportation due to changing weather patterns. This can be seen through the example given by Patricia Forou of snow in the northern regions of Greece that affect road quality when transporting goods to those regions.

TOURISM IN GREECE PLACES EXTRA STRAIN ON ACCURATE ANTICIPATION OF DEMAND FOR DISTRIBUTORS

In our interview with Nikolaos Georgiadis S.A., they noted that there is a population exchange of about a million people in the summer months from Thessaloniki to the Halkidiki region. Interestingly, there is a connection between the two markets as seen through the swap in population and the associated demand in each location. In the summer months their workload increases so much the profits they make during the summer season are much larger than that of the winter months causing a skew of profits to reflect the increased food demand. The Greek Tourism Minister said in a statement that he expects tourism to grow by 20% in 2023 in comparison to 2019 (Vassilis Kikilias, 2023). It places a higher demand on the distribution firms who have to anticipate and match this growing need. This is seen in our conversations as a season that places extra strain on the accuracy of predictions for distribution firms (Greece, Tourism Forecast 2023, 2023).

HOW IS INFORMATION TECHNOLOGY (IT) APPLIED IN THE DISTRIBUTION SECTOR?

We found that distributors use IT to improve operations in three areas: traceability, organization, and adherence to regulations, as seen in the figure below and explained in the following subsections.

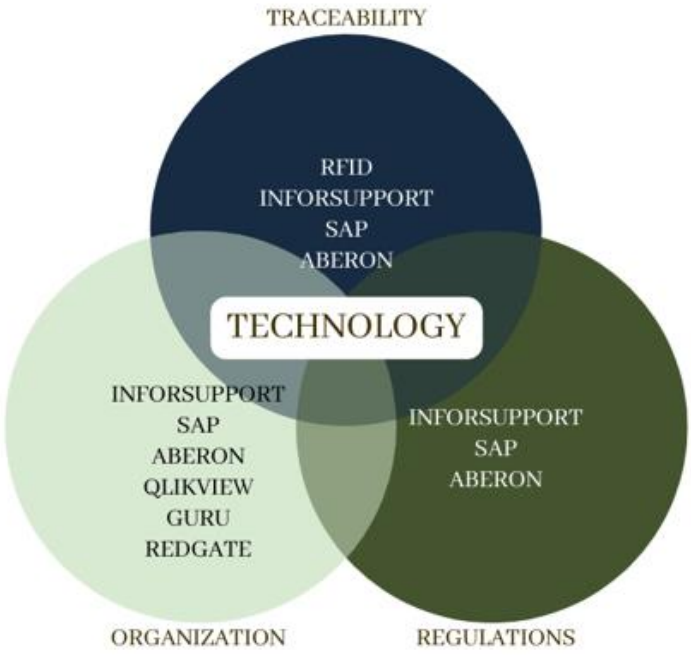


Figure 12. **Use of Software for Major Challenges**

STAKEHOLDERS IMPLEMENT TECHNOLOGIES IN THE WAREHOUSE AND DURING TRANSPORT FOR TRACEABILITY PURPOSES

Traceability and tracking needs were found to be managerial improvements, easing management processes by converting to automated systems. For the interviewed companies, traceability referred to the tracking of product from farm to fork, and vice versa. For food distribution specifically, the safety of their consumers is a big priority, so traceability is essential to ensure high quality products. “We deliver food so it’s obligatory to have… traceability down to the point of sale… Anything that has to do with human consumption, it is something that you need to know. Anything can go wrong so it is the basis of a company that distributes food to have… technology in what concerns traceability,” explained Patricia Forou.

To improve tracking capabilities, companies use various software platforms in their warehouses and in their trucks during transport. In the warehouses, ERP systems were the basic technology for tracking inventory to stay organized. ERPs typically work with one or two software programs: System Analysis Program Development (SAP) and Aberon.

SAP is a software that collects and processes data that can be accessed and updated in one platform via a database or the cloud. This software is used alone with ERP or in association with Aberon as a finance and business management system. Combined with Aberon and ERP, this software helped to facilitate business processes and with tracking data (SAP Sofware, n.d.).

