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FACULTY OF ECONOMICS AND MANAGEMENT

''MASTER IN BUSINESS ADMINISTRATION''

Logistics and Agricultural Production

MASTER THESIS

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Summary

This thesis highlights the logistics system in the Agri-food chain and present a case study of tomatoes in Latin America. More specifically, it examines the bottlenecks that exist in the tomato supply chain between Costa Rica and Nicaragua and suggests improvements in the food logistics system.

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Chapter 1
Introduction

During the last decades, logistics has become an important issue for managers as it extends beyond a firm's boundaries, across the supply chain. Companies put efforts to apply their business processes to the whole supply chain in order to overcome challenges related to product's quality, customer's waiting time, product's cost, uncertainty and variability of logistics processes. However, this is a difficult task, as it requires among other things long-term relationships, trust and loyalty among firms and suppliers. Moreover, increased variety of goods, the just-in-time delivery system, low load rate, specialization and centralization of production systems, globalization of marketing and seasonal variations make even more urgent the need for an effective logistic system (Harrison and Hoek, 2008). These are the reasons that nowadays logistics preoccupy many managers' and researchers' mind. Logistics is a part of the supply chain and it is referred as *the task of coordinating material flow and information flow across the supply chain* (Harrison and Hoek, 2008 p.7). In other words, logistics is a practice that is used to determine how to move people and materials more efficiently between a source and a destination (Aghazadeh2004, p.263). Figure1 depicts a relatively simplistic supply chain.

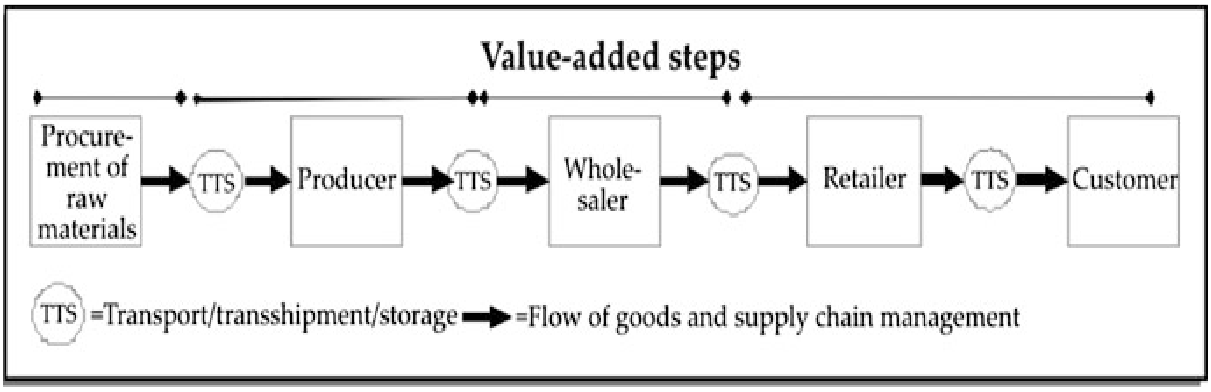

Figure 1: Model of a logistics chain (Gleissner and Femeling, 2013)

According to Gleissner and Femerling (2013), logistics systems can be divided into procurement, production, and distribution. Procurement is concerned with the organization and the physical processes involved in the transport and supply of the input factors for the corporate process, whereas production deals with all tasks related to the planning and controlling of those internal processes that relate to the materials flow, storage, and internal transport. Finally, distribution is primarily concerned with the coordination of all processes that serve to deliver the goods to the recipient or to the point of sale for consumption by the end user and includes all elements of logistical spectrum.

Effective logistics is critical for both manufacturers and retailers. It also requires delivering the right product, in the right quantity, in the right condition, to the right place, at the right time, for the right cost and it has a positive impact on the success of the partners in the whole supply chain (Gebresenbet and Bosona, 2012). Effective logistics can lead to a competitive advantage as well. This stems from the fact that if a company manage to control the challenges that have been mentioned above (quality, time, cost, uncertainty and variability of logistics processes), then this will lead to increased sales and profits. For instance, a company with a good logistics system would expect to offer a product that meet the quality standards expected from the customers in a lower price and on time, without delays. In addition, the customers could have the possibility to trace the product in order to know their origin and how it has been produced and transported in all stages. In a different situation, an ineffective logistics system would lead to low quality products, empty shelves due to delays or cancelation of orders, increased prices because of difficulties in reaching the customers, which lead to higher expenses. All these in combination with uncertainty would harm a firm's reputation and would lead to lower profits (Harrison and Hoek, 2008).

Food sector in Europe is one of the main contributors to the GDP of many countries, particularly in developing countries. According to the European Commission (2016), the food and drink industry is one of Europe's most important and dynamic industrial sectors consisting of more than 300,000 companies, which provide jobs for more than 4 million people. Agricultural products that are part of food sector are divided in three categories. These are plant, fishery and animal products. Logistics of these products differ from a usual product, which lead researchers to investigate logistics of agricultural products separately from other products. According to Fredriksson and Liljestrand (2015), the logistic solutions applied to common products are not applicable to agricultural products. This happens for several reasons. Food sector must deal with several challenges like changes in lifestyle and increase in food consumption (Fritz and Schiefer, 2008). In the past consumers used to shop from mini markets and now shop from big supermarket chains and hypermarkets that are specialized in these products. Furthermore, due to globalization is more urgent the demand for fresh products. What is of great importance is that agricultural products would lead customers to change a company or supermarket if they were not satisfied with their requirements. (Fearne A.,Hughes A., 2000). On the other side, food perishability, dependency on the natural conditions, fluctuation on demand and supply in combination with the fact that any misfortune could cost a lot of money, are some more factors that strengthen the need for separate research of food logistics.

All the above, have led logistic researchers to develop solutions for the specific products. To add more, because of the perishability, demand on quality and traceability, the actors in the whole supply chain are interdependent more than in other products. So, it has been given great importance in logistics in food industry as the aforementioned factors have led, among others, to food security issues, increase in products' prices and decrease in producers' income (Liu and Ke,2012). This stems from the fact that supply chain is too long and everyone in the chain should be paid. Second, cold chain logistics is underdeveloped which means that fresh food cannot be transported far from the place they are produced since agricultural products are characterized by short shelf life and the trading hours without the appropriate refrigeration are limited. There is not good enough logistics information technology system in order to capture accurately the supply and demand in the market but also to trace and track products. Finally, logistics infrastructure is underdeveloped which leads to higher travel time and urgent need of freight systems (Liu and Ke, 2012). As a result, food chain logistics is a significant component within logistics system as a whole and should not be ignored. On the contrary, more research should be done on the food logistic system, as there is room for development. From the aforementioned, one should assume that, to date, the connection between logistics systems of the stakeholders in the agriculture and food supply chains is loose and fragmented. Even within individual firms, the vertical and internal integration as related to freight and logistics is loose, and therefore they are both economically and environmentally inefficient and not sustainable.

So, which are the potential solutions to the loose food logistics system? According to Liu and Ke (2012), the potential solutions are: an establishment of a traceability system, improvement of information technology system, improvement of road transportation system, efficient use of vehicles, reduce of negative environmental impact, application of cold chain logistics and third-party logistics. To elaborate, by traceability system we mean a tracking method to differentiate goods with lower quality products or defected ones. This could lead to elimination of food security issues and scandals, and better quality for the customer. By improvement of information technology systems, we refer to the creation of an integrated logistics system and the use of network marketing. With the latter, we mean the connection between consumers and producers through an e-commerce platform. This would lead to elimination of the intermediaries and increase of the value for both firms and customers. The improvement of transportation system would lead to lower costs, as it would mean more convenient and easier transportation. By changing the business model and using third party logistics, a firm could improve the communication of agricultural products, improve operational efficiency, reduce costs and increase farmers' income. Finally, the application of cold chain logistics would help to increase the products' life cycle and keep them fresh for a longer period. This means that the products maintain their quality for a longer period and firms do not run the risk of losing money through losses in food quality.

In this regard, this thesis highlights the logistics system in the Agri-food chain and presents a case study for tomatoes in Latin America in order to suggest improvements in the food logistics system. The remainder of this thesis is organized in five chapters. In the second chapter, a literature review of the food logistics issues that prevail nowadays are going to be presented. Then, in the third chapter will be discussed the concepts of logistics and management. In the fourth chapter will be introduced the method used to investigate our topic. Finally, in chapter 5 we will conclude.

Chapter 2
Literature Review

Literature review in logistics of agricultural products is limited. According to Fredriksson & Liljestrand (2015), industry-level food logistics have been studied mainly under three different perspectives. These include distribution issues that focus on transportation/collection, food security issues namely traceability, transparency, time, trust and cold chain logistics, and information technology issues that focus on e-commerce and integrated information technology systems. In the next paragraphs, we are going to present previews researches that have been conducted in these areas.

2.1. Distribution

The greatest importance concerning logistics has been given to distribution, as an integrated approach is required in order to reduce food issues and reassure food safety and profit for all persons involved. By distribution, we mean the coordination of all processes that serve to deliver the goods to the recipient or to the point of sale for consumption by the end user. Distribution logistics describes the interaction of transport and storage processes within logistics systems for the distribution of a company's goods (Gleissne and Femerling, 2013). Rural transportation is divided in on farm and off farm transportation. (Gebresenbet and Bosona, 2012).

On-farm transportation includes:

a. transportation within fields

i. collecting harvested crops to one point for processing in the fields and temporary storage;

ii. distribution of fertilizers and seeds;

iii. transporting of firewood, timber and

iv. water,

b. transport of agricultural products from fields to homesteads,

c. transport of agricultural implements from homesteads to fields and vice-versa,

d. transport of seeds and fertilizers to the fields;

e. transport of implements between different plots etc.

Off-farm transportation includes:

a. transport of agricultural products including animals to local markets,

b. transportation to grinding mills

c. transport of industrial products (commercial fertilizers, implements, seeds, etc.) from markets to homesteads,

d. transportation to health centers and schools, religion centers, and

e. transportation to towns and bigger market

In figure 2 they are presented the typical transport requirements for a small householder.

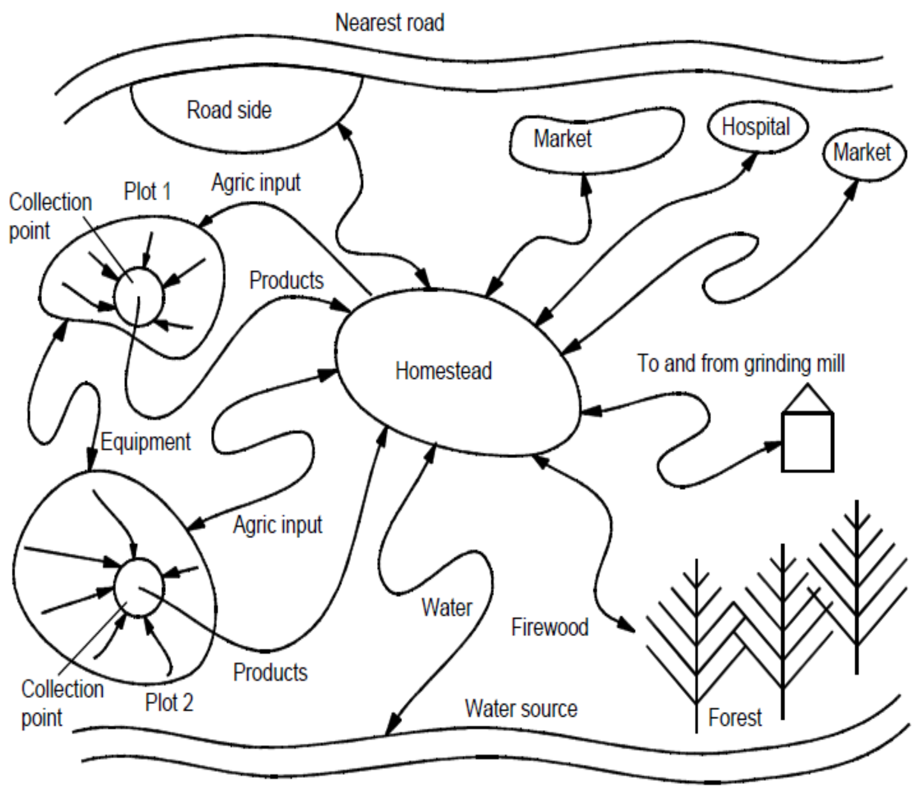

Figure 2: transport requirements for a typical small householder (Gebresenbet and Bosona, 2012).

Gebresenbet and Bosona (2012) supported that coordination and optimization in food distribution is a potential strategy to promote economically effective and environmentally sustainable food distribution. According to them, this coordination could among others, improve the vehicle load rate, motor idling, emission from vehicles and congestion. This could be succeeded through partial or total optimization of vehicle fleet, through combine loading of products and through back haulage. They reached these conclusions by researching among others the meat distribution. They observed that besides the improvement of vehicles and handling methods, they should measure the factors that provoke stress to the animals and reduce them as they lead to deterioration of product's quality. The second observation that they made was the minimization of products' transportation through small-scale local abattoirs or semi mobile abattoirs. Small abattoirs could lead to consumers' confidence regarding quality but also could lead to savings in transport distance, time and emissions unlike the transportation directly from farms to a central abattoir.

A factor that has influenced the food supply system by increasing distance of transportation is globalization (Gebresenbet and Bosona, 2012). Potential producers of local food want to increase their sales but they need to overcome some problems such as low size of production, volatility of market price and high seasonality of food products on market, inadequate packing and storage facilities, limited or no transport and limited knowledge of potential markets. It is worth noting that there is a difference between developed and developing countries. Whereas in developed countries emphasis should be given mainly on packaging, in developing countries emphasis should be on collection, packaging, storage and distribution of agricultural primary products (Gebresenbet and Bosona, 2012).

Packaging is important as it serves the following purposes: to hold the contents, to protect against mechanical and environmental hazards, to identify the contents and assist in selling the product and to offer convenience throughout the production process. Concerning fresh products, after harvest a number of changes take place to fresh crops such as, they lose water and begin to wilt or shrivel, fruits continue to ripen and microorganisms and naturally occurring enzymes change a crop's color, flavor and texture. As a result, packaging is required to contain the crops and prevent damage during transport, storage and sale. If the crops are kept in cold-rooms, they may require packaging to prevent them losing water and shriveling (Fellows, 2011). In Taipei, China and Japan, the cooperatives give special attention to the packaging standards used and enforce its adoption. All goods should use the same packaging standards and should shipped in appropriate containers depending on the product. For example in China, many vegetables are packaged in standardized cartons, which are marked with key information about the origin of the produce, product grade and the specific producer. The use of standard packaging has provided benefits along by enabling faster processing and reducing product loss.

Figure 3: Stackable fruit trays and crates prevent fruits and vegetables

Harvesting, storage facilities as well as location of them are important too. Choosing the correct harvest time is crucial. By correct harvest time, it is referred to both the correct day and time but also and to the ripeness and maturity of the production. In addition, the harvesting should be done manually and the products should be placed on baskets and not on the floor. Before put in storage production should be cleaned and place by quality. Time span between harvest and placement into storage should be kept as short as possible. Having storage facilities eliminates the need to market the products immediately after harvest. Although the costs may be not affordable for single producers, cooperatives could use the same facility in order to reduce the costs (Scheepens et al., 2011). Fuente and Lozano (1998) developed a method for finding the best warehouse locations for dairy products in the area of North Spain in order to maximize the profits. The costs that took into account were long distance transport costs, long distance rail freight costs, storage costs and structural costs. By doing cluster analysis, they found the ideal number, geographic position, capacity and size of warehouses to be set up so that their contribution to profits is maximum. In order to do this, the price of each product for each market, the products and the quantities that should be supplied from the factory, the ideal size of each distribution center, as well as the products and quantities that should be delivered from each warehouse, were established.

