E-commerce and its influence on the logistical processes in the food supply chain

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Abstract

This thesis will look into the relation between E-commerce and developments in the supply chain's logistical structure between businesses in the food sector. This study aims to find the effects of E-commerce on the logistical structure by researching two specific parts of the logistical structure: supply chain design and supply chain operations and dividing E-commerce in:

- EDI
- E-auctions
- E-Hubs
- E-markets

This results in the following main research question: "What have been the effects of E-commerce on the logistical structure in Business to Business supply chain in the food sector?"

The methods used to find the data was a literature research on supply chains in the food sector, E-commerce, supply chain design, supply chain operations, and developments in these fields. Research on these literatures has resulted in identification of multiple developments in all fields, mainly increasing usage of E-commerce, (semi) automation of multiple processes within the supply chain, the globalization of the supply chain, the increase in size of suppliers, the growing importance of sustainability. The results were that E-commerce technologies had influence on most developments in the food supply chain and that it can be concluded that E-commerce has effected the logistical structure in almost every facet.

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Chapter 1 Introduction

This thesis will look into how E-commerce effects the supply chain's logistical structure between businesses in the food sector. Logistics as a term has been used in commercial sector since the 1960's (Langevin & Riopel, 2005). The term logistics has been employed to refer to procedures related to the physical organization of a business, specifically the movement of products before, during and after manufacturing (Langevin & Riopel, 2005). The logistical structure will be researched by looking at two elements of the structure; the supply chain operation and the supply chain design elements. The supply chain operation is defined as:" *the planning, execution and control of the movement and placement of people and/or goods and of the supporting activities related to such movement and placement within a system organized to achieve specific objectives.''* (Gleissner & Femerling, 2013) For example in the agribusiness the planning and execution of transport of feed from a warehouse to the farmer is a form of supply chain operation. On the other hand the location of the warehouse is a form of supply chain design. Supply chain design is defined as how the supply chain is outlined , the processes, mode of transportation and locations. (Meepetchdee & Shah, 2007) A big part of design is where to put warehouses or plants and the size of them. The location is in relation with distances between the DC and its buyer. If distances are bigger then there will be more transport costs due to the fuel and possible alterations in mode of transportation. The objective of the design and operation is to minimise costs, which results in bigger profit margins. The objective of this thesis is to investigate if E-commerce has changed the supply chain design and operations. If we specify this to the food sector, logistics can becomes more complicated because most food is perishable. This means that the time in storage has to be minimised and the transport has to be quick, because it is desirable to deliver the products as fresh as possible.
The supply chain will be split in two main processes (Beamon,1998), namely:

- 1. Production Planning and Inventory Control
- 2. Distribution and Logistics

The main processes 1 and 2 are illustrated below in figure 1. This figure shows the basic framework for conversion and movement of raw materials in final products (Beamon, 1998).

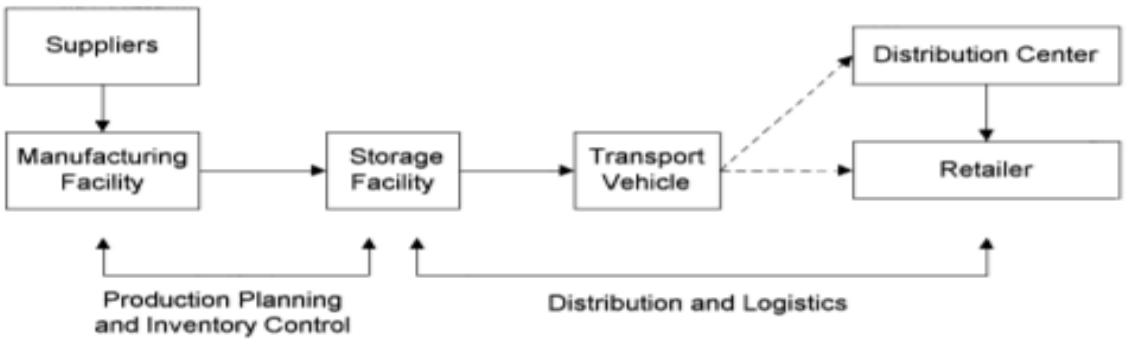

Fig. 1. The supply chain process (Beamon, 1998)

1. The Production Planning and Inventory Control contains the manufacturing and storage sub-processes. To be more precise Production Planning describes the design and management of the complete manufacturing process. Inventory Control describes the design and management of the storage policies and procedures for raw materials, in process inventories and final products (Beamon , 1998).
2. The Distribution and Logistics Process is about the collection and transportation of products from warehouse to retailer or distribution centre. These processes and subprocesses interact with each other to produce an integrated supply chain (Beamon, 1998).