Aberon is a warehouse and distribution management system with a range of purposes. The software is compatible with SAP and RFID technologies and can make predictions based on prior data to reduce the need for manual input. ERP systems alone require employees to input inventory into the database by hand, so SAP and RFID help automate this process (Aberon., n.d.).

Below is a diagram showing the connection between Aberon and ERP in the workplace. This software allows data to flow through the warehouse and transportation systems wirelessly and without the need for user input. All data contained in these systems can be accessed at any level of the distribution process and are secured in a database or the cloud.

Figure 13. **Aberon and ERP Systems Functioning Together**

ERP systems were noted to be the most helpful and most commonly used technology. Stavros Dimitrakopoulos noted that **"What I have seen [ERP] has improved [functions] a lot… and even now they are improving it, especially in logistics."** We found that some companies preferred simple updates to software used with ERP systems rather than implementing new technologies, such as AI, for two reasons: it's not necessary and the training and implementation processes are not time efficient. Regarding PINDOS's ERP system, a representative said, **"It's too difficult…In order to change our ERP system, we have to analyze all our procedures in all the departments and that would take us about three to five years…We can't skip any steps because the whole process will collapse… We have started it, but we stopped it because it's also the cost."**

While ERP systems and compatible softwares like SAP and Aberon were used for traceability at all interviewed companies, RFID has been in use at Barba Stathis for less than two years for tracking purposes as well as at Elgeka as a mandatory technology for traceability. Elgeka representative Patricia Forou mentioned traceability technology as mandatory according to their implement is subject to the company itself. This technology benefited the companies that used it by increasing time efficiency, as the automation reduced the time taken for inventory checking previously done by hand. The use of RFID has benefited these companies by automating tracking and logging responsibilities, allowing for product data all the way back to farm plot number to be instantly accessible to all employees through the use of the cloud.

ERPs and RFID technologies were used across the larger companies we interviewed, however, more basic, manual software was used in the smaller firms. Nikolaos Georgiadis S.A., relied on Infor

Support to track products in and out of the warehouse to the final destination.

Infor Support is a software specific to industries like distribution to anticipate challenges and maximize communication through a shared database (Infor Customer Support, n.d.).

DISTRIBUTION FIRMS UTILIZE PLANNING AND TRACKING SOFTWARE FOR ORGANIZATION AND MANAGEMENT OF FACILITIES

Companies used ERP systems not only for traceability but also for data analytics and cybersecurity. Elgeka uses data analytics to predict future sales and which products will be in high demand. Through Patricia Forou at Elgeka, we found that they used three different software for data integration and confidentiality. These technologies were Qlikview, Guru, and Redgate.

Qlikview is a software focusing on analytic solutions that allow colleagues to work through data together on the platform. The software compiles and organizes data in a platform accessible to all employees throughout business processes that is available in real time (Qlikview, n.d.).

Guru is a specific software solution that is used to customize software and software functions for businesses to improve management and organization.

Redgate is software that produces specialized database management tools and helps companies share and update information in real time in a secure manner (Ltd, R.G.S., n.d.).

These softwares are very specific programs that can be applied to businesses to improve management and organization. These were used in conjunction with ERP as customizable software for needs specific to distribution firms. ERP systems cannot be updated quickly enough to keep up with the demand of the distribution sector, so implementing these software helps the companies process and secure data in a much more timely manner. Barba Stathis, however, relied only on SAP and Aberon software for managerial and organizational needs. The smallest firm, Nikolaos Georgiadis, also relied on its Infor Support system for both tracking and managing needs.

Distribution firms recognize the benefits that technology can have within the food distribution system, primarily speaking about the current systems in place. The two categories that companies were most satisfied with are predictive software (ERPs) and traceability technologies (RFID). On ERP systems, Christos Mourtziopoulos said they "**make the logistics, by far, easier**." From the perspective of a small distribution firm, ERPs have helped them "**overcome one major problem which is expired products**," supporting the idea that technology can be beneficial to distributors of all sizes.