The development of a coordinated distribution system to improve logistics through the development of clusters of producers and determination of the optimum collection centers linking food producers, distributors and consumers/retailers is very important and it is a way not only to handle competition but also to include all the factors mentioned above, important for the distribution of agriculture products. Gebresenbet and Bosona (2012), after conducting a route analysis, they reached the conclusion that coordination and integration of logistics activities of local food delivery system reduced the number of routes, the transport distance and transport time for the delivery system of local food. To a country level, last years, Dutch agribusiness has changed with the implementation of cooperatives and the concentration of production processes. This change was created by the need of the small business to compete in the international environment. Therefore, in order to cope with higher costs, transportation difficulties, cultural differences and lack of knowledge about the abroad market the creation of clusters is inevitable. With the clustering of companies in the agribusiness knowledge and expertise can be shared among companies, costs can be decreased and transportation can be done on a larger scale level. These three cluster effects increase the competiveness of Dutch agribusiness on an international level (2011). According to Schouten (2011), clusters could influence competition in several ways:

- ***Access to specialized inputs and employees***: such as machinery, services and employees that are superior or have lower costs compared to input alternatives from distant locations.
- ***Access to information and knowledge:*** knowledge about the market, technical knowledge and specialized knowledge accumulates within a cluster. This can be accessed best and at lowest costs from within the cluster. In addition, the existence of personal relationships and community ties that arises in clusters fosters trust and stimulates the flow of information.

- ***Complementarities***: a cluster enhances productivity by facilitating complementarities between activities of cluster participants. When a part of a cluster performs badly it negatively influences the performance of the rest of the cluster. Marketing is a form of complementarity; a group of related firms and industries can efficiently work together in joint marketing. It can also enhance the reputation of a certain location or field (M. Porter, 2000).
- ***Access to institutions and public goods***: firms can benefit from local public goods such as infrastructure or benefit from locally situated institutions at low costs.
- ***Incentives and performance measurement:*** clusters can give incentives to improve productivity or efficiency of firms; competitiveness is the main incentive. Clusters also facilitate performance measurements

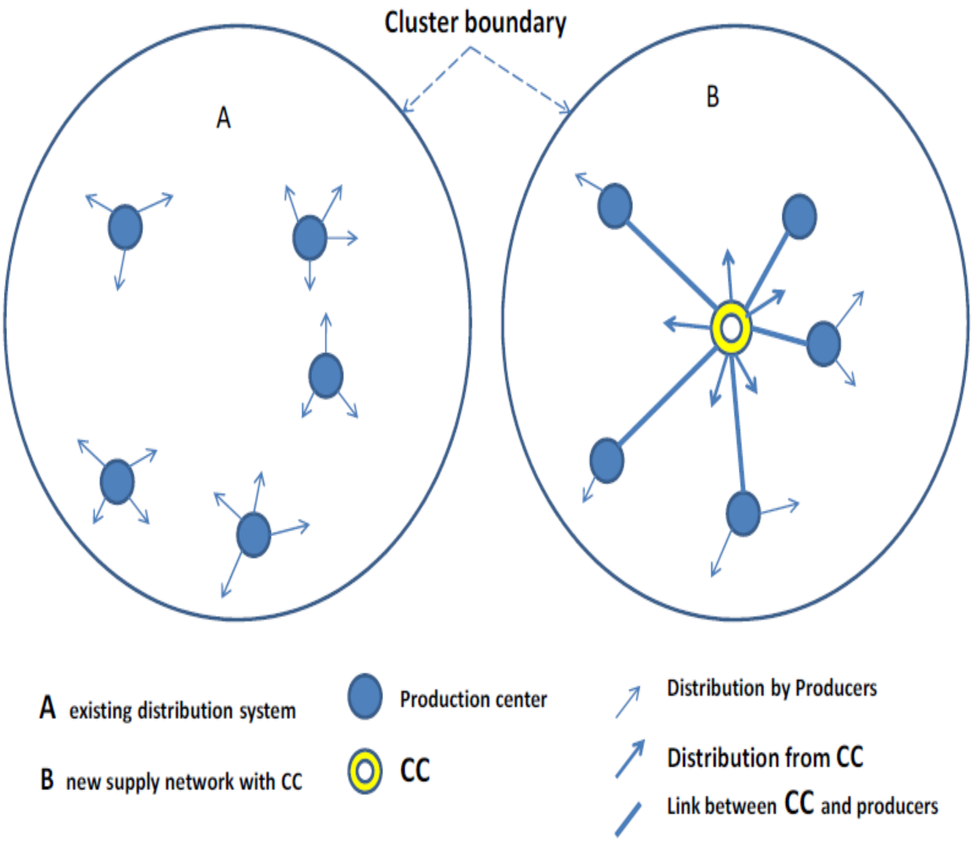

Figure 4: Fragmented distribution system and newly proposed distribution system via collection center (CC) to different customers (Gebresenbet and Bosona, 2012).

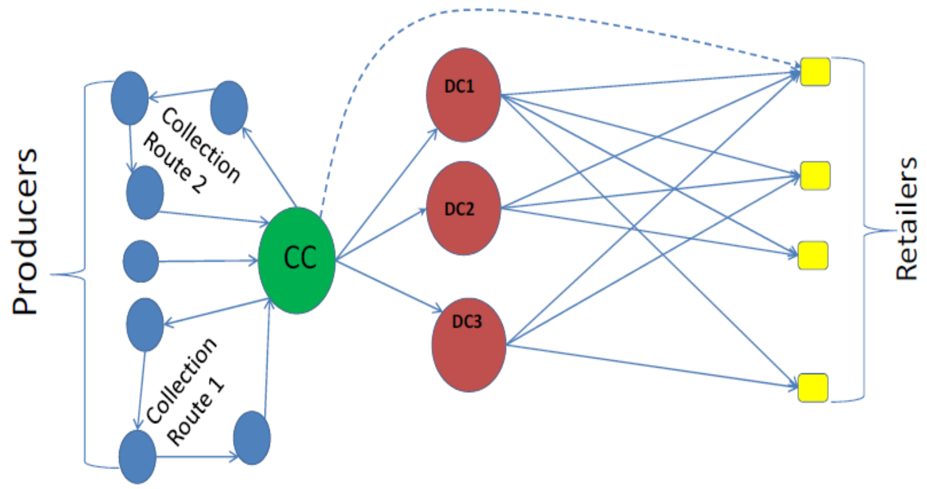

Figure 5: Network of product delivery system with coordinated collection. DC1, DC2, DC3 represent three of large-scale food distribution channels. The dashed line indicates the case of direct delivery from CC to retailers or customers (Gebresenbet and Bosona, 2012).

Besides clusters, in Europe there is an initiative to create location specific agricultural clusters, called agro parks, which bring together agro-food production and related economic activities (Dani, 2015). Agro parks offer many advantages as they link food and non-food business together creating more sustainable production and economic benefits for their parts. They achieve it by higher resource productivity, better utilization of production, utilization of waste products and by-products of the process and deployment of new technologies. For example in India it has been established an agro park which aims to give access to their member to appropriate infrastructure such as cold chain, preservation facilities, pack houses and so on (Sani, 2015).

Therefore, from the aforementioned we can assume that some of the main issues that require immediate attention are encouragement of private entrepreneurs to take the responsibility of service provider in storage, packaging and transport services and development of collection center systems to promote marketing possibilities by facilitating coordinated transport services. Constraints associated with the flow and storage of produce and services in food and agribusiness that exist in developing countries include lack of adequate storage facilities and knowledge of handling, poor processing, management and transport services (Gebresenbet and Bosona, 2012).

2.2. Food security

Nowadays a food security issue could have global implications and it could either lead to a competitive advantage or destroy a company's reputation. That is why traceability, transparency, time and trust are important. Traceability could lead to a number of advantages (Dani, 2015) including:

- Increased transparency
- Reduced risk of liability claims
- More effective recalls
- Enhanced logistics
- Improved control of livestock epidemics
- Possible positive effects on trade
- Easier product licensing
- Possible price premiums

Bosona and Gebresenbet (2013) give a definition for food traceability. According to them *food traceability is part of logistics management that capture, store, and transmit adequate information about a food, feed, food-producing is correct animal or substance at all stages in the food supply chain so that the product can be checked for safety and quality control, traced upward, and tracked downward at any time required*.

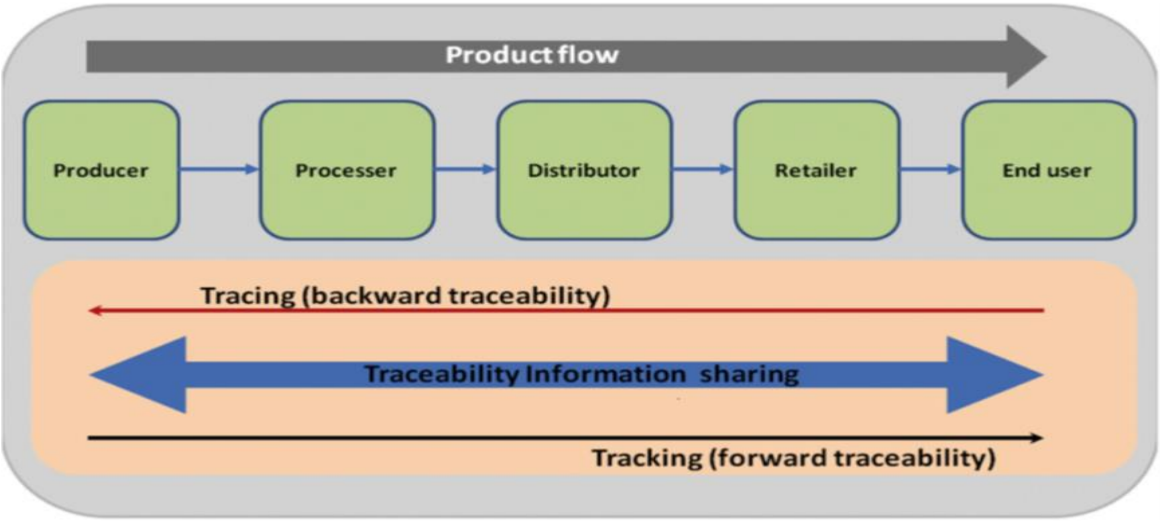

Figure 6: Conceptual representation of material and traceability information flow that best reflects the case of food supply chain (Bosona and Gebresenbet ,2013)

They emphasize the interconnection of food traceability, quality and safety assurance, as according to a study, consumers were willing to pay 40% more when they were reassured that the three aforementioned standards were met, compared with 7% that they were willing to pay for traceability alone. Leat et al. (1998), have pointed out how important is traceability within food industry as it provides consumer assurance about the sources and safety of food; allows identification of the source of infected or substandard product; monitors for disease control and residues; supports measure verification; and satisfies the requirements of labelling regulations. Maruckecka et al. (2011) outlined the importance of product safety in a global level with researching five industries including food industry. They supported that food supply chains are highly interconnected due to their perishable character and so all parties should give high importance to the safety and timely distribution. Nevertheless, it has been observed that companies pay more attention to quality, delivery and price when selecting a supplier than in safety unless products originate from a foreign country. What they suggest for assurance of products' safety is the use of global certifications like International Standards Organization (ISO) and Hazard Analysis and Critical Control Points (HACCP). The latter reassure the quality of the product through the successful management of data relating to design, production, support and ultimate disposal. Also, they suggest the use of Radio Frequency Identification (RFID) tracking method to track and trace the products, recognize the suppliers if a problem appears and take measures immediately.

2.2.1. Food Global Standards

Tracking and tracing are procedures that are necessary for companies so there is the need for global standards in order to meet the needs of operators, manufacturers and distributors. Through this procedure, products and materials can be visible across the supply chain. GS1 is a global organization that was created to meet these needs. As far as the food industry is concerned, tracing is important so that the producers, the fields and the production could be identified through the procedures of packaging, transportation and storing throughout the supply chain. GS1 standards are divided in identification standards, capture standards, GS1 standards for information share and combination of them.

- *Identification*

Include standards that define unique identification codes (called GS1 identification keys) which may be used by an information system to refer unambiguously to a real-world entity such as a: trade item, logistics unit, physical location, document, service relationship, other entity. Such identification codes are: Global trade item number (GTIN), Global location number (GLN), Serial Shipping Container Code (SSCC), Global Returnable Asset Identifier (GRAI), Global Individual Asset identifier(GIAI), Global service relation number(GSRN), global document type identifier(GDTI), Global Identification Number for Consignment (GINC), Global Shipment Identification Number (GSIN), Global Coupon Number (GCN), Component/Part Identifier (CPID).

- *Capture*

GS1 data capture standards currently include definitions of barcode and radio frequency identification (RFID) data carriers, which allow GS1 Identification Keys and supplementary data to be affixed directly to a physical object, and standards that specify consistent interfaces to readers, printers, and other hardware and software components that connect the data carriers to business applications. Barcodes are symbols that can be scanned electronically using laser or camera-based systems. They are used to encode information such as product numbers, serial numbers and batch numbers. Barcodes play a key role in supply chains, enabling parties like retailers, manufacturers, transport providers and hospitals to automatically identify and track products as they move through the supply chain. The Electronic Product Code™ (EPC) is syntax for unique identifiers assigned to physical objects, unit loads, locations, or other identifiable entity playing a role in business operations. EPCs have multiple representations, including binary forms suitable for use on Radio Frequency Identification (RFID) tags, and text forms suitable for data sharing among enterprise information systems. GS1's EPC Tag Data Standard (TDS) specifies the data format of the EPC, and provides encodings for numbering schemes -- incuding the GS1 keys -- within an EPC. Then unique EPCs are encoded onto individual RFID tags, radio waves can be used to capture the unique identifiers at extremely high rates and at distances well in excess of 10 meters, without line-of-sight contact. These characteristics of RFID can be leveraged to boost supply chain visibility and increase inventory accuracy.

- *Share*

GS1 standards for information sharing include data standards for master data, business transaction data, and physical event data, as well as communication standards for sharing this data between applications and trading partners. Other information sharing standards include discovery standards that help locate where relevant data resides across a supply chain and trust standards that help establish the conditions for sharing data with adequate security.