Now that the key words in the logistical structure are defined, it is time to define E-commerce. Business to Business E-commerce is defined as: '' *Internet-enabled B2B technologies used by firms to conduct buying, selling, and exchange of information with their supply chain partners''*. (Alsaad et al., 2018). Despite of that definition not all technologies have to be internet based. There are technologies that are based on intranet. The focus of this thesis is to research if there are noticeable effects on the logistical structure of the supply chain caused by E-commerce.

Following an article written by Bloemhof et al. (2015). In fresh supply chains, the main logistic processes are the handling, conditioned storing, packaging, transportation and especially trading of goods. A big factor in the fresh food supply chains is food safety and food quality (Bruzonne et al., 2014) . Due to increasing complexity of the supply chains, the risks of contamination of fresh products becomes increasingly higher (Bruzonne et al., 2014)
The problems discussed above results in the following research question: What have been the effects of E-commerce on the logistical structure in Business to Business supply chain in the food sector? To answer this question firstly the following sub questions have to be answered. In these sub questions a time period of the last two decades is chosen. This period is chosen, because of the technological developments of this time period and the relevance of these developments on this thesis.

What are the functions and characteristics of E-commerce in the food sector and how has the technology developed in the last two decades?

What are the changes in the in the supply chain design between businesses in the food sector of the past two decades?

What are the changes in the supply chain operations between businesses in the food sector of the past two decades?

How has E-commerce changed the supply chain design and supply chain operations of businesses in the food sector?

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Chapter 2 Methods

The literature used for this thesis was found using Scopus and the WurLibrary. For basic knowledge about EDI, wi-fi and the history of the internet, internet blogs were used. For news about certain companies, newspaper articles were used. The following key words were used: supply chain, supply chain and fresh food sector, supply chain design, storage policy design, material handling, manufacturing process design, supply chain and transport. With these keywords the following key articles were found: (Beamon, 1998), (Meepetchdee & Shah, 2007), (Manzini, 2012), (Fawcett, Ellram & Ogden, 2014) and (Grunow & van der Vorst, 2010).
The following keywords: E-commerce and business to business, developments E-commerce, electronic data interchange, e-auctions, e-hubs, e-markets, benefits and e-commerce were used to find the following key articles: (Alsaad et al., 2018), (Caniato et al., 2010), (Kaplan & Sawheney, 2000), (Narayanan et al., 2009).
The following keywords: supply chain operations, developments and supply chain operations, manufacturing and supply chain operations, food and sector and supply chain operations, logistics and supply chain operations, transport and supply chain operations, environment and supply chain operations, sustainability and supply chain operations were used to find the following key articles: (Gleisnsner & Femerling, 2013), (Argeneto, et al., 2008), (Jabbarzadeh, 2018), (Manning & Baines, 2004), (Busse et al., 2016) and (Meneghetti & Monti, 2016)
First the abstracts were read of the articles after they looked appropriate the article was studied carefully.

Chapter 3 E-commerce

3.1 Introduction

The rise of the internet has played a big part in the development of E-commerce. The internet is a big electronical network and is well fitted to facilitate E-commerce, because E-commerce technologies need a network. There are two business options for commerce in general : B2C which stands for business to consumer and B2B which stands for business to business, which is the focus of this thesis. (Meier & Stormer, 2009). An example of Business to Consumer E-commerce is an electronical shop, a good example is Bol.com. Bol.com is a business that sells only online. There is no physical store and payment usually are done electronically. An example of Business to Business E-commerce is an online ordering program used by [1]DetailResult which exists between a DC and store. Via the program it is possible for a store manager to order products. In this chapter the functions and characteristics of E-commerce will be discussed and also the development of the technology involved in E-commerce will be discussed.

3.2 What are the characteristics and functions of Business to Business E-commerce?

Business to Business E-commerce is defined as: '' *Internet-enabled B2B technologies used by firms to conduct buying, selling, and exchange of information with their supply chain partners''*. (Alsaad et al., 2018). B2B now holds a bigger part of the overall E-commerce landscape. It is believed that B2B will keep growing and will be the leading manner of conducting business in the near future(Lau, 2006). B2B E-commerce is seen as an important measure for accomplishing economic and social welfare of developing as well as developed economies (Alsaad et al. , 2018). But there is a gap between the developed and developing countries in usage of E-commerce, as one can see in table 2. More than seventy five percent of total B2B transactions are dominated by developed countries. Many public and global organisations strive to narrow the diffusion gap, but it was broadened rather than narrowed during the last decade. (Alsaad et al., 2018). In the table countries are ranked on basis of the internet use index, this is measured on a scale from 1 to 7 where 1 is the lowest and 7 the highest use index.