DISTRIBUTORS APPLY TRACEABILITY AND ORGANIZATIONAL SOFTWARE PLATFORMS TO ADHERE TO INDUSTRY AND GOVERNMENT REGULATIONS

The four distribution firms we interviewed used ERP systems and RFID to comply with the HACCP, ISO 22000, and ISO 14001 regulations mentioned above. All companies noted that following regulations

meant improved function in all processes within distribution; all technologies used throughout the process to optimize capabilities were the same as those for regulations. Regarding traceability systems, RFID helps companies be confident that they are fulfilling EU regulations for forward and backward traceability. International and EU regulations are mostly in regard to food integrity and promoting more sustainable practices. Through the use of ERPs, RFID, and the software mentioned above, companies can ensure the safety of their consumers and the environment, therefore properly adhere to such regulations.

POINTS OF LIMITATION IN CURRENT TECHNOLOGY

While there are benefits of implementing information technology into their practices, companies also recognized that these systems are still subject to error. For Nikolaos Georgiadis S.A., upgrading technologies is not feasible, as it requires too much time for implementation and training, and is not financially possible. Even for a larger company, updates and implementation of new technology were not chosen even if financially feasible because of the timeline and overall lack of need, as Elgeka E-Commerce manager Stavros Dimitrakopoulos informed us. These technologies were found to be beneficial to companies interviewed, but innovations posed challenges themselves, which will be discussed in greater detail in the following section.

WHAT ARE THE BARRIERS TO IT INNOVATION IN THE FOOD DISTRIBUTION SECTOR?

THE BIGGEST CHALLENGES IN IMPLEMENTING NEW TECHNOLOGIES ARE COST, EMPLOYEE TRAINING, AND ACCURACY OF PREDICTIVE SOFTWARES

Stakeholders explained that firms are satisfied with the IT systems they have in place, but are hesitant to explore newer technologies because of challenges regarding cost, employee training, and accuracy of the systems. We learned from Alex Georgiadis and Dr. Stella Despoudi that SMEs are reluctant to implement more advanced WMS and ERP systems due to cost barriers. Stavros Dimitrakopoulos from Elgeka said that large companies are also limited by the expense of dedicating money and time to new technology systems. In the case of larger companies like Barba Stathis, Elgeka, and PINDOS, they are often motivated to experiment with new IT or AI systems by external support from the EU and other international companies.

Other concerns about innovations are addressing how well technology will perform at their company. Both large and small distributors that we interviewed struggle to train employees to adapt to new software programs such as Infor Support at Nikolaos Georgiadis and Redgate at Elgeka. Regarding Elgeka's most recent Redgate modification, Stavros Dimitrakopoulos said, "**It took one year for our salesforce to adopt it. It was too difficult for our salesforce to understand that everything is in the tablet…still we are using it in 70% of its capabilities. It is something**

that *we* have modified, but still we don't use it." Another representative of Elgeka said, "**the tool is there, but if you're not using it correctly, then of course it will fall short**." Alex Georgiadis had a similar statement about challenges at Nikolaos Georgiadis, saying, "**we need to educate [our staff] better**."

The companies claim that they cannot fully rely on predictive technologies such as SAP and Infor Support since there are factors such as tourism, sales promotions, and changing demand that cannot be predicted by software. In order to benefit from these increased sales opportunities, companies prefer to rely on the predictions of their experienced employees. When using Infor Support at Nikolaos Georgiadis, "**the program can't be exact. It's the [salesperson's] experience that can make it work properly**." A 2019 literature review comparing the use of judgmental and computer prediction found that "retail promotions are the key reason for applying human judgment in forecasting" (Perera et al., 2019), which is consistent with our findings from stakeholder interviews.

Another problem with predictive technology is attributed to inadequate sales data from retailers. "**We are using [software] behind the estimation, but still, because we don't have much data from the chains, it's not accurate. It's 70% accuracy**," according to Stavros Dimitrakopoulos from Elgeka. Lack of sales data from retailers proves to be a challenge for the whole back end of the food supply chain, leading to food waste at the expense of the suppliers (Ghosh and Eriksson, 2019).