2.2.2. Cold Chain Logistics

Logistics activities in food sector operate in four temperature bands (Dani 2015):

- Ambient (e.g. canned food)
- Fresh produce (fruits and vegetables)
- Chilled (dairy products)
- Frozen (frozen fresh produce)

The complexity of food distribution depends on the type of the product, the available modes of transport between farm and fork, legal requirements and so on. The temperature zones differ according to whether the temperature requirement is for frozen (-25o C, ice cream), cold chill (0-1 o C, fresh meat), exotic chill (10-15o C, potatoes, eggs), and medium chill (5o C, butter). By the time an agriculture product reaches the consumers' hands, it would have transited through many actors using different storage and transportation equipment. Product losses in food transportation due to temperature mismanagement and quality decay can reach up to 35 percent (Hafliðason et al., 2012). In addition, although logistics partners agree on temperature conditions, in practice it is difficult to control it, as there is frequent interruption of the cold chain during loading and unloading. As a result, appropriate temperatures throughout the transportation are essential in order to avoid both development of bacteria and risk of food safety but also losses in money. According to Dani (2015), there are a number of factors to be considered when designing cold chains:

- Maintaining the seamless cold chain from source to retailer
- Mode of travel
- Food safety
- Appropriate packaging technology- to match product characteristics in order to reduce exposure and increase self-life
- Technology for real time monitoring of temperature, movement, location, humidity levels
- Effective on costs, on time delivery and understanding the dynamics of cold chain

Sahin et al. (2007), supported that the traditional date code labels used to the products during the transportation have some limits since the product shelf life information is based on some average distribution conditions and do not consider the temperature fluctuations occurring during the transportation process. However, these fluctuations could harm products quality and risk people's health. To elaborate, code labels used widely nowadays, are easily recognizable with the form "open dating" which involves a clearly distinguishable date code, recognizable by humans, in a month, day, and year format. Date codes are often prefaced by statements such as "sell/use by" (which corresponds to the expiry/expiration date) or "best before". The use/sell by date information is essential to track the freshness of product categories that should not be consumed past a date beyond which they are unsafe. Whereas, for product categories that do not represent a sanitary risk, the best before date enables to monitor how long products conserve their best quality. However, this method does not capture very well the level of freshness of perishable products. They support that there are devises that monitor freshness based on time temperature integrators. For instance, there are devices that judge the freshness of a product based on the temperature history experienced by the product. These devices are called time temperature integrators (TTI) technologies and differ from the Temperature Indicator devices that focus only on tracking and tracing temperatures. Time temperature integrator (TTI) helps reveal rises in temperature and abusive storage conditions and/or indicate how much actual product shelf life is left has been developed in order to improve the performance of supply chains. There are three types of TTI. TTI type 1 system provides information on whether a product is fresh or not by considering temperature conditions. This is succeeded by checking the microorganisms that have been involved. TTI type 2 system provides a continuous real-time information on products' remaining lifetime by recording in memory the time-temperature relation. TTI type 3 system, provide information on products' freshness and remaining shelf lives at predefined growth rates, which could be considered as an extension of TTI type 1. Apart from TTI devices, RFID could also be used as a means of checking a product's freshness. RFID technology has the advantage that you do not need to have physical contact with the products as done with barcodes. In addition, barcodes identify product type, not a unique item. Therefore, with RFID that can identify a unique item it could be checked if a product is about to expire.

All in all, by using such systems a company could improve its reputation and competitiveness as these systems reduce the risk of unsafe products and, they could reduce costs in inspection processes (Sahin et al., 2007). An illustration is presented in figure 5. As it can be seen in the model below, a company that stores its products in a central warehouse and does inspections every week that last 5hours/week, when using a TTI type 1 system could reduce its inspection time to 0.5 hours and the frequency of the inspection at twice a month. This would offer to the firm a reduction of 4500 euro per year.

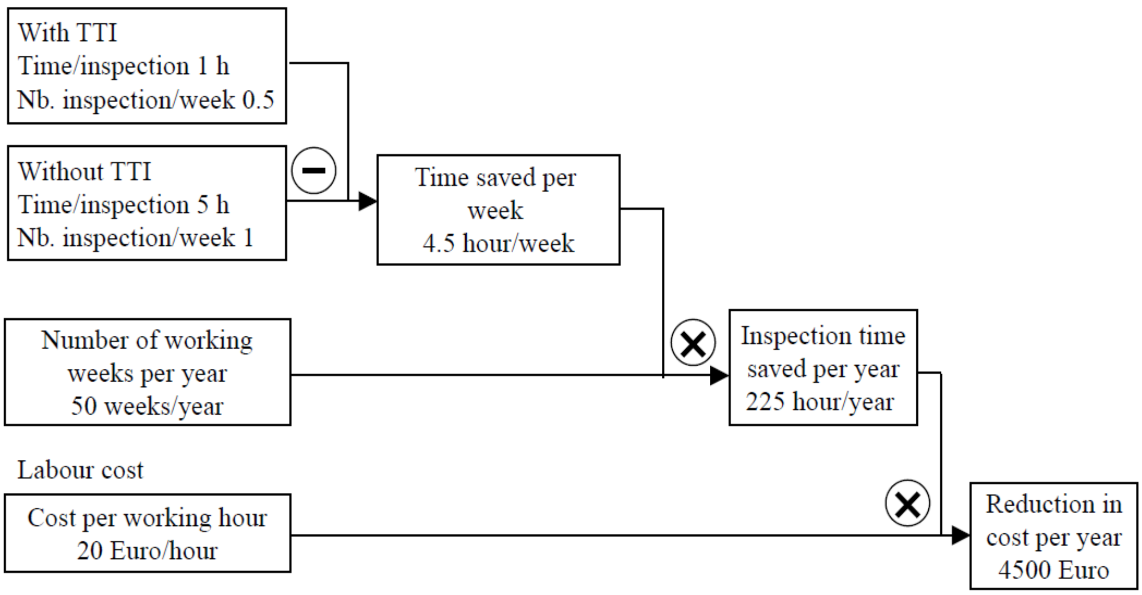

Figure 7: Evaluation of the annual reduction of inspection costs (Sahin et al., 2007)

According to Hafliðason et al. (2012), nowadays food producers are tracking perishable products being shipped, by using temperature data loggers or they monitor each location. As far as the data loggers, the inspection is done manually and required the package or container to be opened. In addition, damaged product is only discovered in the final destination when is too late. As a result, they propose an online temperature monitoring that would provide all actors in the supply chain with improved transparency and less waste. Wireless sensor networks (WSN) is another method that combines both RFID and data loggers and could provide better solutions in surveillance, tracking, locating and so on. These devices can actively monitor the products and verify temperature of goods or send notification if potential quality problems are noticed which could allow corrective actions before the transport arrives at its destination.

From the aforementioned, we could observe the existence of several technologies and strategies that could measure a product´s freshness and improve the logistics process and the products´ quality with minimizing the costs and losses. However, these technologies require an investment that the majority of small entrepreneurs do not have.

2.3. Information technology issues

Issues concerning information technology systems could be categorized in two areas. First network marketing and e-commerce models could lead to new business models with smaller supply chains, lower prices and higher profits with the reduction of the intermediaries. Second, integrated information technology systems could lead to a better manageable distribution system and a competitive edge. The two areas are explained below.

2.3.1. Network Marketing

E-commerce could allow overcoming the challenges that parties face in the supply chain. With using e-commerce not only one could reduce costs, but also could exploit growth opportunities (O'Keeffe, 2001). According to O'Keeffe (2001), internet could be an opportunity for a firm's growth and development if this firm does not follow a transaction based approach but seeks long-term relationships and good reputation. Therefore, in order to achieve development, one should consider a few things. First, internet is not a barrier between seller and buyer but the opposite as the key is to adjust these relationships to the new reality and create a new level of competitiveness through reputation and relationship management, as on internet this matters the most. Second, firms could not only reduce transaction costs but also could exploit pre-transaction process cost savings like demand forecasting and inventory management and post transaction process cost savings like post transaction reconciliation and management analysis. Firms should use a hardware that is not limited to a single purchase but creates a dynamic relationship between the seller and the buyer. The use of internet for companies does not necessarily include high costs and has a low risk trial adoption. Finally, internet help companies to strengthen their existence, mainly those that have invested in reputation and relationship management.

E-business could change the way that firms do business. Van der Vorst et al. (2002) propose a new model that moves from the traditional value chain to value web. Therefore, according to them the chains will transform to business webs (b-webs), defined as business gathered to serve customers' need and create value for them.

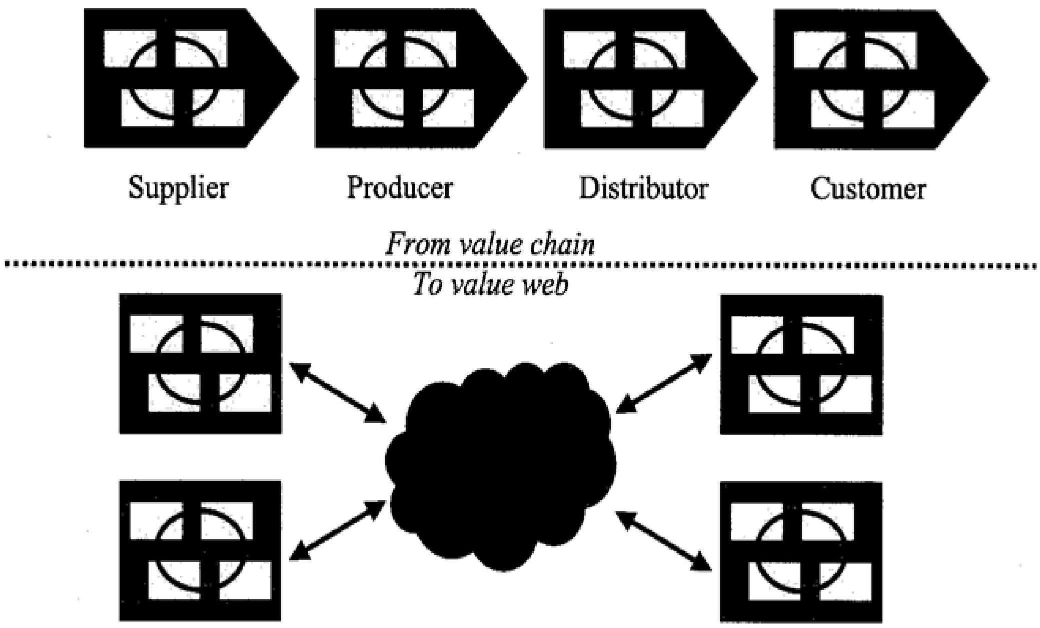

Figure 8: From the value chain to value web (Holland et al., 2000)

E-business goes beyond having an e-mail or a website. The cost reduction opportunities that offer for a business are: reducing product handling with a shorter supply chain, postponing product differentiation until after an order is placed, decreasing delivery cost and time with downloadable product, reducing facility and processing costs, decreasing inventory costs through centralization, improving supply chain co-ordination through information sharing. On the other side, the revenue-enhancing opportunities are: offering direct sales to customers, providing 24-hour access from any location, aggregating information from various sources, providing personalization and customization of information, speeding up time to market, implementing flexible pricing, allowing process and service discrimination, facilitating efficient fund transfer. Therefore, what we could assume from the possibilities that the e-business model offers is that a company adopting this model could lower its costs as the intermediaries are eliminated and this could lead to higher profit margins for both sellers and customers. In addition, firms could be more flexible and provide better quality, as they could distribute according to the orders and do forecasts regarding previous sales. Moreover, a firm that wants to implement an e-business model in food industry should make sure that the accurate certification and documentation of the origin and the identity of products are provided since these are important for the customer (Van der Vorst et al., 2002).

2.3.2. Information technology systems

Information technology is an important prerequisite to good logistics management (Chiu, 1995). Generally, a logistics system is comprised of a variety of components: corporate headquarters; retail stores; distribution centers (DCs); suppliers; manufacturers; distributors; carriers; networks; information service providers; insurers; and bankers. Moreover, a logistics system is comprised of four flows, which are: material flow (goods flow from sources to stores,), merchandise flow (marketing flows in the channel of distribution), money flow and information flow (Chiu, 1995). Since most companies have a small portion of the whole supply chain, linking closely with trading partners to achieve synergy is essential.

The information technologies that are used frequently from all partners in practice are:

(1) Point-of-sale (POS) systems;

(2) Barcoding;

(3) Electronic data interchange (EDI);

(4) Value-added networks (VANs); and

(5) Electronic ordering systems (EOSs).

To elaborate, The Universal Product Code (UPC) data and price list are regularly (usually nightly) provided by the mainframe in the corporate headquarters. In each store, a super-micro or minicomputer that monitors the POS terminals maintains the UPC database and price list. Almost all sale information can be gathered by the front POS (FPOS) system in a more timely and accurate way. The rear POS (RPOS) system analyses sales information from the FPOS system, prints out the UPC barcodes, manages goods by product and places electronic orders. In addition, the RPOS system handles merchandise receiving and inspection, inventory control, physical counting, accounting and vendor management. One benefit of POS systems is that the results from sales analysis can show which product is the best seller and which is the sticker. EDI refers to the direct transfer of information between trading partners. After POS data have been processed by the RPOS system, electronic orders are automatically placed when certain stock levels of products in the retail store are reached. In addition, the store manager can use a hand-held terminal to enter his orders if required. Orders from all retail stores are received over the VAN by the mainframe at the headquarters. Then they are recorded, approved and forwarded electronically to the appropriate distribution centers or suppliers.

These practices in combination with the fact that firms should maintain close relationship and communication with their channel trading partners, led Chiu (1995) to research the idea for an integrated logistics system. A typical logistics system is presented in figure 8. As shown in the figure, a large general merchandiser with geographically dispersed DCs and retail outlets may need a dedicated satellite network. The POS terminals in each store are connected to an in-store micro or minicomputer. The store computer is then connected to the satellite network and can be accessed directly by the corporate mainframe. However, for a local, medium-sized company, using standard telephone lines or leased lines may be enough. The mainframe in the headquarters maintains all records of the current stock levels at each DC. Thus, purchase orders can be transmitted directly and accurately from the mainframe to the computers of the vendors. Therefore, the use of this system could improve logistic efficiency and support improved customer service levels. In addition, they could enable retailers to save on labor, increase accuracy, to quicken services, and cut costs (Chiu, 1995).

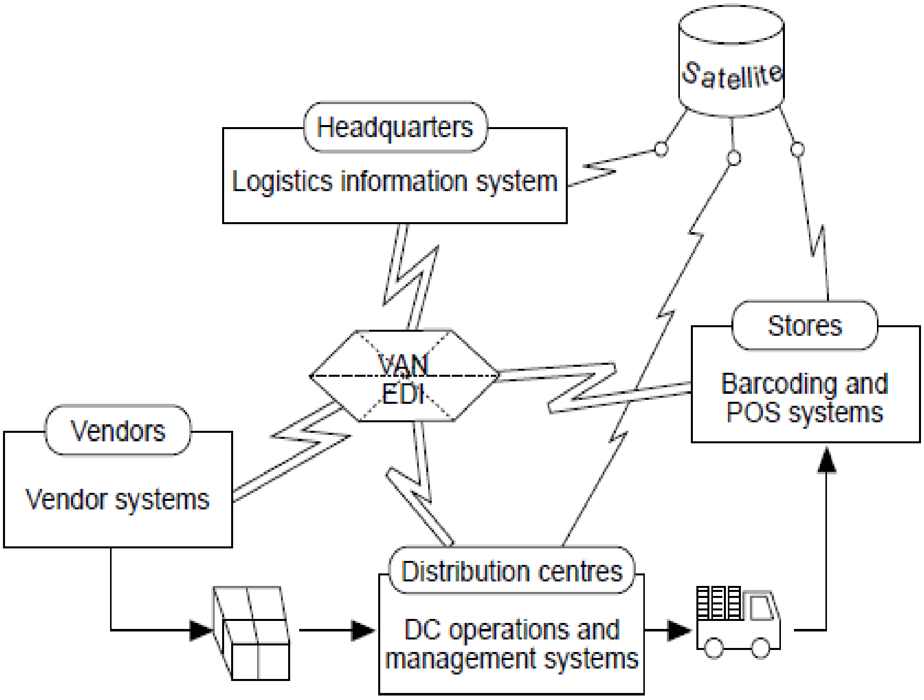

Figure 9: A typical logistics system, Chiu (1995)

Chapter 3
Logistics and Management

Logistic services may generate several opportunities for strategic competitive advantage (Gleissner and Femerling 2012). Three basic approaches for competitive advantage are cost leadership, differentiation and focus scope. Each company chooses the strategy that wants to follow dependent on its objectives and the group that wants to target. Cost leadership pursues cost minimization across all business functions. The organization of logistics systems is important in order cost leadership strategy to be achieved. Therefore, network structures in distribution logistics and procurement determine warehousing and transport costs. Also, the degree of automation of technologies influence costs. Finally, the organization design of logistics – order processing, inventory planning and disposition of materials- influence costs, which in turn are influenced by the IT, information, and communication systems that are used. On the other hand, companies pursuing a differentiation strategy try to achieve a unique product for a customer. By achieving it, it is often possible for a company to establish higher prices. In addition, differentiation generally enables more customer loyalty, which helps prevent new market entries and substitution products. Among the forms of differentiation, we can distinguish between the criteria of quality, design, image, and service. Thus, service differentiation is aimed at providing services, which offer the consumer or customer additional benefits apart from the actual product. Finally, focus scope is niche strategy focus on individual market segments.