Table 1 B2B internet use index of selected countries 2014-2016

	B2B EC Internet Use Index		
Country name	2014	2015	2016
United Kingdom	6.260	6.296	6.368
Korea, Rep.	6.173	5.970	5.777
United States	6.169	6.257	6.321
Netherlands	6.010	6.030	6.040
Sweden	5.975	6.027	6.005
Japan	5.963	6.069	5.953
Taiwan, China	5.927	5.727	5.289
Norway	5.847	5.924	5.798
Czech Republic	5.824	5.791	5.772
Lithuania	5.813	5.913	5.827
Estonia	5.795	5.797	5.787
Australia	5.781	5.672	5.477
Switzerland	5.773	5.799	5.721
Myanmar	3.242	3.216	3.313
Guinea	3.095	2.989	2.989
Gabon	3.089	3.038	3.205
Mauritania	3.085	3.086	2.775
Lesotho	3.069	3.073	3.299
Lebanon	2.985	3.150	3.545
Bhutan	2.982	3.124	3.463
Algeria	2.725	2.895	3.310
Ethiopia	2.677	2.759	3.441
Burundi	2.613	2.622	2.622
Chad	2.472	2.203	2.202

(Alsaad et all, 2018)

[1] DetailResult is a Dutch supermarket chain.

B2B E-commerce technologies differ between technologies that are accessible for many actors, such as internet based technologies, versus those that only connect a small number of actors and are not accessible to others, such as electronic data interchange (EDI) (Bakker et al, 2008). Business to Business E-commerce beholds a broad selection of technologies including; EDI, the internet, E-auctions, E-markets, E-hubs and E-supply chains.(Alsaad et al., 2018). The type of technology depends on the relationship between actors.
The origin of EDI can be found in the 1960s. In the 1960s computer systems gained the ability to interchange data (McCarthy, 2013). Ed Guilbert expanded the standardized shipping manifest he had developed in the 1940s. Guilbert's expansion was an electronic message format for sending cargo information (McCarthy, 2013). The first EDI messages were sent in 1965 by the Holland-American steamship line. In 1968 the Transportation Data Coordinating Committee was formed by a group of railroad companies to standardize the format used to exchange the EDI messages (McCarthy, 2013). Until then shipping companies, railroads, airlines and trucking companies used varying formats which resulted in problems. In 1973 the File Transfer Protocol was in operation and made file transfer between internet sites possible. In 1975 the first Value Added Network Telenet was established. Telenet was the first commercial packet switching network which added more than the basic service of linking computer systems (McCarthy, 2013). In 1982 businesses in the automobile and retail sector like Ford and General Motors started to use EDI with their suppliers. Since then more and more industries started to pick up EDI to the point where most companies are using it today. But what are the functions of EDI? EDI is usually used to exchange corporate documents and transactions between supply chain actors and is as stated above a closed system, because it is unwanted that other actors have access to those files. EDI replaces postal mail, fax and email between supply chain partners. The exchange of the business documents is done in a automate computer-to-computer style. This means that the exchange is done by computers and that there is no human interference. Having no human interference speeds up the exchange. EDI documents sent by the senders computer flow straight to the matching application on the receivers computer. Albeit EDI is a closed system 60 per cent of electronic transactions is based on EDI technology, while the remaining 40 per cent is based on internet technology (Caniato et al, 2010).