DISTRIBUTION FIRMS ARE UNLIKELY TO IMPLEMENT NEW TECHNOLOGIES BECAUSE THEY ARE SATISFIED WITH THEIR CURRENT SYSTEMS

Many firms are likely to only upgrade their IT systems when they are no longer sufficient in meeting the needs of the market. Stavros Dimitrakopoulos said, "**Because all these organizations are too large, they are not very keen in changing their system. It's too difficult…The only way to overcome those difficulties is if the whole market pushes in that direction. Let's say if something changes tomorrow and we have to adapt and our system, since it's highly modified, can't fulfill that need, then we will have to try to change our ERP system**." He provided the example of the rise of e-commerce during the COVID-19 pandemic. Although e-commerce only accounts for 2.5% of sales at Elgeka, the Greek agrifood sector was not prepared to shift to the digital market, so distributors had to modify their ERP systems to work with online retail. Athanasios Falaras provided a similar sentiment that businesses in all sectors in Greece are "**stuck to old ways**" regarding the use of technology and Konstantinos Rotsios explained that, in Greece, "**the food industry is a very traditional sector, especially agriculture**." This is consistent with a 2022 study conducted by EY Greece and Piraeus Bank that surveyed 436 professionals in the agrifood sector. When asked to rate the changes that they believe should be made in the Greek agrifood sector, increased innovation and digitization was ranked eleventh out of twelve options (*How can the Agri-Food sector face the challenges of tomorrow, today?*, 2022).

Stavros Dimitrikapoulos elaborated on the reasons many firms choose not to innovate, saying **"They haven't updated because they didn't see any need for updating the system. They are using the old fashioned way of 'I have my system, I have my Excel as a program to do my analysis, and that's all.'"** Rather than exploring technology that could modernize

their business practices, firms opt to rely on the current systems they have in place to avoid the cost, time commitment, and risk of system failure that comes with implementation of new technologies.

LARGE COMPANIES IN THE AGRIFOOD INDUSTRY ARE INVESTING IN NEW TECHNOLOGIES WITH THE SUPPORT OF EXTERNAL STAKEHOLDERS

Some of the largest and most profitable companies within the food sector are proactive in exploring innovations that are likely to play a role throughout the distribution sector in the future. Ioannis Patounas, a PINDOS representative, explained how upgrading their technology systems will give them a competitive advantage, saying, "**we are not waiting to see the problems**." Multiple companies are investing in new technologies with the help of external support. Barba Stathis is participating in a program that uses sensors and drones to detect the best time for harvesting, which is an important part of logistics in the primary sector because it determines when trucks need to arrive at farms to collect produce. At Elgeka, 5G and 6G technologies, which allow for faster data processing, increased number of connected devices, and more efficient long-distance communication between devices, are being implemented in warehouses as part of an EU initiative to explore the potential of such systems in the agrifood sector. DP World is a multinational logistics company that is helping introduce 5G technologies to warehouses, claiming that it will "bring about changes for traditional warehousing practices and make smart warehouses a much more common feature in the transport industry" (*5G and the Warehouse of the Future*).

"**Robotics are coming into logistics a lot**" to automate warehouses, said Christos Mourtziopoulos. Zenon Automation is a Greek company that specializes in automated warehouse systems, and it has introduced robotics into warehouses of various companies in the food supply chain for sorting, packing, and palletizing (*The Greek Food Industry Invests in the End-of-Line Automation*). FDL Group, another company in logistics innovation in Greece, says "flexible sorting robots…help SMEs and big brands alike meet customer expectations for accurate and efficient services to compete and grow" (Geek+, 2021).