As far as agricultural products is concerned, what is usually the ultimate goal is cost minimization in combination with quality. This stems from the fact that agricultural products are referred to all people, as they are considered necessary for a household. However, last years there has been noticed a turn in consumer preferences in ready-to-eat food, which has created economies of scale and this, has led fresh and vegetables to be more expensive than processed food (Dani, 2015). This is a challenge that all the actors in the supply chain of agriculture products have to overcome.

3.1. Inventory and Stock Management

The logistical aim of inventory management is to optimize the entire supply chain across the different stages to serve adequately the demand. Depending on its position in the value chain, inventory can comprise material goods (raw, auxiliary, and operating materials), intermediate, or semi-finished products (parts, components, modules), or finished products (end products). Keeping inventory stocks entails inventory costs in the form of storage costs (building, technology, staff) and inventory carrying costs (capital commitment, shrinkage, obsolescence). Unavailability of out-of-stock goods leads to production downtime and drops in sales, which can be classified as out-of-stock costs, sales shortfalls, and shortfalls in profit margin.

One of the most popular methods of inventory classification is the ABC analysis. ABC analysis suggests that a company's inventories do not have the same value and they are categorized in three groups. Category that include A-products, which are products that represent a 75-80% of the products' value and as a result if they are in shortage will lead to losses. These products are monitored carefully from warehouse managers. B-products represent a 10-15 percentage of the total value of the products and are handled through information technology (IT) systems. Finally, C-products represent a 5 to 10 percent of the total value of the products and are mainly small products. The purpose of this analysis is to assess a specific inventory's share of value in e.g. turnover and to determine regularities in consumption.

As far as food industry is concerned, inventory and stock management is important as food has a certain shelf life and will go off if not utilized immediately (Dani, 2015). On the other hand, lack of production in order to satisfy demand will lead to customers' disappointment and loss of market share. Product stock out may also lead to customers' disappointment. In order to be avoided this, processors and retailers many times try to use substitutions. However, in the case of food products this is not always successful, as some customers may not like the substitution or have allergies or diet restrictions. As a result, predictability in buying patterns will lower food costs for consumers and maintain customer satisfaction (Dani, 2015). Efficient product handling which is a subsequent of the design of the facility could also affect the availability and security of the inventory. Managing quantities in order to meet customers' demand is important, as we have already mentioned. Some safety stock is necessary to prevent manufacturing operations from running out of food. Common measures of inventory efficiency are the days of inventory on hand and the turnover rate:

Ending inventory/ average daily food cost= days of inventory on hand,

Number of serving days/ days of inventory on hand= turnover rate.

3.1.1. Transportation

Transport service is a basic element of logistics services. Transportation is important in order products to be shipped in time and with the expected quality to the buyers. Road freight transport is the most important mode of transport although it is controversial. This is because of its environmental pollution through energy consumption, exhaust emission, noise generation, and traffic congestion. The most important distinguishing characteristics of road freight transport are commercial freight transport and private haulage (Figure 10). Commercial road transport is the transport of goods by means of motor vehicles in a business context or in return for payment. Private haulage, however, is transport carried out by industrial companies or commercial enterprises using their own vehicles.

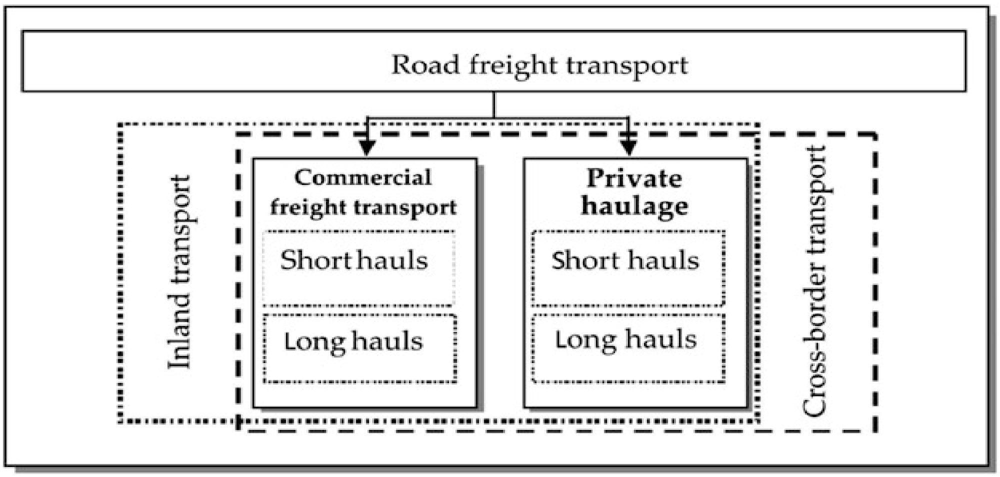

Figure 10: Distinguishing characteristics of road freight transport (Gleissner and Femerling,2012)

Sometimes a buyer assigns to a regional freight carrier to organize the composition and bundling of shipments from suppliers within a specific area and implement transport of the shipments to the production site of the consignee (Gleissner and Femerling 2012).

The buyer determines:

- The allocation of the regional freight carrier to the location of the supplier
- The processes the supplier should follow at the point of contact with the regional freight carrier, e.g. scheduling of readiness to dispatch, specification of pickup notification from supplier to regional freight carrier
- Specifications to be observed by the regional freight carrier as to means of transport, containers, load carriers, timeframe for unloading, and delivery times

The regional freight carrier is responsible for:

- Implementation of collection rounds (timetable)
- Consolidation of individual shipments at central transit points
- Transport to consignee in complete, point-to-point shipments
- The prerequisites for the regional freight carrier concept are:
- Delivery conditions ex works, i.e. the regional freight carrier delivers by order of the consignee
- Suitability of goods for consolidated transport
- Limited need for speediness

- Negotiable delivery dates and loading times between suppliers
- Sufficient special concentration of the suppliers (Gleissner and Femerling, 2012, p.:152-153)

Concentrating on one carrier per collection area has many advantages. First of all, it facilitates scheduling through central disposition and increases the reliability of incoming shipments. Second, consolidation of good flows results in cost advantages. Moreover, bundling a number of individual shipments into consolidated shipments results in a reduction of traffic and thus in a decrease both in environmental pollution and transport costs. In addition, bottlenecks at the buyer's goods receipt may be avoided and the coordination of delivery dates can be simplified. Nevertheless, in food products there must be attention to the products that we put together in a shipment. Different products require different temperatures during the transportation. If in a shipment we include different type of products an optimum temperature or a limited number of different temperature setting are used. In addition, carrying out different type of foods may cause risk of product interaction (Dani, 2015).

The key requirements of quality of transport are:

- Mass transport capacity: capability of a means of transport to transport large volumes at low costs
- Speediness: Transport duration, transport speed, capability of a means of transport to quickly transport goods
- Network-forming capability: capability of carrying out spatially inclusive and comprehensive transport
- Predictability: Measurement for transport time reliability (timeliness) of transports
- Flexible schedules: Frequency of transport services, capability to adapt to changed schedules and requirements
- Spatial Flexibility: Capability of spatially relocating/integrating means of transport and transport capacities
- Safety: Measurement for accident frequency of transports and the amount of damage
- Environmental impact: especially the use of energy, pollutant emission, and noise emission

3.2. Logistics Network Planning

Network planning is essential factor in order to achieve improvements of the logistics performance. The goal conflict between market driven logistics services and minimal logistic costs poses a challenge. Although logistic costs differ from company to company, minimum costs are always the goal.

Logistics networks could have many forms dependent on their complexity. Distinctions can be made between one-step direct nets, two-step indirect nets, multi-step indirect nets and hybrid, and combined nets. The table below represents an example from consumer goods logistics with respect to the distribution.

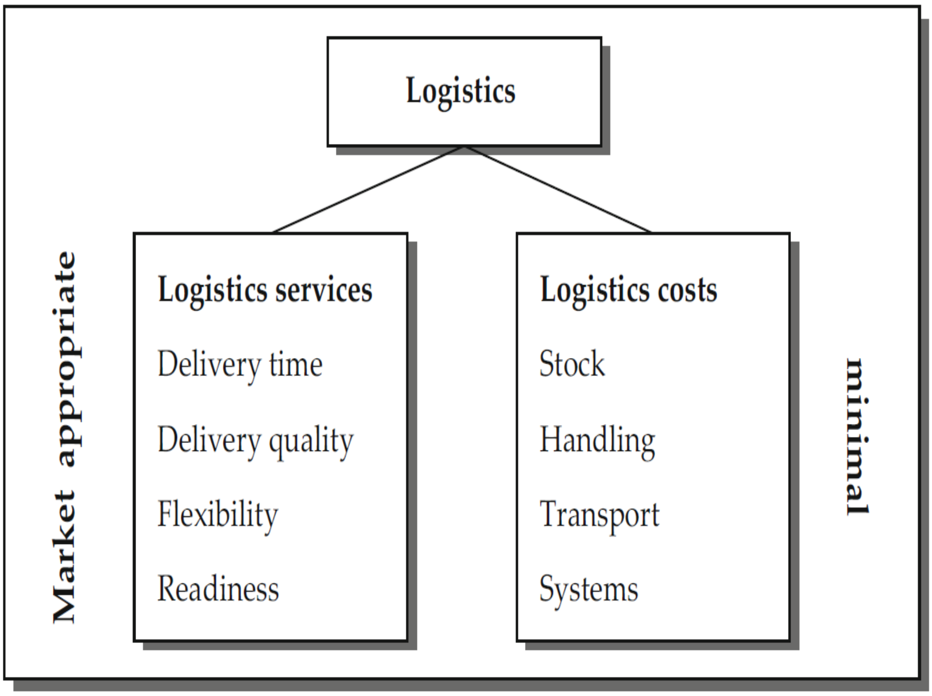

Figure 11: Goal conflict in logistics performance, (Gleissner and Femerling 2012)

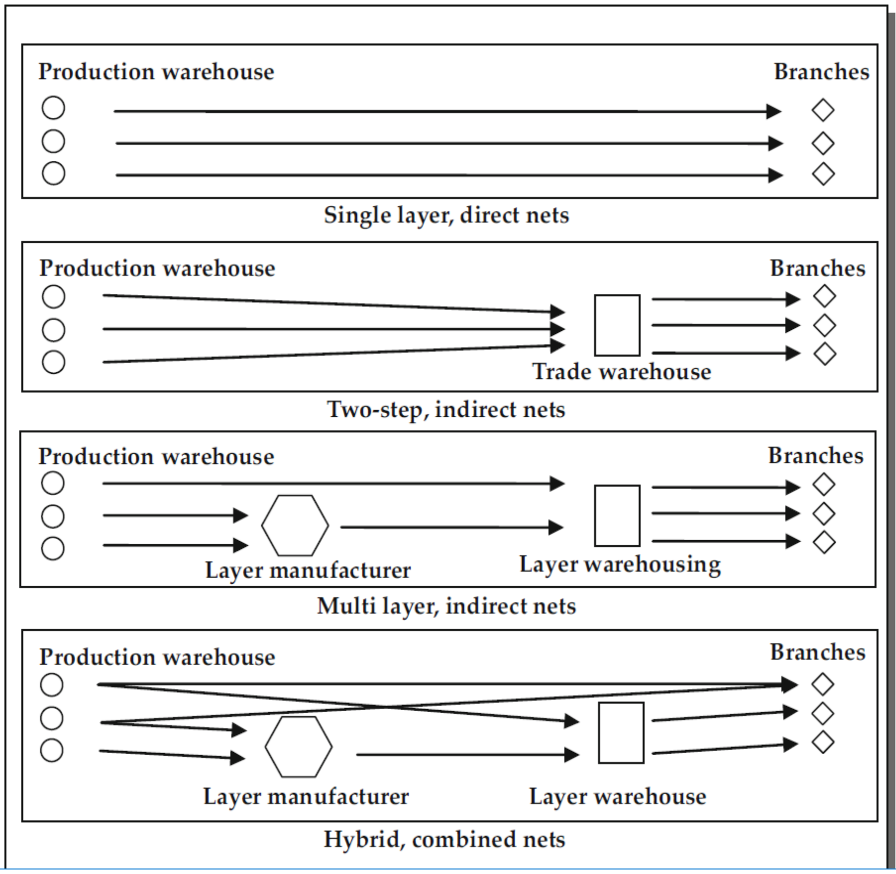

Figure 12: Representation of a network for the flow of goods (Gleissner and Femerling 2012).

3.2.1. Warehouse networks

Location planning is important for a company's strategy. Location factors are divided into quantitative (e.g. transport costs, property prices, staff costs, support measures, taxes) and qualitative factors (e.g. geographical location, condition, infrastructure, possibilities for recruitment, legal aspects). These factors inform location strategies aimed at the creation of capacity: adding capacity in new regions or increasing capacity in existing locations, capacities may also be concentrated in existing locations by (partially) shutting down other locations. For any location, the structure of a warehousing system is analyzed as a vertical one and a horizontal one. The horizontal structure is defined by the number, capacity, and geographical location of the warehousing and handling processes on every warehousing stage; it defines the degree of centralization of a distribution system. The vertical structure of local warehousing and handling processes defines the hierarchy and the number of steps of a warehousing system (Gleissner and Femerling 2012).

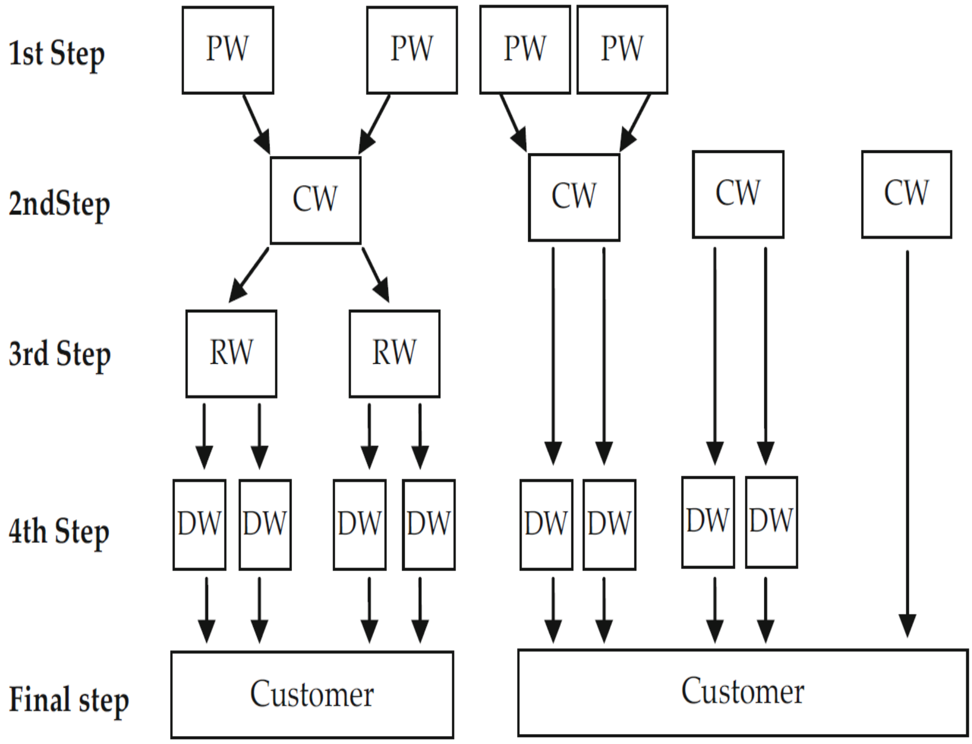

Figure 13: Number and degree of centralization of distribution systems, (Gleissner and Femerling 2012).