E-hubs are a form of E-market. A non-electronic hub is a junction in a network where a redistribution of goods or people takes place to their end destination. An electronic hub is the electronic version of the hub but without the physical redistribution, thus it is a junction where from – in this case- goods go to their end destination. E-hubs are not physical thereby it is comparable to a E-market, because there is no physical redistribution in a warehouse of the intermediate E-hub. It is an electronic redistribution where goods gets shipped from one business to the other. There are two kinds of relationships between actors; systematic sourcing and spot sourcing. Systematic sourcing involves negotiated contracts with qualified suppliers. Because the contracts tend to be long term, the buyers and sellers often develop close relationships (Kaplan & Sawheney, 2000). In spot sourcing, the buyer's goal is to fulfil an immediate need at the lowest possible cost. Commodity trading for things like oil, steel, and energy exemplifies this approach. Spot transactions rarely involve a long-term relationship with the supplier; in fact, buyers on the spot market often don't know who they're buying from (Kaplan & Sawheney, 2000). The kind of relationship can affect the E-commerce technology used. If it the relationship is systematic sourcing the buyer can consider putting the seller in its EDI system.
The type of goods that can be traded are direct and indirect goods. Direct goods are goods directly used in the production process, so called manufacturing inputs. Indirect goods are goods not used directly in the production process. They are also called operating inputs or maintenance, repair and operating goods (MRO) (Kaplan & Sawheney, 2000). Under these indirect goods fall for example computers and cleaning services. Below the kinds of hubs are listed with their characteristics (Kaplan & Sawheney, 2000). There are four different kinds of E-hubs depending of the relationship

between the actors and the kind of goods. The first (1) are MRO hubs. In MRO hubs indirect goods are traded. These goods tend to be low-value goods with relatively high transaction costs. MRO hubs provide value mostly by increasing efficiencies in the buying process (Kaplan & Sawheney). The second (2) are Yield Managers. Yield managers create spot markets for common operating resources like manufacturing capacity, labour and advertising, which allow companies to expand or contract their operations on short notice (Kaplan & Sawheney, 2000) Yield Managers create the most value in situations with great fixed costs assets that cannot be disposed or acquired quickly, like manpower. The third (3) are Catalog hubs. Catalog hubs create the ability to automate the sourcing of all other direct inputs than raw materials (non-commodities). The created value of Catalog hubs is the same as the created value of MRO hubs: reducing transaction costs by bringing together many suppliers at one website. The difference between MRO hubs and Catalog hubs is that catalog hubs are industry specific. That difference lies in the fact that MRO hubs are hubs where indirect (operating) inputs are traded, for example copier paper is not industry specific whereas in Catalog hubs direct (manufacturing) inputs are traded which is industry specific. The last (4) kind of hubs are Exchanges. Exchanges facilitate a spot market whereby raw materials (commodities) can be quickly exchanged. The Exchange maintains relationships with buyers and sellers, in many exchanges buyer and seller don't know each other. The Exchange makes it easy for buyer and seller to conduct business without negotiating contracts or working out terms of relationship (Kaplan & Sawheney, 2000). Below an overview of the E-hubs and their characteristics.

Table 2 E-hubs

(1) MRO hubs
- Enable systematic sourcing
- indirect inputs

(2) Yield Managers
- Spot sourcing
- Indirect inputs

(3) Catalog hubs
- Systematic sourcing
- Direct inputs

(4) Exchanges
- Spot sourcing
- Direct inputs

There are hubs for every kind of purchase desired by a company. Due to these markets it is easy to shift between suppliers. Also the improved transactional efficiency of E-commerce has led some companies to explore ways to sell more materials by spot transactions and less by contract. Now, since online exchanges make it possible to conclude spot deals in minutes (online auctions and hubs), the rounds of phone calls and faxes involved in traditional negotiations are eliminated. On the buyer side of the equation, distributors are using E-commerce to find new suppliers and lower product prices (Wen, Lim & Huang, 2003).

E-auctions or online auctions are the electronic version of the normal auction. Just as with the normal auction there are different types of auctions possible. The two biggest auction types used with E-auctions are: forward auctions and reverse auctions. Forward auctions is the type best known and understood by most people. This type of auction contains of a seller offering a item for

sale and multiple buyers bidding against each other in an upward fashion. eBay is a great example of a forward auction site. Only eBay is not per definition a business to business auction site. The most buyers on eBay are consumers, but it is possible that a business buys via eBay. A reverse e-auction is a time-bound event, usually enabled by a third party auction facilitator, and is typically of one to two hours duration (Tassabehji, Taylor & Beach, 2006). The auction commences with the buyer posting the initial contract price, often at a value that is lower than the historical figure, already representing a unit cost reduction. Suppliers proceed to bid against unknown competitors under a downward price mechanism until the price-floor is reached. At this point, the auction concludes and the contract is awarded, theoretically to the lowest bidder (Tassabehji, Taylor & Beach, 2006). To simplify what is said above, in a reverse auction there is a single buyer who demands an item, then there are multiple suppliers bidding against each other in a downward fashion until the price-floor is reached.