Regarding the use of AI in distribution and logistics, stakeholders say it has proven to be a challenge to apply to the food distribution system in Greece. The most promising opportunity for AI in distribution is prediction of the demand for products, but it is difficult to develop an accurate model due to the lack of point of sale data from retailers and the variation in consumer demand in the market. Stavros Dimitrakopoulos from Elgeka said, "**AI in Greece is not so popular yet…The main problem in this industry is that there are too many estimations without actual data [from retailers] to support the estimation…that is why AI is not even close for our sector**." At PINDOS, they are working with a Greek university to develop an AI model to predict the demand for products, but Ioannis Patounas explained that "**right now, the algorithm cannot predict more than 60%, and [prediction from experienced managers is] at 85-90%**." Even while using data from the past 15 years, "**the market depends on the mentality of the consumers, like you can predict something and they hear the news of avian flu around Northern Europe and suddenly the demand will go down to 50%. This is something that no artificial**

intelligence can understand." Based on a literature review of research done to develop accurate AI models for prediction of food demand, there can be a large variance in the accuracy of the model based on the type of algorithm and number of data points used (Lutoslawski et al., 2021, Hodzic et al., 2019, Ning et al., 2009). For this reason, PINDOS estimates it will take 2-3 years to develop an accurate model. The variable nature of the food industry is a limitation of the accuracy of predictive AI models, which is why companies may prefer to rely on experienced salespeople. However, the current interest in AI by large companies in the Greek agrifood sector proves that it has the potential to be integrated into the whole system.

LIMITATIONS OF OUR RESEARCH

In scheduling and conducting our stakeholder interviews, we successfully interviewed representatives of four companies of various sizes to learn about their perspectives on challenges and technologies that may impact the future of the food distribution system. However, these claims may not represent the opinions of all firms in the industry. Our findings could change if we interviewed more companies which would provide a larger variety of perspectives to draw key findings from. Since we were trying to set up interviews with food distribution companies leading up to Greece's largest holiday, Greek Orthodox Easter, many firms were busy and some unavailable to meet with us.

Due to time constraints and since there will be other groups researching the other sectors of the food system, we did not conduct interviews with stakeholders from production, processing, and retail, but the desires of stakeholders in these sectors also have an impact on distribution strategies. Our interviewees had their own interpretations of the interests of producers, retailers, and consumers, but these may not accurately represent the actual interests of the stakeholders.

AREAS OF CONSIDERATION FOR FUTURE RESEARCH

CHAPTER 5.
AREAS OF CONSIDERATION FOR FUTURE RESEARCH

A large part of this project is looking towards the future, and by doing so the team uncovered several different topics that could have an effect on the food supply chain that we were unable to fully uncover. Such topics either came up during our research of journals, articles that have similar interests in the food supply chain or during our interviews with stakeholders.

Impacts of AI on Food Systems

As described in the Findings chapter, companies within the food distribution sector are interested in the use of AI as it has been globally implemented throughout the whole food supply chain. In Greece, however, AI has not reached its full potential within the agrifood sector. Future research on AI in the food system may focus more on the socioeconomic impacts of total automation of the food supply chain with the use of AI. Our project researched some of the benefits of AI, but implementation of this technology throughout the agrifood sector may come at the cost of lost jobs and businesses for producers, processors, distributors, and retailers that do not have the expertise or money to implement such systems in their businesses. Future research could focus more on social rather than technical implications of AI on food systems.

Food Supply Chain Trends

When stakeholders, described the growing trend for vertical integration they did so without providing more detail than their observations. For this reason, we would like to suggest that further research be done to understand the specifics of this trend, including the rate at which it's happening, the motivations to pursue vertical integration, the ways in which companies achieve vertical integration, and the financial power these vertically integrated companies wield within the Greek food When stakeholders, described the growing trend for vertical integration they did so without providing more detail than their observations. For this reason, we would like to suggest that further research be done to understand the specifics of this trend, supply chain. In addition, consideration should be given to how these companies affect the other businesses in the food supply chain that can't or don't attempt to vertically integrate as well as the effect on the end consumer.

Our research led us to understand that there is an appreciable presence of the short food supply chain within Greece, but our interviews with distribution firms mainly gave us a deeper understanding of the long food supply chain. We would therefore recommend more research into the short food supply chains of Greece, notably their share of the market, the demographics they serve, their importance to small farmers, and the recent trends within this section the food supply chain.