The definitions of the resulting warehousing types are as follows:

- Production warehouse (PW): Storing of finished goods from a production site for short-term balancing of stock volume
- Central warehouse (CW): Storing of a full product range, supply for lower warehouse levels or, in a centralized structure, for distribution to deliver a customer order
- Regional warehouse (RW): Buffer for a specific sales area to relieve earlier or later warehousing stages
- Distribution warehouse (DW): Separation function to compile the ordered quantity in a specific sales area (spot delivery), (Gleissner and Femerling 2012).

Degree of centralization is important as it can lead to reduction of the number of connections between the points of delivery and receipt and it could reduce the stock. Centralization could be achieved by eliminating a full warehouse level or by reducing the number of warehouses on one level. This could lead to fewer warehouses but to higher delivery time. So decentralized regional warehouse is suggested if delivery time or costs are factors that are more important. Apart from centralization, capacity and layout planning are also taken into consideration and they are influenced when the configuration of the warehouse network is realized. Capacity planning must take into consideration the respective customer and order requirements regarding flexibility and productivity and it has to consider the current order volume – e.g. represented by the number of storage places, the number of orders within a given period of time, and the chronological demand history – with respect to the possible monthly, weekly, daily, or shift performance. Anticipatory capacity planning must also take in account that the spatial and handling potentials as well as the staff capacity of a warehouse location must cover different workload volumes. Layout planning includes floor space dimensions and structure, the definition of the number and the arrangement of gates and ramps; space and room requirements for discharging, conveying, storing, commissioning, temporary storing; providing and other functional areas; the spatial arrangement and the shape of the building, the technical equipment of the storing, sorting, and commissioning areas (shelves, packaging machines, palletizers, lifting trucks, stackers) must be specified, as well as the staff capacities according to their numbers and necessary qualifications.

IT systems are essential for a successful control and stock management. They are generally divided in four levels that are presented below (Gleissner and Femerling 2012).

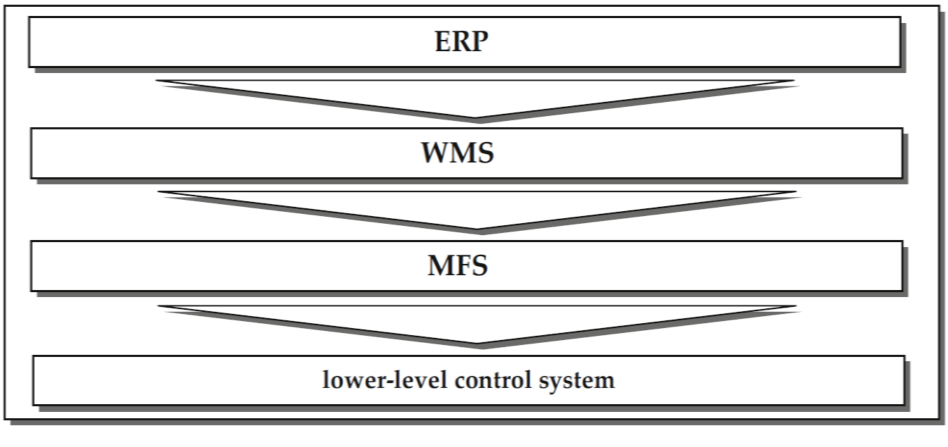

Figure 14: Network of IT systems in the warehouse, (Gleissner and Femerling 2012)

The first and highest level is the ERP system. The stock management, the economic assessment of the inventory situation, the purchase controlling, and the initiating of reorders as well as the recording and management of customer orders take place here. The second level is the warehouse management system (WMS). Its tasks are local stock management, the storage area management and assignment as well as the stocktaking and replenishment planning. The material flow system (MFS) is the third level. It controls the internal transports, orders of goods coming into and going out of the warehouse as well as the individual procedures for replenishment, picking, and stocktaking. The fourth, lowest and purely operative level is the lower-level control system by programmable logic control unit (PLC). Their elements control the handling technology and data transmission systems as well as peripheral devices like printers for receipts and barcodes.

3.2.2. Transport networks

Transport planning must occur analogue to the planning of warehouse structure (Gleissner and Femerling 2012). Tasks of transport comprise supplying goods to plants, warehouses, and selling places as well as the disposal of materials and goods, which are no longer needed. The transport services necessary for this are realized in transport nets. Configurations of transport nets can be divided into one- or multi-stage forms of line, ring or star structures; consecutively arranged vertices and edges characterize line structures. In this structure, transports have a high number of empty runs. Those tend to be prevented with ring traffic. The average vehicle utilization is increased and the cycling of the means of transport is optimized. The aforementioned forms of net structures are presented in figure 12. From these basic network structures, further forms can be derived which are employed mainly in practical transporting: grids, hub and spoke nets, and hybrid net structures (mixed forms). In grids nets, all shipping and receiving depots are connected by direct traffic (complete network). Hub-and-spoke nets are characterized by the traffic between the dispatching and the receiving depot being channeled to and from a central handling depot (hub). There are no direct ways between two depots, i.e. all transports are made via the hub(s).

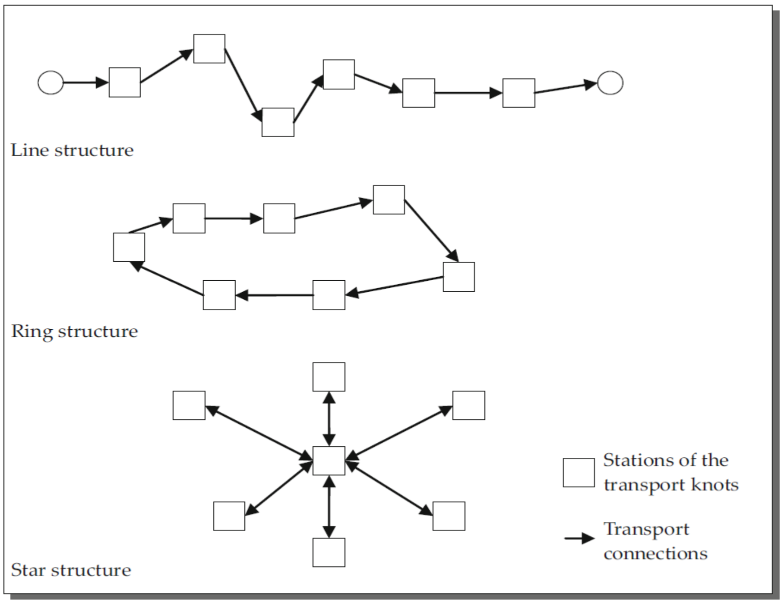

Figure 15: Forms of net structures, (Gleissner and Femerling 2012)

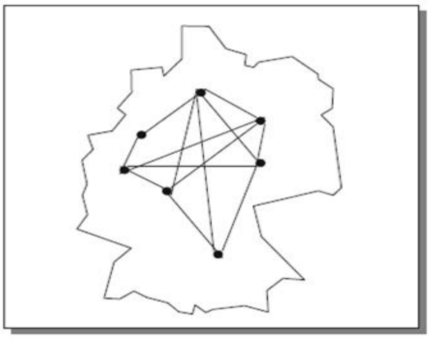

Figure 16: net configuration: grid (Gleissner and Femerling 2012)

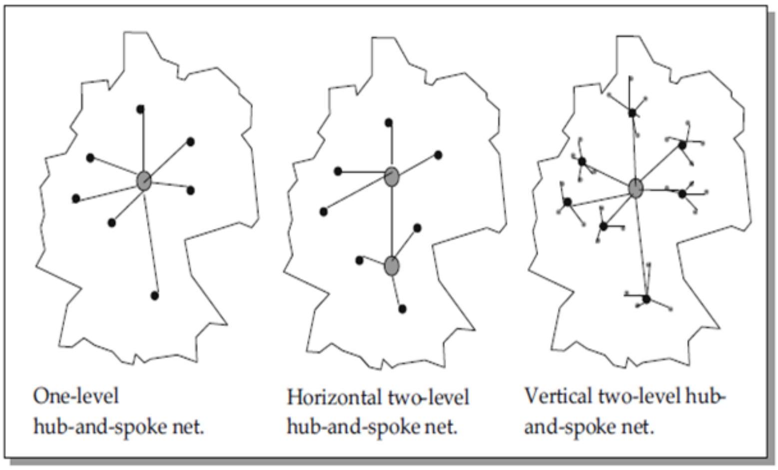

Figure 17: Net configuration: hub and spoke (Gleissner and Femerling 2012)

Another design variable of transport nets is transport consolidation, which has to be a part of the planning (Gleissner and Femerling 2012). Consolidation is the combination of shipments by more than one loading and/or receiving points during collection and/or distribution runs. In procurement and distribution logistics of the consumer goods industry, numerous consolidation concepts are employed.

With the multi-pick concept, the ordered quantities of a retailer and its branch for a defined replacement period are collected during a defined tour of manufacturers and are sent bundled to the trading warehouse. This requires giving the collecting and delivering job to one logistics service provider. Effects are the increase of the average utilization of means of transport and of the discharged quantity per delivery. The by-pass concept includes picking up shipments that are already commissioned for the branch at the manufacturer site. The goods are not stored but passed through. During this process, an order joining takes place with branch shipments from the warehouse of the retailer. With the branch orders being divided into order parts (warehouse and manufacturer), not only the provision of the shipment from the trade warehouse must be realized in the order cycle but also the branch commissioning by the manufacturers. Advantages are the reduction of handling efforts as the loading and discharging processes in the warehouse are no longer necessary. The cross-docking and merge-in-transit concepts are closely related to the reduction of warehouse levels. For cross docking, the handling process means that goods are cross-exchanged (cross) between delivering trucks from different carriers that dock to the goods receipt of the transit terminal at the same time (docking) and empty delivery vehicles, which are ready for loading in the goods outwards. The basic requirement for this concept is advance information, in order to control the operation factors; i.e. there must be a clear coordination regarding minimum and maximum order volumes with the suppliers. High reliability is required here, with no stock buffer planned between the manufacturer and the branch. The cross-docking platform must be able to handle a high volume in little time. Some effects are a clear reduction in the order lead-time, from the placement of the order to the goods arriving at the

branch, a reduction in stock in the branch, the increase of the goods handled, and the storing and take-out processes no longer being necessary
With respect to its steps, cross-docking (CD) can be divided in:

- 1-step CD: The manufacturer commissions for the branch in advance; then the shipments of more suppliers are joined in the cross-stocking point for the delivery to single branches without manipulation to each shipment (e.g. pallet) itself.
- 2-step CD: The manufacturer sends pallets by sort that are recompiled at the cross docking point for final shipments to single branches.

The merge-in-transit concept must be seen in the context of production sites located all over the world which makes it more and more necessary to join products from a customer order not in a warehouse but to merge the individual items in handling terminals (in transit) to complete orders before the actual delivery. The direct-store delivery concept makes it possible to compile the goods for a branch already at the manufacturer. The latter must make the commissioning efforts. Depending on the size of the shipment (vehicle utilization), combined runs can be made directly to the branch or compiled in a transit point after handling of the shipments with respect to the relation to define delivery runs.

Route planning or scheduling systems are IT applications that support transport fleet managers to efficiently plan routes for delivering or picking up goods (Gleissner and Femerling 2012). A number of customers, the demands and locations of which are known, are to receive a defined good from one deposit with a number of vehicles with certain capacities. The system gives suggestions about how the routes should be made in order to minimize total transport costs while adhering to certain secondary conditions (e.g. capacity and time restrictions). The determinants of route planning are collected in Table 1.

Distance determination	■ Digital network method
Travel time calculation	■ Digital road network ■ Average speed ■ Speed depending on the distance ■ Speed depending on the streets ■ Weather factors ■ Traffic/road works
Loading/unloading/ waiting times	■ Minimum standing time per customer (paper processing, maneuvering time) ■ Time depending on the quantity ■ Time depending on the customer
Other restrictions	■ Driving and resting period regulations ■ Regulations about working times for drivers and loading/unloading staff ■ Different types of vehicles with different maximum loads; equipment necessary for delivery, e.g. hydraulic ramp, forklift) ■ Empties/back loads ■ Uncalculated waiting times at customer sites ■ Driving ban on holidays, due to weather and in inner cities

Table 1: Determinants of route planning and scheduling (Gleissner and Femerling 2012).

3.3. Logistic costs

There are different logistical cost types. In the field of transport, for example, it is possible to differentiate among the cost types parcel service, forwarder, or own transport fleet. As cost centers, transport costs can, for example, be differentiated between purchasing transports, transports between sites of the own company, and delivery transports to customers.

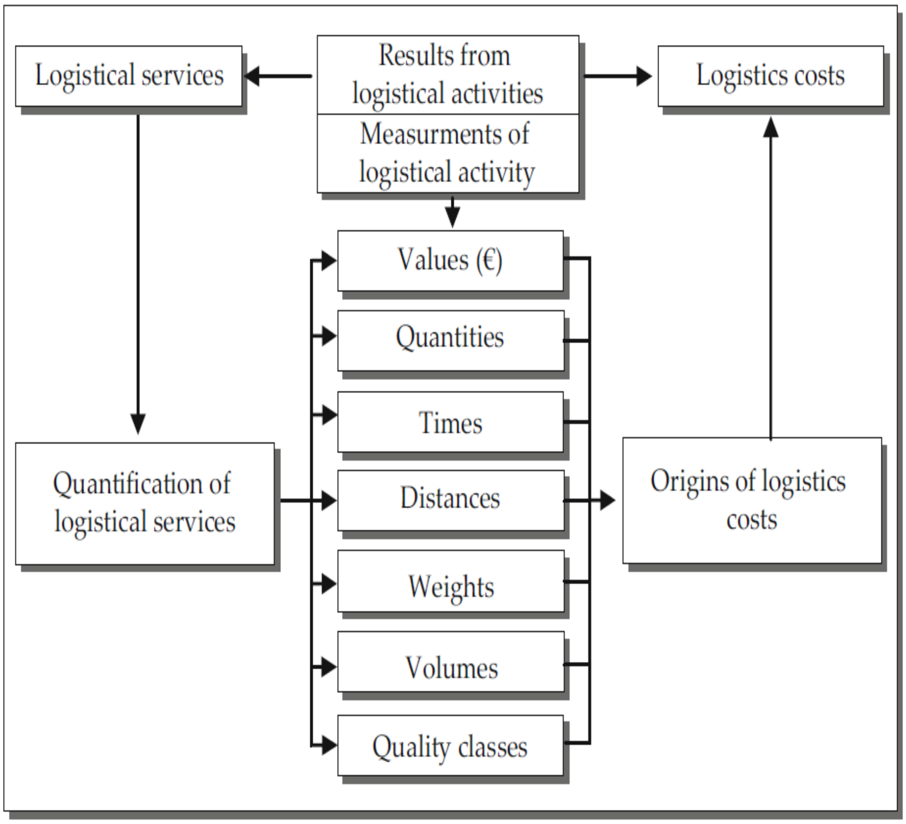

Figure 18: Characteristics of logistical activities (Gleissner and Femerling 2012).