E-market is a broad concept and in fact an overarching term. E-auctions and E-hubs are a form of E-market. E-markets can have many different forms in E-hubs and E-auctions and even EDI. The characteristics of E-markets are thus the same as the characteristics of E-auctions and E-hubs and EDI. EDI can be a form of E-market if there is an automated electronic purchase system linked to it.

3.3 What are the benefits of E-commerce?

The benefits of E-commerce are lower product prices for buyers , faster trade, faster trade-off between suppliers or buyers. Many forms of relationships, can be 1 to 1 to 1 to many all depending on the technology used. An open network usually means more actors, closed networks usually means less actors (Narayanan et al., 2009). The latter is a result of the ease of which a supplier can find a new buyer or a buyer a new supplier thanks to an online network. Thus it is possible for a buyer to find a supplier who is able to supply the same good for a lower price and vice versa. It is also claimed that transaction cost decline as a result of E-commerce (Molla & Licker, 2005). Due the increasing degree of automation B2B E-commerce is becoming more efficient, thus a function of E-commerce is to automate certain parts of the supply/ ordering processes which in turn results in less labour hours which results in lower cost which results in higher profit margins. Negotiation agents is software that negotiates on behalf of the party that uses it. These negotiations agents are believed to be able to reduce human negotiation time and identify optimal or near optimal solutions (Lau, 2006).
Below an overview of benefits per E-commerce technology.

Table 3 Benefits per E-commerce technology

EDI benefits tied to the internal integration decision are (Narayanan et al., 2009) :

- cost efficiencies due to decreased paperwork and lower workforce
- increased quality due to fewer errors and improved data accuracy
- improved productivity by eliminating redundancy in processing and better customer service due to better planning of shipments
- fewer stock-outs and more accurate planning of shipments and deliveries

Benefits of E-hubs per hub are:

- MRO hubs
  increasing efficiencies in the buying process

- Yield Managers
  fast acquirement/disposal of great fixed costs assets

- Catalog hubs

increasing efficiencies in the buying process

- Exchanges
  simplification of conducting business

Benefits of per type of E-auctions (Tassabehji, Taylor & Beach, 2006):

Reverse E-auction

- Buyers find the reverse e-auction process attractive because of the tangible benefit of price reductions and the prospect of reduced transaction costs.
- Suppliers can benefit from the opportunities to bid for new business and to penetrate new markets
- Enables buyers to identify the price-floor

Forward E-auction

- Removal of expensive intermediaries
- Opportunity to pay less
- Lower transaction costs

Benefits forward and reverse E-auctions:

- Both parties gain from less paperwork

3.4 How has the technology of E-commerce developed the last two decades?

Midway the 1990's the internet started its rise. Popularity among businesses and consumers grew rapidly. For businesses a new way of conducting business arose. Due to the internet applications like e-mail communicating became easier and due to the world wide web businesses could reach buyers or suppliers they would otherwise have more trouble to reach. The biggest developments to the internet as network itself are in the method it is transferred. The first internet connections were using the already existing telephone lines and one had to dial in to use the internet. It was only possible to use the internet when the telephone was not used. These connections were replaced by broadband transmission which made it able to use both the telephone and the internet and made the internet significantly faster. Nowadays most cables are replaced with glass fibre cables which make the internet faster. Another way to facilitate internet is via Wi-Fi. At the end of the 1990's Wi-Fi became available for home use and made a steady development. In the years that passed it became stronger, which resulted in faster internet and a broader reach. (Thomas, 2014) There are also many developments in technologies using the internet, but those are not developments of the internet itself. The biggest developments of the internet is the way it channels and the increase of the speed that comes along with it.

Electronic Data Interchange has been viewed as a technology pivotal to supply chain management that has also provided benefits to firms on multiple levels (Narayanan et al., 2009). It has been one of the primary enabling technologies for conducting B2B transactions (Narayanan et al, 2009). EDI started to gain popularity among businesses in de 1980's. As stated above it was first picked up by the automobile industry to be implemented in their supply chain. The economics involved with EDI was a barrier for some firms for a long time, but the arrival of the internet in the 1990's has made EDI feasible even for small firms. This has to do with the network EDI uses, without internet companies had to invest in an intranet which made it possible to share with the connected firms. Now with the availability of the internet the network is already there. Many firms have integrated EDI with their order-processing and inventory-management system. There is written that more innovative integrations include electronic funds transfer where funds are electronically remitted to suppliers and electronic graphic interchange where visuals and drawings are electronically