Traceability in Food Supply Chains

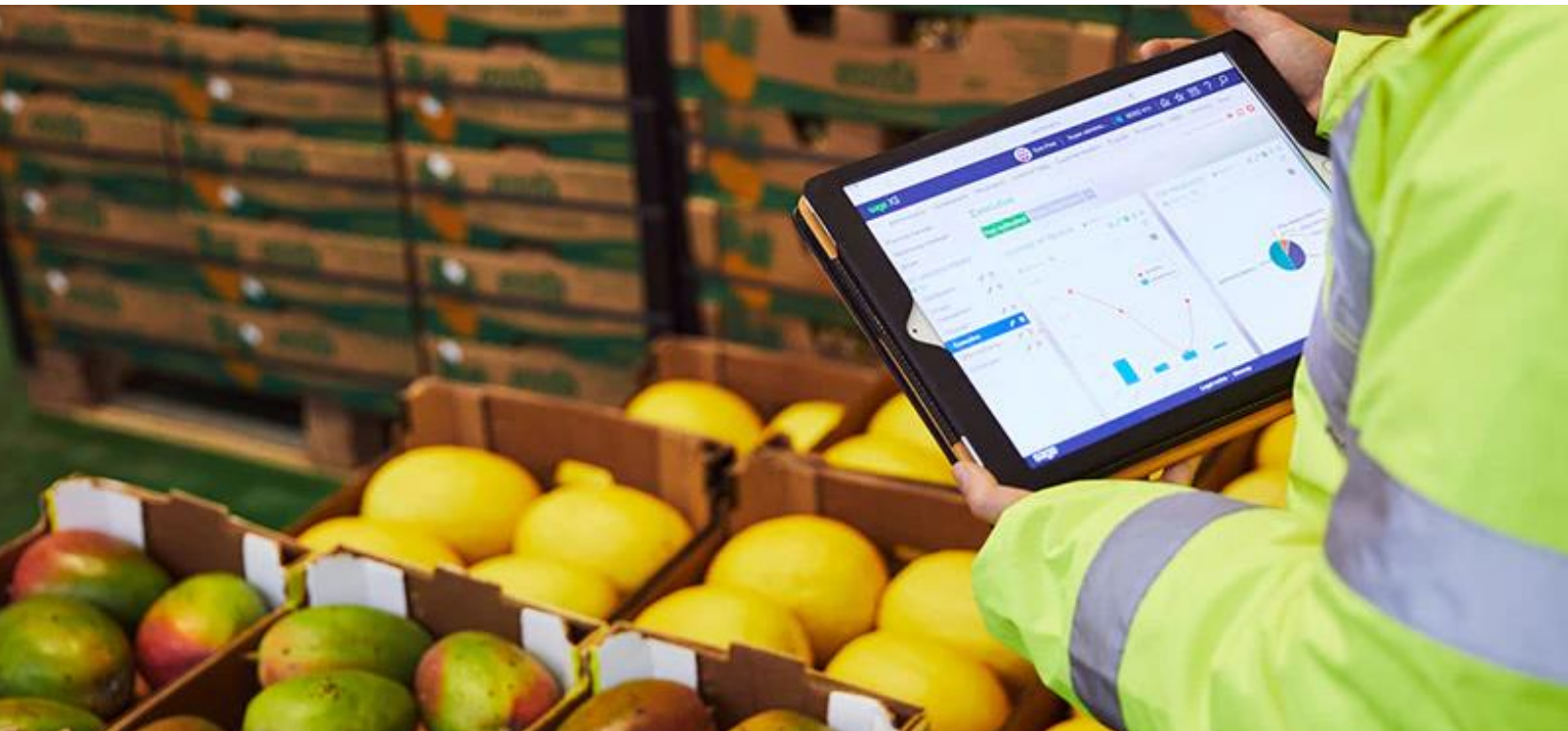
As we learned through our interviews with stakeholders, traceability has been a growing demand for industries. Currently, in Greece, traceability relies on ERP systems and software programs that still require manual input. Considering the amount of product distribution firms transport in a single day,

the time needed to input data by hand limits their ability to reach their full potential. Our project had limited time, so an area that future projects could further explore is traceability specifically in relation to recalls. Understanding how companies address such a challenge and what technological applications they implement to prevent or be better prepared for a recall will expand knowledge on the direction of the distribution sector in relation to innovation. We recommend interviewing companies that have previously had a recall in order to understand their experience and consider possible areas for innovation. Future projects could develop a more narrow scope on traceability technologies and how companies apply them to avoid loss of profit, time, and product.