The Basic elements of logistics costs are:

- Order processing costs
- Transport costs for covering distances in the logistical process
- Warehouse costs, for covering time in the logistical process
- Stock costs
- Control and system costs, for logistical control, administration and IT used in Logistics

The elements of the costs are important to be categorized and analyzed for the company as the elimination of those costs would be the final target in combination with the quality so as the company to have a competitive advantage.

Logistics outsourcing could lead to the reduction of costs. This stems from the fact that logistics costs are reduced by optimizing, as the logistic service provider manage to reach a high average utilization. High fixed costs caused by capacities targeted towards high peak loads can be made variable by outsourcing. Labor costs can be reduced by sector arbitrage, e.g. because of more favorable wage agreements for service providers. Furthermore, the reduction of opportunity costs should be realized so that companies can concentrate on their core business and not on logistics. Despite the advantages that outsourcing offers, the assessment of the appropriate outsourcing company as well as the decision of whether is a good deal to cooperate with an outsourcing company, can be made according to formal, functional, and commercial criteria:

- Formal criteria are, among others:

– Quality of the offer (Completeness, presentation)
– Price tables completely filled
– Offer documents signed

- Functional criteria rate e.g. the

– Concept solution: The offered solution fulfills all functions and requirements
– Functionality: Method of the realization (technology, equipment etc.), capability of the IT competence
– Service realization: Availability of sufficient capacities or resources, qualifications and experience of the staff
– Relevant and suitable references

Commercial criteria help to rate the following:

- Prices for the different services, including reference objects, fixed costs, variable cost rates etc.
- Yearly costs resulting from the planned quantities and services costs
- Payment modalities like payment deadlines and escalator clauses
- Liability/warranty: Regulating the amount and the length of the warranty agreements and defining the liability sum and the penalty for faulty services

3.4. Performance measurement

Measurement of the performance of the supply chain is important as it allows of tracking the failures and leads to more informed decision making regarding the chain design and how the things work in it (Aramyan et al., 2007). According to

Aramyan et al. (2007), the indicators that define the good performance of the supply chain of agricultural products are efficiency, flexibility, responsiveness and quality. As seen in figure 16, efficiency is measured by the production distribution and transaction costs, profits and return on investments. Flexibility is measured by mix and volume flexibility. Mix flexibility is the ability to change the variety of the products produced, which enables the firm to enhance customer satisfaction by providing the kinds of product that customers request, in a timely manner. It is easily measured by the number of different products that can be produced within a given time period. Volume flexibility is calculated based on expected sales and intention is to produce as much as possible, even if the demand for the product is low. Responsiveness is measured by lead-time and customer complaints. Finally, food quality is measured by appearance of the products as well as product safety.

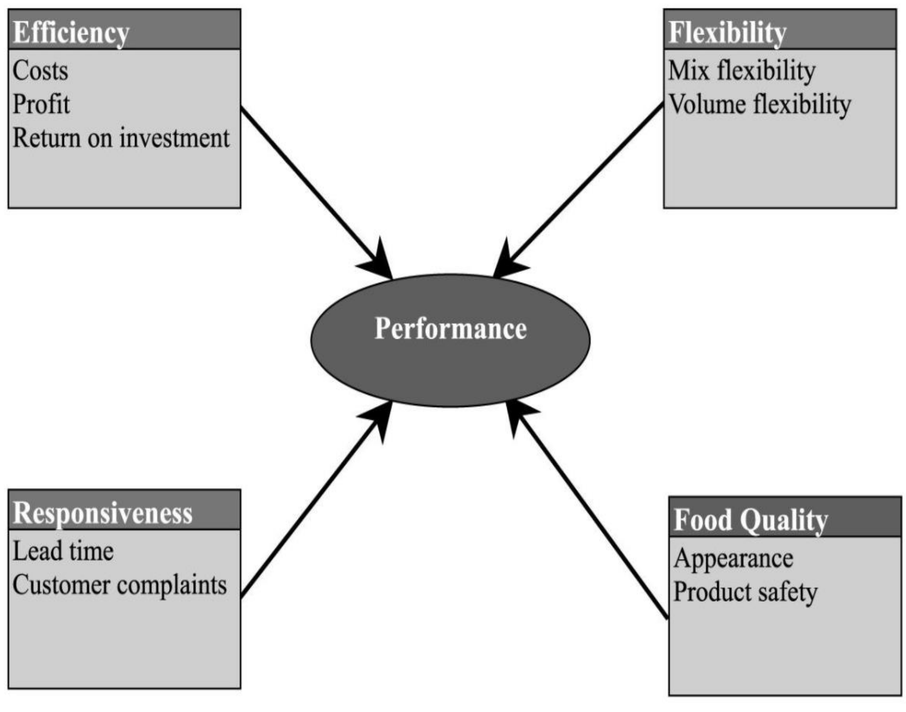

Figure 19: Conceptual framework of agri-food supply chain performance categories and indicators

The performance measurement framework mentioned above, allows supply chain members to develop a clear view on performance of the entire supply chain, as well as on the different aspects of the performance of their own organization, which allows them to make tradeoffs between different aspects of performance (e.g. increased costs, but higher quality products). This is important, as assists the companies and the chain in making comparisons or finding the dependence among the indicators (For instance, what impact has improved food quality on responsiveness and efficiency?). This system also allows observing the impact of, for example, policy implications/regulations or innovations on the whole performance of the supply chain.

Chapter 4
Research Analysis

As we have already mentioned, perishable agricultural products have a unique set of characteristics that require specialized logistics systems; most important for this analysis are the following:

- Remoteness of production zones
- Time sensitivity
- Required temperature control
- Sanitary inspection procedures

In this analysis, we present some of the logistical bottlenecks that constrain the movement of agricultural products both within and beyond Central America and particularly between Costa Rica and Nicaragua and make some suggestions for improvements in order to reduce the costs.

4.1. Background

Costa Rica is a small country (51.000km) with a population of 4.8 million in 2014. Agricultural sector is an important one for Costa Rica since it is rich in natural resources and has favorable climate conditions. Furthermore, it has an abundant of water supply although water scarcity is a growing concern in certain regions. Agriculture‘s share in GDP has declined over the past decades- from 13.7% in 1995 to 5.6% in 2013- due to structural transformation in Costa Rican economy. Nevertheless, the agricultural sector remains the second largest source of employment in Costa Rica. Costa Rica has been successful in exporting new crops like pineapple, where it is a leading exporter with a world market share of 55% in 2015, as well as continuing successfully export more traditional crops. Costa Rica’s main export destination is the United States although exports to other countries in Latin America are increasing. The agricultural sector in Costa Rica has a dualistic structure, with a strong agricultural export sector, accompanied by a low productivity, traditional sector producing mostly for the domestic market.

The marketing channel followed in Costa Rica can be seen in the figure below. The main stages include producers, wholesale markets, distributors, and retailers. Depending on the commodity, additional stages can include industrial processors and exporters to industrial markets.

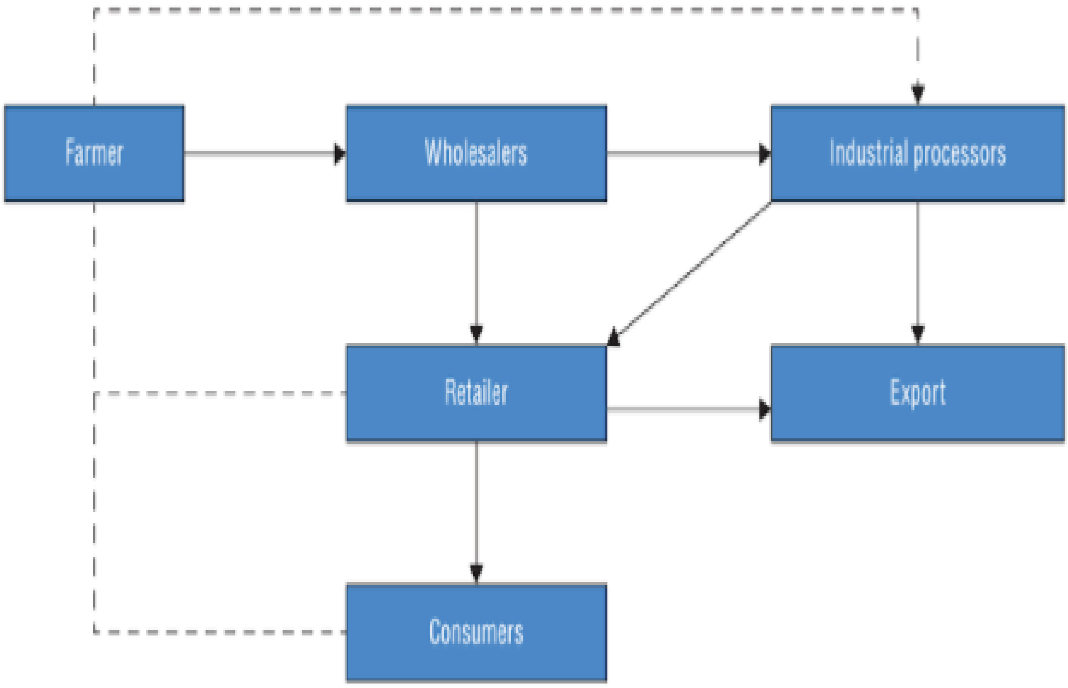

Figure 20: standard marketing channel for agricultural commodities in Costa Rica

Figure 21: Map of Costa Rica Figure

4.2. The case of tomato

We will analyze the tomato trade between Costa Rica and Nicaragua. Tomato crops for processing are subject to environmental constraints, which impose production seasonality due to climate and land use conditions. The demand of manufactured tomato-based products has experienced fluctuations due to market behaviors, particularly related to different regions worldwide and periods of the year. Data from the Food and Agriculture Organization of the United Nations (FAO) show that the tomato is the second most produced vegetable crop in the world. The country pair was chosen to capture movements between the region's highest and lowest performers on the World Bank's Logistics Performance Index (2012). Tomatoes were chosen because : (i) their unusual sensitivity to time and susceptibility to damage make them greatly dependent on efficient logistics movements; (ii) both large and small shippers could be evaluated along the supply chain; and (iii) among vegetables, tomatoes represent the most important export to Nicaragua in terms of value. Due to their short shelf life, time is an important factor that impact tomatoes' logistics costs. Tomato crops have a production cycle which last from 100 to 120 days. Interviewees reported that a tomato's lifetime is equal to 5 days or 120 hours, from the time it is picked at the farm gate until it perishes at the shelf.

In the trade of fresh tomatoes from Costa Rica to Nicaragua, Figure 22 and Figure 23 provide a general picture of the different steps involved in transporting 1 kg of tomatoes from Costa Rica to Nicaragua for both a small exporter and a large exporter. The small exporter receives the fresh product in 18 kg plastic boxes from a small producer located in Cartago, located about 36 km from San José, who transports it to the exporter's distribution center located just 4 km away from the farm gate in a small, non-refrigerated truck. Once at the distribution center, the product is transferred to 23 kg cardboard boxes and loaded into a 40-feet container, which then starts traveling towards Peñas Blancas, the border town between Costa Rica and Nicaragua located at about 319 km from the distribution center. The truck travels up the Pan-American Highway at a speed of 60 to 80 kilometers per hour and takes approximately 7 hours non-stop. Once at the border, the shipment must pass through Costa Rican and the exporter transfers the product to cardboard boxes since transporting Nicaraguan customs and travels 3 to 4 hours from the border until it arrives at the Mercado Oriental, where the product is sold to both big wholesalers and retailers.

Overall, the large exporter's chain has a similar structure to that of the small exporter. The large exporter purchases product all year round from a large independent producer who controls market prices due to its overwhelming share in the country's tomato production. The large producer then transports the product in a 20-feet truck with a capacity of up to 700 boxes of 13 kg each to the large exporter's distribution center, located approximately 60 km away. Once at the distribution center, the boxes are then loaded into a 45-feet container that can carry up to approximately 1,200 boxes. After the container is fully loaded, the truck travels towards Peñas Blancas, crosses the border, and arrives at the distribution center in Managua, located at 149 kilometers from the border. Finally, the product is then consolidated with other goods at the distribution center and transported in 8 meters refrigerated trucks that can carry up to 6,800 kg to different supermarket points in Managua.

Figure 22: Tomato transport distances from Costa Rica

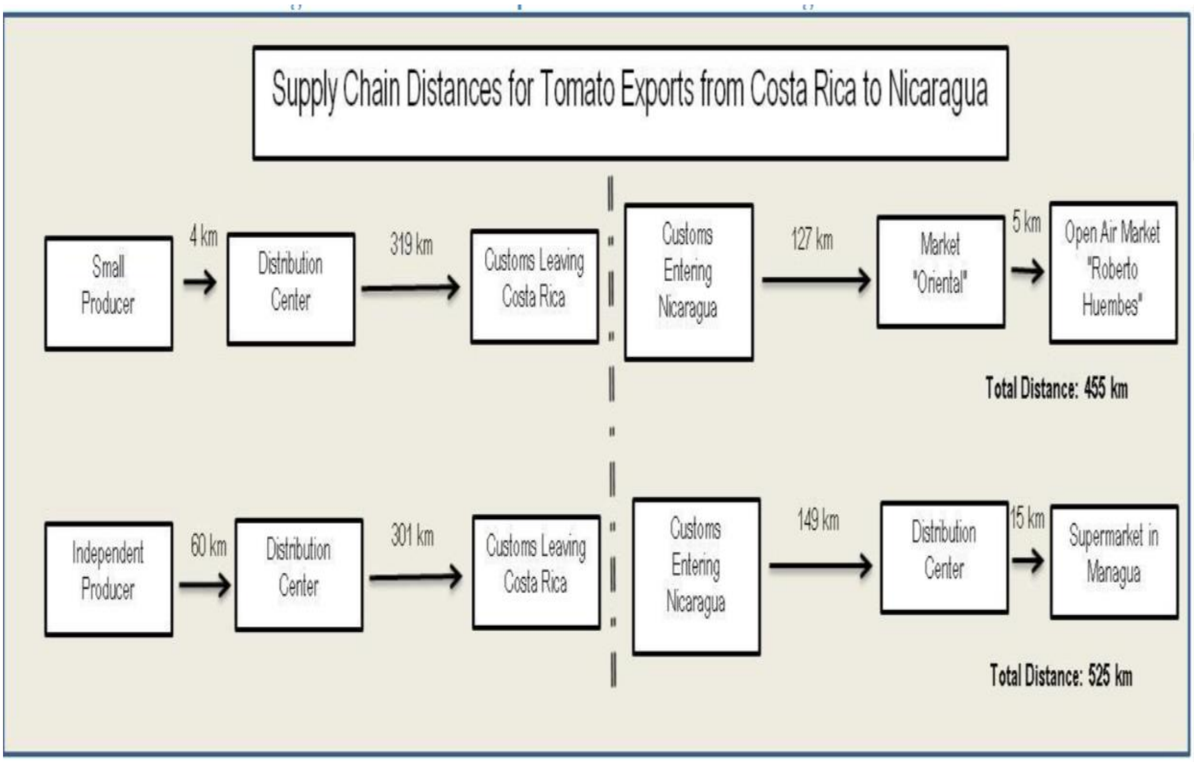

Figure 23: Tomato transport distances: small vs large producer

4.2.1. Logistics bottlenecks in tomatoes

In the case of tomatoes, the advantages of scale, in terms of the final market and a more integrated supply chain can cut logistics costs in half. Logistics bottlenecks that cause unexpected delays and extend transit times can more than double logistics costs for both high and low value goods. In the diagrams bellow we can see the share of costs in every step for small and large exporters that determines the final price. As it can be seen in the diagrams below, the biggest cost for the final price for small exporter is in the farm gate followed by the profit of the retailers and the transportation from the distribution center to border. In contrast, for large exporters, the biggest cost is the retail cost followed by the costs in farm and the retail profit. As the costs that the traders buy and sell are defined by the market and cannot be change, we will examine the costs provoked due to the distribution of tomatoes.