transmitted to support new product development and bidding processes (Narayanan et al.,2009). EDI itself has not changed significantly the last twenty years, the way it is used has, because of combining functions. Where it was first used to replace the paper exchange of order invoices and shipping information etcetera, it is nowadays integrated with other applications. From EDI the next steps in the E-commerce line are E-marketplaces and E-auctions. These will be combined in this thesis in E-procurement, this because they are similar in technology. From the technological perspective, there is wide agreement about three main [2]E-procurement architectures: buyer-hosted, seller-hosted and intermediated (Caniato et al. , 2010). The buyer-hosted architecture characterizes itself by the fact that the applications and information are stored in the customer's servers. This means that suppliers have to connect to the customer's platform to be able to do transactions. In the seller-hosted architecture things are reversed, the customer has to connect to the seller's platform. In the intermediated architecture a third party is the host, this third party can have technological role or a commercial role. For example, application service providers usually rent their technological platform to customers and/or suppliers, so they are focused on technological aspects (Caniato et al., 2010). E-procurement is mostly used in the acquisition of indirect materials, EDI is mainly used for the procurement of direct materials (Caniato et al., 2010). This is quite logical because EDI exist usually between supply chain partners, so it would be odd to acquire your direct materials via another route.

There is a trend visible in the technology of B2B E-commerce and that lies in the automation. By increasing the degree and sophistication of automation, B2B E-commerce will become much more dynamic, efficient, and hence more widely adopted by organizations. Intelligent software agents are promising to enhance the degree of automation and sophistication of B2B E-commerce. Software agents are encapsulated computer systems situated in some environments such as the Internet and are capable of flexible, autonomous actions in that environment to meet their design objectives (Lau, 2006). The outcome is that due the development of technology less and less human interference will be necessary. The biggest developments are relating to automation and integrating the multiple E-commerce technologies.

[2] Definition: the use of ITs to facilitate B2B activities of purchase and payment of goods and services(Caniato et al., 2010)

Chapter 4 What are the changes in the supply chain design between businesses in the food sector of the past two decades?

4.1 Introduction

Supply chain design (SCD) is a specific part of the supply chain, but what is a definition of a supply chain? A supply chain may be defined as an integrated process wherein a number of various business entities (i.e., suppliers, manufacturers, distributors, and retailers) work together in an effort to: (1) acquire raw materials, (2) convert these raw materials into specified final products, and (3) deliver these final products to retailers. This chain is traditionally characterized by a forward flow of materials and a backward flow of information (Beamon, 1998). To demonstrate how elaborate a supply chain can be figure 1 is inserted.

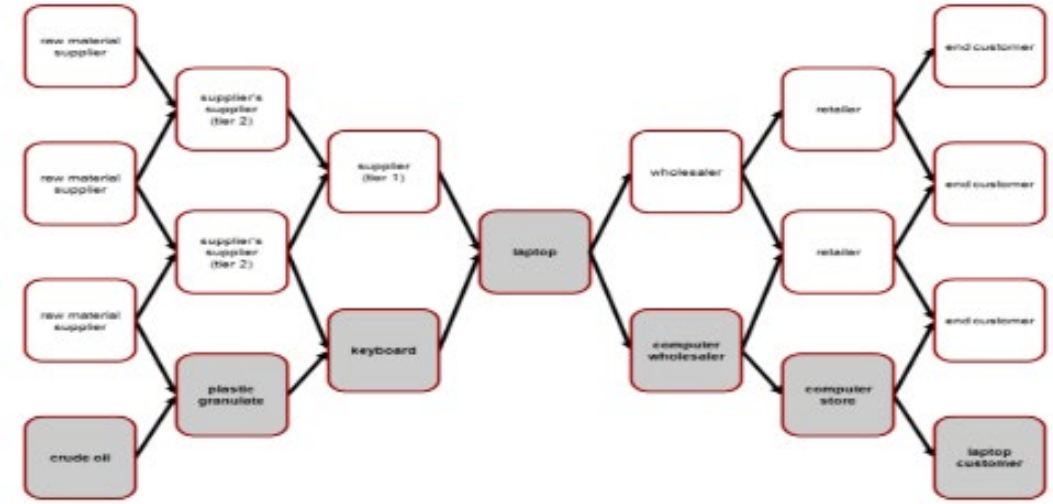

Figure 2 Supply chain network (Wieland & Wallenburg 2011)

This figure is applied to a laptop as final product, but a supply chain network of a food product can be just as elaborate or even more so. There are far more elaborate supply chain networks than the one in this figure. For example to show how a food sector supply chain can be as elaborate as the one in the figure: the final product is a microwave lasagne. There are multiple raw material suppliers, like milk for the cheese on top, wheat for the pasta blades and tomatoes for the sauce. All these raw materials will be bought by a tier 2 supplier, it is possible that these food products are bought by the same supplier. The wheat has to be transformed to wheat and the milk to cheese this can be done by a supplier tier 1 and make this supplier makes to materials into a lasagne. There is also another supply chain for the aluminium trays. Thus the elaborateness of the supply chain network of figure 1 can be applied to the food sector.