Consumer Interests

There was a noticeable disconnect between distributors and the food consumers as distributors expressed their being a lack of data on purchasing habits as brought up by Ioannis Patounas of PINDOS. Consumer interests have the ability to influence the entire market starting with their buying habits to the attitudes towards key words on packaging. Research on Greek consumers' influence on the market can help stakeholders understand the role they have in the food system as well as help predict future trends. As within PINDOS their largest struggle with making AI software is the lack of data on consumers.

This project attempted to highlight strengths, challenges, and opportunities for advancement in the food distribution sector in Greece. We found that there is great likelihood for the sector to rely on new innovations and technologies in the future to make it more profitable and sustainable. Regardless of the limitations and additional research topics related to this project, we are satisfied with our contribution to the larger research initiative at Perrotis College and the potential that this research has to be used for the education of future stakeholders in the Greek agrifood industry.



APPENDIX A: GLOSSARY

Term	Definition
Agri-food	All food and beverage products contained within the agriculture food supply chain.
Artificial Intelligence (AI)	The development of computer systems able to perform tasks normally requiring human intelligence.
Centralized market structure	A supply chain in which a small number of large distributors and retailers control market prices for producers and consumers
Cold-chain	A food supply chain for perishable products that need to be chilled during distribution
Distribution Management System (DMS)	A collection of applications designed to monitor and control the distribution networks efficiently and reliably.
Enterprise Resource Planning (ERP)	The integrated management of main business processes, often in real time and mediated by software and technology.
First-In-First-Out (FIFO)	A standard for Warehouse Management Systems (see below) to improve efficiency and ensure high quality product.
Food and Agriculture Organization of the United Nations (FAO)	An international organization of the United Nations focused on ending world hunger
Food miles	A measurement of the total distance food travels from producer to consumer, including a measurement of the emissions based on the mode of transportation used
Greenhouse Gas Emissions (GHG)	The release of harmful gasses (primarily CO_2, CH_4, N_2O) into the Earth's atmosphere.
Gross Domestic Product (GDP)	The total value of goods produced and services provided in a country during one year.
Long Food Supply Chain (LFSC)	A supply chain that involves a variety of individual organization across multiple sectors (i.e processors, distributors, and retailers) to reach the end consumer
Food Supply Chain Logistics	The strategies and methods employed by organizations to facilitate the efficient flow of food products

Radio Frequency Identification (RFID)	Automatically identifies and tracks tags attached to objects.
Short Food Supply Chain (SFSC)	A supply chain based on the minimal number of actors needed to reach the consumer.
Semi-structured interview	A research method that combines a set of open questions with the opportunity for the interviewer to explore further.
Small and Medium-sized Enterprises (SME)	Businesses whos personnel and yearly profit are below a certain range.
Traceability	The ability to track any food, feed, food-producing animal or substance that will be used for consumption, through all stages of production, processing, and distribution
UN Sustainable Development Goals (SDG)	An overarching idea of creating a more sustainable future by 2030 consisting of 17 specific goals.
Unstructured interview	Interviews without a prespecified list of questions.
Vertical integration	The process in which an organization expands to control all or most sectors of its given supply chain
Warehouse Management System (WMS)	A set of policies and processes intended to organize the work of a warehouse or distribution center.

APPENDIX B. STAKEHOLDER INTERVIEW PROTOCOL

Written Consent Form

Investigators: Lauren Averka, Isaac Noble, Elinor Ross, Alexandra Spezzano
Contact Information: Tel. +30 694 826 5886, Email: lbaverka@wpi.edu, ipnoble@wpi.edu, emross@wpi.edu, acspezzano@wpi.edu
Title of Research Study: Feeding Greece: The Future of Distribution and Logistics
Sponsor: Perrotis College, Kostas Rotsios

Introduction:

You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks, or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of Study:

The purpose of this study is to gain an understanding of the current state of the Greek agrifood system, where the Greek agrifood system is headed in the next few years, what innovations are being used in the distribution system here, and what perspectives stakeholders in the system have on this.