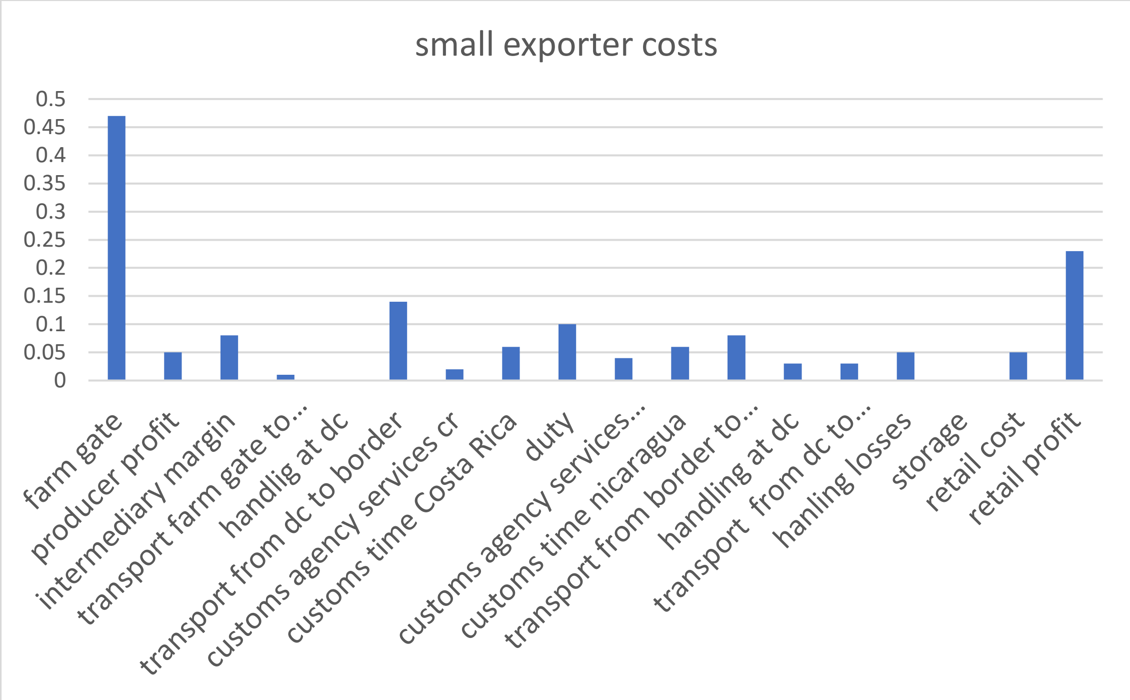

Diagram 1: Share of costs for small exporters

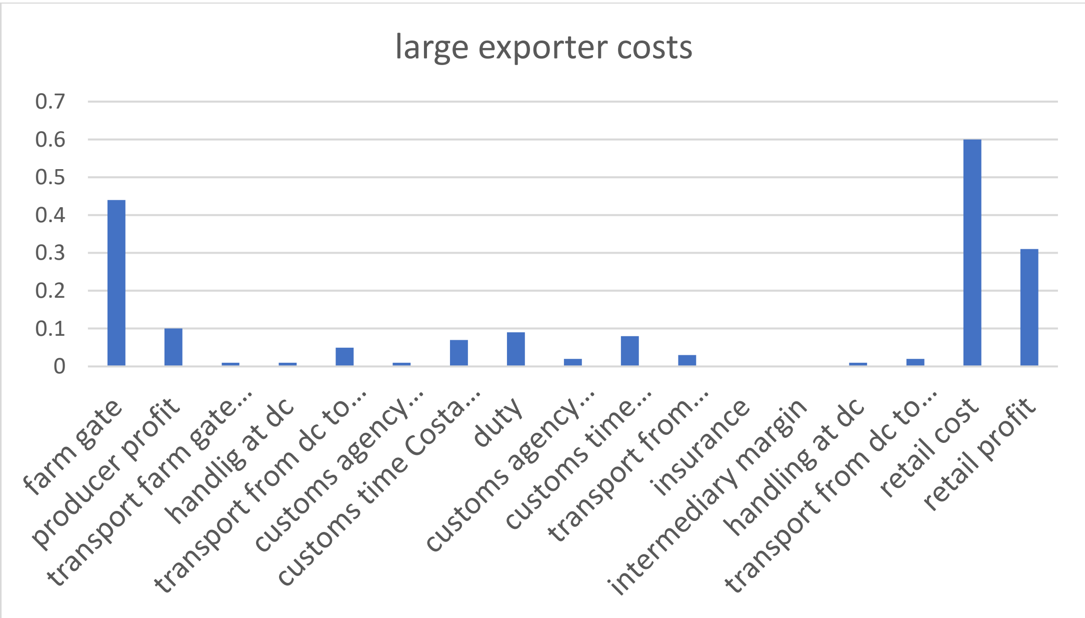

Diagram 2: Share of costs for large exporters

One of the factors that influence logistic costs is the border crossing. Border crossing and related procedures are not only costly, but a source of uncertainty (Cunha and Jaramillo, 2013). Therefore, coordinated policy actions in this area can bring larger gains. Waiting times at border crossings vary widely within Central America, within each country, and even within bi-national borders. Trucks can wait up to 20 hours to cross the border, which is especially costly for those carrying perishable goods. Long and unpredictable waiting times at border crossings are mostly a result of the lack of coordination and inefficient processes and procedures of border agencies, as well as limited equipment and infrastructure. For instance, the lack of a single window and inconsistencies in hours of operations among border agencies and brokers often cause delays.

To trade fresh tomatoes, it takes at least 3 hours to go through customs, phytosanitary, and narcotics inspections on the Costa Rican side of the border. On the Nicaraguan side, waiting time can equal 5 hours to re-do the same inspections and procedures (Cunha and Jaramillo, 2013). Logistics costs for a large tomato exporter in Costa Rica, including ground transport, handling and customs service fees are estimated at around $0.15 per kilogram, while the value of time spent waiting at the Peñas Blancas border crossing, on a typical day under typical circumstances almost doubles the logistics costs by adding an additional $0.14 per kilogram in hidden costs through losses of this extremely perishable product. For the small exporter, the value of time spent waiting at the Peñas Blancas border crossing is estimated at around $0.12 per kilogram in hidden costs. These increase the total logistics costs from $0.29(16%) to $0.43(24%) for large exporter and from $0.53(35%) to $0.65(43%) for small exporter. These costs due to border delays include fuel costs to maintain containers refrigerated, waiting time costs for truck drivers, and costs associated with inventory management, delayed distribution and reduced shelf time of the product. Delays at the border could be attributed to service and infrastructure factors including the following:

- Lack of technical skills of custom agents and corruption
- Poor risk management systems leading to 80-100% cargo inspection rates
- Limited coordination of multiple border protection agencies
- Underuse or erratic functioning of electronic information management systems
- Poor spatial layout, making it difficult to direct trucks to different lanes, depending on risk

All these factors mentioned above have as a result to the increase of logistic costs.

What we can assume from the diagrams 3 and 4 shown below is that total logistic costs are a significant proportion of the price. For the large exporter the logistic costs are almost the same as the price that the exporter buys the tomatoes from the farmer while for the small shipper the logistic costs overcome the price that the exporter buys the product. So, if the logistic costs were eliminated this would be good for both farmers and exporters since they could acquire more profits that could use both parts to be competitive. From the part of the producer, they could use the extra profit to improve the quality or increase the production in order to be more competitive and claim better prices. From the part of exporter, they could be more competitive paying some extra cents in order to be more competitive compared with other exporters and claim better quality of the products.

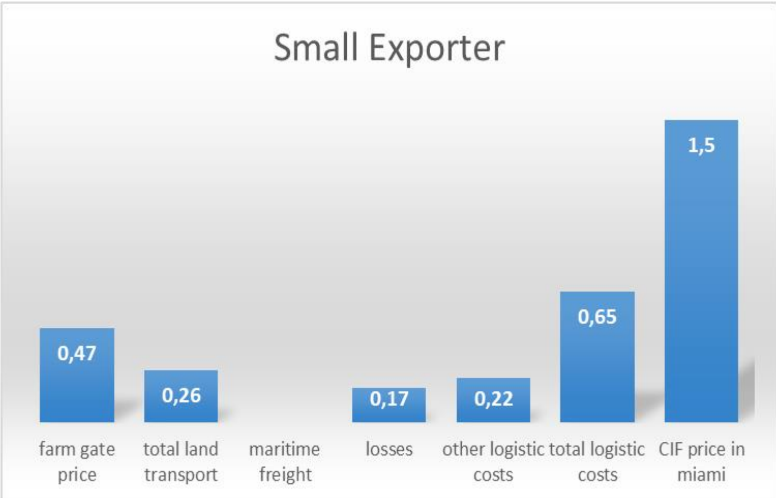

Diagram 3: Logistic expenses for small exporter

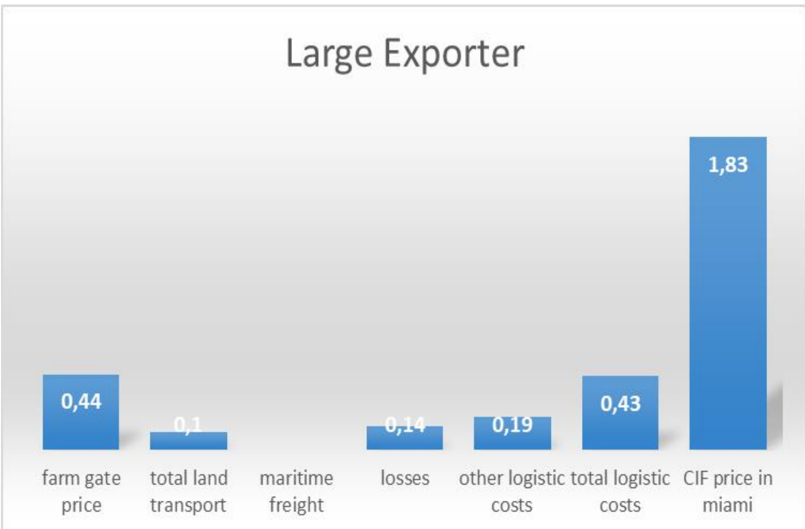

Diagram 4: Logistic expenses for large exporter

Another factor that influence logistic costs is the lack of adequate infrastructures. According to the research for the Agro-logistics in Central America (2012), poor access and quality of rural roads can affect the exportation of perishable agricultural products in two different ways. When the constraint is related to access, producers either face large losses moving their product to market on foot or using animals, or simply never develop their production beyond household subsistence levels; for these producers, anticipated logistics expenses may be prohibitive, and serve as a barrier to entry. Access constraints may keep many small producers out of the market, and are nearly impossible to capture with a supply chain analysis. In the second case, producers have access to a rural road, but the quality is so poor that transporting their goods is too expensive and time consuming to be profitable. These producers may not enter the market, or may sell a much smaller quantity of their goods, only at the highest point in the harvest season, when they can accumulate enough volume to make it worthwhile. According to Cunha and Jaramillo (2013), poor quality of second and rural roads is identified as a major challenge for agro-producers in all countries in the region, with a larger impact on small producers. The lack of good-quality paved roads linking farms with cities impedes intraregional commerce notwithstanding the relatively good condition of the major transit arteries. In fact, paved roads represent less than a third of regional road network. The poor road quality, in turn, causes direct losses from delays in shipments, breakage, losses in weight (cattle) and quality (perishable goods), of 8 to 12 percent of the sales value. Small producers are particularly affected by rural road quality.

For the tomato export chain, the largest transport cost components, measured by $US/kg/km for both small and large exporters pertain to transport from the farm gate to the consolidation center as well as to domestic transport costs once the product arrives in Managua. Transport from the farm gate to the distribution center represents 0.0028 US$/kg/km and transport from distribution center to the open-air market represents 0.0060 US$/kg/km. These costs are large if we take into consideration that the distance between farm and distribution center is 4km and for distribution center to the market is 5km. Likewise, for the large exporter, the largest cost components within shipping are transport from the farm gate to the distribution center at 0.0003 US$/kg per km for 60kilometers, and transport from distribution center to the supermarket at 0.0010 US$/kg per km for 15 kilometers. According to the research, the relative weight of these two legs within shipping as compared to the other two legs can be because trucks must pass through secondary roads crossings in congested city centers at reduced speeds of 20 to 40 km/hour, as opposed to 80 km/hour on the Pan-American Highway. Uneven pavement can lead to breakage, and congestion can cause delays that directly influence product quality as we have already mentioned above.

Other factors that could increase logistic costs are transport regulations such as weight restrictions, overloading, and truck quality and safety. Although these factors may increase transport costs, the lack of regulations and/ or enforcement creates costs such as damaged goods and increased vehicle-operating costs. Together with poor infrastructure, uncontrolled speeds, cargo weights and vehicle types make roads and highways very insecure for cargo, public and personal transport. As far as sanitary and inspection processes is concerned, poor administration and operation of national laboratories can raise costs and times to export, and lead to product rejection. Moreover, for intraregional exports, the right to inspect, review, sample, and reject cargo upon arrival can be used as a non-tariff barrier to importation.

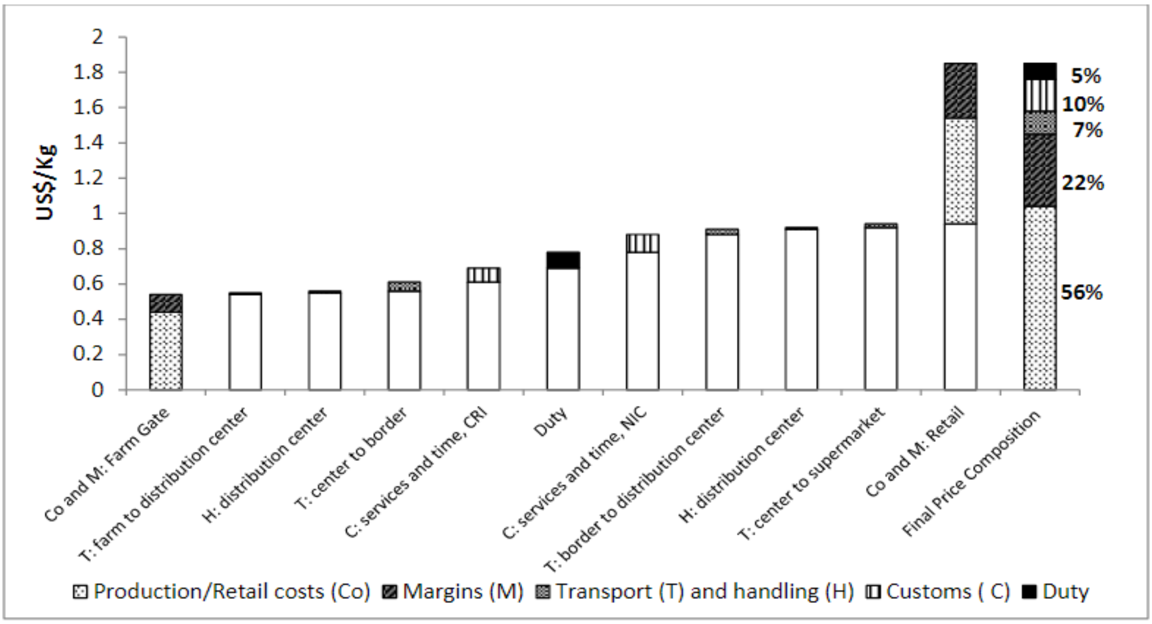

Figure 24: Costs faced by a large Costa Rican tomato producer exporting to Nicaragua

All in all, for tomato exports from Costa Rica to Nicaragua logistic cost vary from 22 percent of the final price for large producers to up to 41 percent for small producers (Cunha and Jaramillo, 2013). Transportation costs are the main factor explaining this difference in costs, ranging from 7percent for large to 23 percent for small producers. Small producers pay 3 times more to bring the product from farm gate to the border and spend 5 times more and handling, reflecting poor quality of roads, larger distance and scale issues. Customs is the second most important element of logistics costs. At approximately 10 percent of the final price, customs reflect service fees for both countries and loss due to waiting time. In a congested day can be up to 10 hours to crossing the border. Finally, duties account for around 5 percent of final prices and reflect tariffs and procedures involved in the export process. In the case of a perishable good, such as tomato, phytosanitary (SPS) procedures must take place in both countries.