There is much written about the supply chain the last two decades and there is an increasing interest in the supply chain design and supply chain operation. In this chapter the SCD will be explained and what changes the SCD has undergone the last two decades, specifically in the food sector.

4.2 What is supply chain design?

As stated in chapter 1 supply chain design is defined as how the supply chain is outlined , the processes, mode of transportation and locations. (Meepetchdee & Shah, 2007) To dig deeper into the SDC, the supply chain has to be explained further. The supply chain can be divided in two basic integrated processes: (1) the Production Planning and Inventory Control Process and (2) the

Distribution and Logistics Process (Beamon, 1998). The term production planning is about the design of the manufacturing process in whole (manufacturing process design and material handling design)(Beamon, 1998). Figure 2 is inserted to give an overview of these processes with an example of a design element in a relation to the supply chain.

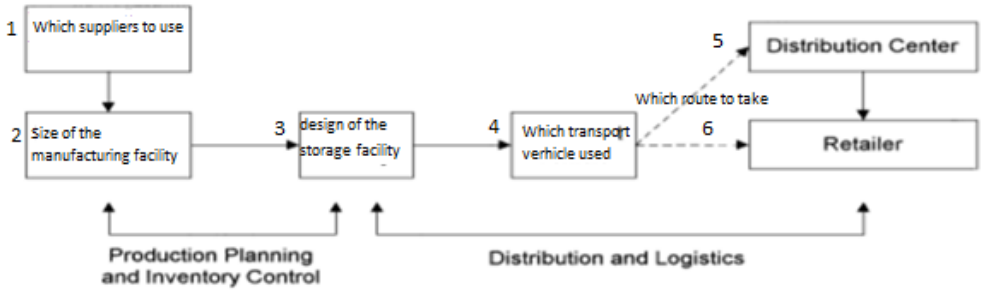

Figure 3. The supply chain design process altered version original from Beamon, 1998

In these two processes one can detect parts of supply chain design. The SCD elements in the first process, the Production Planning and Inventory Control, are:

(I) * storage policy design

This element describes the design of storage policies for raw materials, products that are in process, which means that they are not raw materials but also not final products and it describes the storage policies of final products. This part can be seen in the third column of the figure.

(II) * manufacturing process design (Beamon, 1998).

This elements describes the design of the manufacturing process which includes the acquisition of raw materials and how the materials should be handled and controlled (Beamon, 1998). This element can be found in the first and second column of the figure.

These are the elements of design in this first stage of the supply chain processes. Specific questions in relation with (II) storage policy design are questions about

*(1)storage capacity

*(2)access to storage locations within the facility and

*(3)complexity of the internal structure (Manzini, 2012)

(1)Storage capacity is purely about how many products can be fitted in a warehouse. This can be altered by building bigger warehouses or by storing more efficiently. A manner to store more efficiently is by implementing storage racks if they are not already present in a warehouse or by making the storage racks as high as the ceiling allows it. Another way of storing more efficiently is by altering the floor plan. If aisles are wider than necessary then this will have an influence on the efficiency. If the aisles are made less wide, then more racks can be fitted which increases the capacity.(2) Access to storage locations within a facility has to do with the ground plan or with how products are placed in the assigned space. For example if a pallet is needed from the third story of storage rack, the accessibility is influenced by the pallets on the floor. If these pallets are standing not exactly under the rack but a little outside of it, it will be hard for a [3]reach truck driver to gain access to the required pallet. Another example of accessibility is related to the ground plan. The products will be stored in aisles if there are multiple products in the same aisle and they have to be accessed almost simultaneously this will lead to a congestion and has as result that the accessibility worsens. (3) The complexity of the internal structure is related to different sorts of products a warehouse contains and the grouping of this products. For example a grocery warehouse that

[3] A reach truck is kind of fork lift used often in warehouses.

contains three temperature classes an ambient, cooled and frozen class. The products stored in each zone cannot be stored in another zone and results in more complex structure (Mazini,2012).