Procedures to be Followed:

Research for this study will be conducted through stakeholder interviews. These will primarily be in-person interviews consisting of a list of questions prepared in advance by the research team. Interviews will last approximately one hour.

Risks to Study Participants:

Information gained from the interviews will be publicly available in the final report. Any confidential information that the interviewee would not like the public to know, such as innovations that give their business a competitive advantage, can be omitted from all published materials at the request of the interviewee at any time during the interview.

Benefits to Study Participants and Others:

Participants in this study are assisting Perrotis College in updating their curriculum and strategy for farming practices with the current knowledge of the industry. By keeping Perrotis College's curriculum and farming strategies up to date with real-world applications they ensure students are prepared and use accurate practices.

Record Keeping and Confidentiality:

With the interviewee's consent, the team would like to record the interview. The recordings will be used only during the time of the active study and will be deleted afterward. It is also up to the interviewee if they can be directly quoted in the research paper produced by the team. We are following the rules stated as such: "Records of your participation in this study will

be held confidential so far as permitted by law. However, the study investigators, the sponsor, or its designee, and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you."

For more information about this research or about the rights of research participants, or in case of research-related injury, contact:

Team members - Lauren Averka (lbaverka@wpi.edu), Isaac Noble (ipnoble@wpi.edu), Elinor Ross (Tel. +30 694 826 5886, Email: emross@wpi.edu), Alexandra Spezzano (acspezzano@wpi.edu). IRB Manager - Ruth McKeogh (Tel. +1 508 831 6699, Email: irb@wpi.edu). Human Protection Administrator - Gabriel Johnson (Tel. +1 508 831 4989, Email: gjohnson@wpi.edu).

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the interview at any time they see fit.

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

_____	_____
Study Participant(s) Signature	Date
_____	_____
Study Participant(s) Name (Printed)	Date
_____	_____
Signature of Person who Explained Study	Date

Example Interview Format

Interview With:
Date:
Time:
Location:
Attendees:

Sample Introduction:

Hello,

We are _____, American college students doing research on the food distribution industry in Greece as part of a larger project of the American Farm School. The goal of this report is to gather information about trends in the food distribution system and factors that are likely to impact the system in the future. Before we begin, we would like to thank you for taking the time to participate in the interview which will last about (expected duration of interview). Your participation is entirely voluntary. You may refuse to discuss any question or terminate the interview at any time. With your permission, we would like to record the interview. The tapes, notes, and subsequent transcripts of the interview will be kept confidential and will be accessible to only the members of the team and our immediate faculty advisors. Your name will not be used in any subsequent report or publication without your permission.

You will have access to this report once it is finished as it will be posted online, and if you'd like, we can email you the report. Before we begin, do you have any questions for me/us?

Example Questions During Interview:

1. Do we have your permission to record this interview?
2. Do we have your permission to directly quote you as a representative of your company in this report? If not, with your permission we would like to list you as an "industry expert."
3. We want to understand how distribution takes place on different scales: EU, Greece, regional. Can you explain each of these components?
4. Can you explain how your company fits into the food system in Greece? What methods of distribution and logistics are used in the primary sector (transporting products from producers) and tertiary sector (transporting products to retailers)?
5. What are the biggest challenges to food distribution in Greece? So far, our research has suggested industry competition, traceability, environmental sustainability, government regulations, and consumer preferences as important considerations. Can you speak about these and any other factors you think are important?
6. What sort of technologies are being used at your company and specifically in response to the previously mentioned challenges? Do these technologies present any difficulties for implementation or operations?

7. We have learned that artificial intelligence (AI) is an emerging technology within the food system. Does your company use any type of AI or plan to adopt this technology? How do you see it influencing the food distribution system in the future?
8. What other factors do you believe will have a large impact on the future of food distribution in Greece?
9. Are there any topics that we didn't touch on that you feel are critical regarding the future of food distribution?

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