Farm to Center

- Higher transport costs on unpaved rural roads for Agricultural producers
- Product losses from poor quality roads and time delays

Principal Cargo Transport Corridors & Services

- Without factoring in congestion, urban transit effect can increase travel times.
- Fuel efficiency
- Empty Back-Haul
- Pervasive insecurity has corresponding costs for region's trade

Public sector: Investment and export procedures

- High fees and long waits for laboratory analysis slow exportation, raises uncertainty and hurts reliability of agricultural exports

Border Management

- Waiting at borders, more than any other friction factor, increases wait times and forces cargo flows away from its optimal path.
- Though interest and investment is high, the region has been slow to adapt to electronic document processing systems for exports
- Pervasive insecurity has corresponding costs for region's trade

Figure 25: Summary of logistic bottleneck (Schwartz, 2012)

Correlation between price and logistic costs

Examining the costs in each step of the supply chain we made a correlation analysis for both small and large exporters to observe how the costs the distance and the weight of the cargo are correlated. As it can be seen from the tables, we can assume that for the small exporter the strongest association is between distance and the costs distributed per kilogram (0, 98). The weight of the cargo has also a strong association smaller though (0, 80). In addition, the weight and the distance have a strong relationship that each factor influence each other.

	us/kg	*distance*	*weight*
us/kg	1		
distance	0,983991	1	
weight	0,808396	0,807735571	1

Table 2: Correlation analysis for small exporter (Appendix III)

For the large exporter although distance per kilogram influence the costs to the biggest extent (0,98) , in contrast with the small exporter the association between the weight of the cargo and the distance has a strongest link (0.85) in relation with the weight of the cargo and the distribution of costs in each kilogram (0,75).

	us/kg	*distance*	*weight*
us/kg	1		
distance	0,984876	1	
weight	0,758495	0,851264	1

Table 3: Correlation analysis for large exporter (Appendix III)

To conclude, the factor that has the biggest association for both small and large exporters is the association between distance and the distribution of cost per kilogram, which means that the distance and any delay may add extra costs for the exporters. For small exporters the associations between weight of the cargo and distribution of costs per kilogram and the weight of the cargo and distance have equal importance whereas for the large exporter the second strongest association is the one between weight and distance followed by the relationship between weight and the distribution of cost per kilo. This may be because in general, large exporters carry larger amounts of products and as a result, the distribution of cost per kilo is certain.

4.3. Suggestions for improvement

Some suggestions for improvement that will be elaborated below are better infrastructure, clusters and route analysis, information technology systems and smallholder monitoring tool-kit.

Infrastructure

Infrastructure is a problem in Latin America mainly for two reasons. First, it is very important as non-existent roads or roads that are difficult to access make the tomatoes' transportation last more. As a result, this leads to lower price as when tomato reaches the market or the supermarket has fewer days of shelf life. The creation of roads with asphalts would be an important factor for reduction of costs. As we have already mentioned above, both large and small exporters have extra costs due to lack of adequate roads. This means that the trucks take more time to reach their destination and this leads to more costs to fuels and wages and reduction of the tomatoes lifetime. The government should help producers and exporters in order to be more competitive.

Second, delays in borders through lack of infrastructures is another important factor that increases logistics costs. Maybe is the most important as it doubles the logistic costs. So, a series of improvements are needed in order to reduce costs and time crossing the borders. From the previous analysis (2012), are suggested the introduce of spatial planning into plans for border modernization as it is observed that many times that a truck is inspected there is not the appropriate space that the truck could stop and this has as a result the creation of traffic jam. Moreover, custom systems do not interface seamlessly with sanitary inspection systems as well as sanitary inspection procedures lack of appropriate implementation. In addition, the government has not succeed until now to organize the implementation of the adequate systems. Therefore, although these suggestions are considered as necessary steps that have to been made in order to improve the border crossing, we are going to suggest the application of an online appointment system that the exporters could close on the behalf of their trucks in order to avoid the crowding on the borders. Although this could have its limitations, as it is difficult to predict the exact time of the departure in borders, it could save a lot of time. In addition, the personnel's training along with the processes improvement through a central system that captures all the procedures electronically and reduce waiting time could be the main keys for the reduction of waiting time to the minimum. Although, in some parts of Latin America pilot programs have been used that reduce the waiting time from over an hour to less than 8 minutes this has not been applied to the borders of Costa Rica and Nicaragua and although Costa Rica has TICA, a noteworthy system, it does not support big volumes. However, if this in the end could be succeeded and the processes could be standardized, this would lead to the reduction of logistic costs to a great extent. To elaborate this, if it is managed to reduce the time of papers' inspection to 8 minutes from over an hour that normally takes, this would lead to more profits for the exporter both from the elimination of costs but also for adding more shelf life to tomatoes. If it would also introduced the online appointment would eliminate the waiting time in the borders more. This could reduce waiting hour in borders from 8 hours that it takes now in total – approximately 3 hours in the borders of Costa Rica and 5 hours in borders of Nicaragua- to much less.

Clusters and Route analysis

The development of a coordinated distribution system would lead to the increase of sales as it would assist to overcome the problems of low size of production, market price and , inadequate packing and storage facilities. The development of clusters of producers and the determination of the optimum collection center that would link producers and retailers would be a solution for these problems. Therefore, a route analysis should be conducted in order to determine the optimal place that could eliminate transport, distance and time. This would decrease the ration of us/kg per/km and would reduce the logistic costs especially inside the villages. As we have observed in the supply chain of the tomato from Costa Rica to Nicaragua, tomato passes through several stages and many stations. An analysis should be done whether there could be a distribution center near to the farms where all the process should be done. The transport network that should be followed is the star structure where there is a main center and the farmers collect the tomatoes there so that the exporter process and distribute them. In this distribution center all the collection packaging and storage should be done. In addition, marketing should be done. Another idea would be the decrease of distribution centers from two to one somewhere in the middle and after crossing the borders.

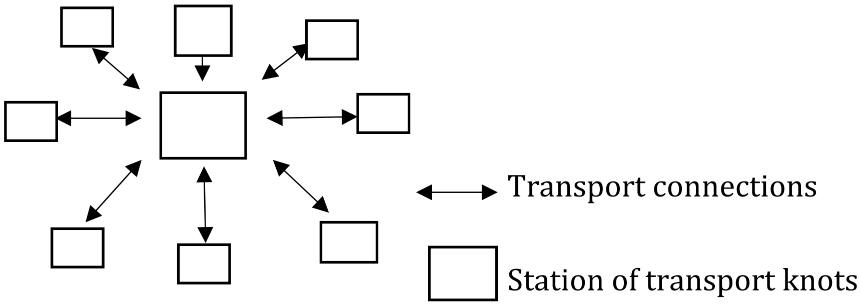

Figure 26: Star structure

Information technology systems

Over the past years, mobile technology has given the access to small farmers to a variety of services and information regarding the cost and distance of inputs, calendars to assist with seeding, planting, harvesting and general price information. However, lot has to be done in this sector in order the farmers to have more access and knowledge regarding the information technology systems. Therefore, a suggestion would be the creation of an online platform that would connect the farmers in Costa Rica with the direct buyers- markets supermarkets- in Nicaragua. To elaborate, intermediary or the farmers themselves with the help of the government could create an online platform. Government could subsidize the farmers and educate them about the tools that they can use. All the farmers could put in this platform the quantity available the quality and information related to them. This would decrease logistic costs through economies of scale as bigger quantities could be transported together. This would be extremely beneficial for small farmers. To elaborate, small farmers pay 0.08 us/kg, which would be transferred to producer profit in order to be more competitive and invest more for the quality of their products. This is important since lack of quality products could delay the inspection procedures in the borders or it could make products last less time. If they invest time in research and development and use methods used in development countries, this could lead to prolongation of the tomatoes' shelf lifetime. What is more, through the platform a larger quantity could be gathered which would lead to even more reduction of the logistic costs as the costs would divided to more kilos of tomatoes.

Smallholder monitoring tool-kit/ Estimation of costs

The improvement of transport efficiency could be succeeded by taking into account both rural transport infrastructure, consolidation system and collection services. A tool-kit was designed by Njenga (2015), which provides important factors that need to be measured in a local level:

a. An inventory of what is being produced in an area,
b. Farm sizes for smallholder farmers,
c. The volumes being produced in an area,
d. Total annual value of agricultural produce by smallholders,
e. The spatial location and spread of farms of where it is being produced,
f. Location of consolidated points and facilities availability ,
g. Perishability of produce/value of post-harvest losses per crop type per year,
h. Availability and reliability of transport services to collect produce,
i. The quality of transport infrastructure and key trouble spots,
j. Key market destinations,
k. Market prices and how they change from time to time,
l. Market destinations,
m. Forms of farmers organizations.

The knowledge and organization of all these factors could lead to better management of the bottlenecks and avoidance if possible. For example, if the farmers belong to a cluster and the manager of this cluster is knowledgably of the farmers, the farm sizes, as well as the volumes being produced by each farmer, and the total annual value gathered from all the farmers together, this could help predict the volumes and create economies of scale through the distribution of cost to larger volumes. The spatial location is important to be known in order the distribution center to be in place that minimize the cost of distance for all the farmers. Quality of transport infrastructure influence the quality of the products and the costs as poor quality prolong the time that is needed to reach the retailer and reduce the shelf time. Market price and the observation of the price changes from time to time is also important as it could provide important insight of what causes the changes in price and how sensitive are the consumers in the price changes.

Chapter 5
Concluding Remarks

Logistic management of agricultural products is a challenge and a lot research has to be done in order to find solution in the logistic problems that these products are facing. This stems from the fact that agricultural products have a limited shelf life and are more sensitive than other products. In addition, the actors in the whole supply chain are interdependent more than in other products. In our research, an effort has been done in order the logistic system of tomatoes to be analysed in Latin America and especially between Costa Rica and Nicaragua in order inconsistencies and suggestions to be presented. However, the results have some limitations. As the data used are secondary (Sustainable Development Department Central America Country Management Unit Latin America and the Caribbean Region the World Bank, 2012), inherent data limitations are present. The first limitation is that the research was dependent on interviews and some interviewers were unwilling to share sensitive information so in some cases inconsistencies may be present. A more comprehensive research should be done through observation of costs and time in order a cost benefit analysis to be presented. Furthermore, this analysis presents the inconsistencies as they are in developing countries. A comparative analysis should be done between developing and development countries in order to observe the inconsistencies in logistic system in a broader context and find potential solutions. In addition, future researches should include longitudinal data to investigate how the results may change over the years. In addition, a research over the years is interesting due to the fact that we can observe how the results may change as stakeholders get more and more educated and familiar with the concepts logistic system and the procedures. Nevertheless, this research contributes to the existed literature with pointing the logistic bottlenecks that exist and mentioned in this paper and suggesting potential solutions that their application could offer substantial advantages through cost elimination.

Appendix I: Transport costs for small and large exporter

Tomatoes				
Small exporter	***US/kg***	***Distance***	***Weights(kg)***	***Ratio US/kg per \km***
Farm gate to distribution center	*0.01*	*4*	*2.250*	*0.0028*
Distribution center to border	0.14	318	5.750	0.0004
Border to distribution center	0.08	127	5.750	0.0006
Mercado oriental to the local market	0.03	5	166	0.006
Large exporter	***US/kg***	***Distance***	***Weights(kg)***	***Ratio US/kg per \km***
Farm gate to distribution center	0.02	60	9.100	0.0003
Distribution center to border	0.05	301	15.600	0.0002
Border to distribution center	0.03	149	15.600	0.0002
Distribution center to supermarket	0.02	15	4.000	0.001

Appendix II: cost structures for tomato supply chain

Small Exporter	Additional Cost US$/Kg	Cumulative Cost
Farm Gate	0.47	
Producer Profit	0.05	0.52
Intermediary Margin	0.08	0.60
Transport Farm Gate to Distribution Center	0.01	0.61
Handling at Distribution Center	0.00	0.61
Transport from Distribution Center to Border	0.14	0.75
Customs Agency Services Costa Rica	0.02	0.77
Customs Time Costa Rica	0.06	0.83
Duty	0.10	0.93
Customs Agency Services Nicaragua	0.04	0.97
Customs Time Nicaragua	0.06	1.03
Transport From Border to Center of Distribution	0.08	1.11
Handling at Distribution Center	0.03	1.14
Transport form Distribution Center to Open Air Market	0.03	1.17
Handling Losses	0.05	1.23
Storage	0.00	1.23
Retail Cost	0.05	1.27
Retail Profit	0.23	1.50

Large Exporter	Additional Cost US$/Kg	Cumulative Cost
Farm Gate	0.44	
Producer Profit	0.10	0.54
Transport Farm Gate to Distribution Center	0.01	0.55
Handling at Distribution Center	0.01	0.56
Transport From Distribution Center to Border	0.05	0.61
Customs Agency Services CR	0.01	0.62
Customs Time Costa Rica	0.07	0.69
Duty	0.09	0.78
Customs Agency Services Nicaragua	0.02	0.80
Customs Time Nicaragua	0.08	0.88
Transport From Border to Center of Distribution	0.03	0.90
Insurance	0.00	0.90
Intermediary Margin	0.00	0.90
Handling at Distribution Center	0.01	0.91
Transport from Distribution Center to Supermarket	0.02	0.92
Retail Cost	0.60	1.52
Retail Profit	0.31	1.83

Logistic expenses for small and large exporter

Tomatoes				
	large		*Small*	
Type of expense	*Expense/kg*	*%*	*Expense/kg*	
Farm gate price	0.44	24%	0.47	31%
Total land transport	0.1	5%	0.26	17%
Maritime freight				
Losses	0.14	8%	0.17	11%
Other logistic costs	0.19	10%	0.22	15%
Total logistic costs	0.43	24%	0.65	43%
CIF price in Miami	1.83	100%	1.5	100%

Appendix III: Data used for correlation analysis for small and large exporters

small exporter	us/kg	distance	weight	ratio/kg/km
farm gate to dc	0,01	4	2250	0,0028
dc to border	0,14	318	5750	0,0004
border to dc	0,08	127	5750	0,0006
mercado oriental to local market	0,03	5	166	0,006

large exporter	us/kg	distance	weight	ratio/kg/km
farm gate to dc	0,02	60	9100	0,0003
dc to border	0,05	301	15600	0,0002
border to dc	0,03	149	15600	0,0002
mercado oriental to local market	0,02	15	4000	0,001

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