Specific questions with relation to (II)manufacturing process design are question about:

* (1) the manufacturing process
*(2) the material handling

(1) The manufacturing process has many facets. The processes are dependent of the product that is being manufactured. In the food industry there will be other sorts of processes than in the automotive industry. For instance in the automotive industry one will face processes as grinding, melting, casting and coating (National Research Council, 1991). None of these processes are represented in a food manufacturing process. Questions a business has to keep in mind when designing this specific part of the supply chain are: what are we producing?, which processes are we using? It may very well be that one facility produces only in process products and that these products are then shipped to another facility where they are manufactured in final products. Another part of the manufacturing process is raw material acquisition. In this part there is a thin line between operations and design but there are design elements present. There will be policies about the raw material acquisition. These policies are design elements and how these policies are executed is operations. These policies can describe between which hours the materials can be ordered, where they can be ordered and the quantity that can be ordered.
(2) Material handling is about the movement of products within a building or between a building and a transportation vehicle(Fawcett, Ellram & Ogden, 2014). This can be done in a automated manner or in a manual manner. For example, there are automated order picking systems. These systems assemble the order automatically, thus without human interference. There are also many businesses that pick order by hand, like the Hanos[4]. It is also possible to pick the products with a forklift, these are all forms of material handling. Material handling also encompasses the deliberation of the protection and control of products throughout the processes. Design questions in relation to material handling are: will the processes be automated?, is this way of handling in best interest to the condition of our products?

The second process is the Distribution and Logistics Process, this process determines how products are retrieved and transported from the warehouse to retailers (Beamon, 1998). Supply chain design in part of the supply chain processes are:

- The chosen transportation vehicle, this can be found in the fourth column of the figure
- The chain a product has to follow; the product can either be transported via a DC or to the retailers directly from the production facility. This can be found in the fifth and sixth column of the figure.
- The locations of centres and facilities, this can be found in the second and third column.

The chosen transportation vehicle depends on the distance, the flexibility and how concerned a business is with the environment. Small distances are most likely to be transported by lorry, but large distances can be done multiple ways. Large distances can be covered by airplane, train or boat. Where the airplane is the most polluting mode of transportation but also the fastest and provides thereby the biggest flexibility. Trains are generally still faster than boats and the least polluting of them all. Boats have as big advantage that they can carry a lot of cargo but as disadvantage that they are slow (Freighthub, 2018). These boats that carry a lot of cargo have as downside that they can only dock at a large port like Rotterdam or Hamburg. Then there is also inland shipping. These boats can access the inland through rivers and are capable of moving big cargos compared to lorries. Questions of designing this part can be: How fast do the products have to be delivered? How important is the flexibility? And how important is the environment in considering the transportation vehicle? What way of transportation costs the least?

[4] Hanos is a wholesaler in the foodsector

The chain a product has to follow is about routing: will the product be transported to retailers directly or via a distribution centre. Reasons to use a distribution centre instead of transporting directly to the retailer can be to use the transportation vehicle as efficiently as possible. There is the possibility that when transporting from the manufacturing facility to the retailer the transportation vehicle's loading capacity wouldn't be fully used. A DC will require more products than a retailer and thereby the chances of the vehicle being loaded optimally increases. Usage of DCs can also increase the flexibility whereas most of the time these facilities are located closer by retailers than the manufacturing facility and thereby decreases the transportation time(Fawcett, Ellram & Ogden, 2014). A big reason to transport directly from manufacturing facility to retailer is to reduce costs. A DC costs money and this can be eliminated by transporting directly.
The location of facilities and DCs are related to costs, accessibility, and flexibility. The smaller the distances between retailers, facilities and DCs the lower the costs are and most often the higher the flexibility is. Accessibility is concerned with how easy it is to reach the facility or DC. For example a DC that is located next to a highway has great accessibility if there is little congestions on that highway, but a DC located in the middle of a urban area will be less easy to access.
Thus the supply chain design has to do with the outline of the processes, location and mode of transportation. The above given examples are just a few examples, in order to paint a picture about the concept of supply chain design.

4.3 What are the changes in the supply chain design between businesses in the food sector of the past two decades?

4.3.1 General developments

The last two decades the economy has attained a global character. Communication has become easier and faster due to applications like e-mail. It's faster than sending a letter and takes less planning than making a telephone call across different time zones. The modern global economy has developed interconnected and complex supply chains. This is in large part due to the benefits companies have found in sophisticated trends and strategies such as global outsourcing, supply base rationalisation and just-in-time deliveries (Jabbarzadeh, 2018). Outsourcing, supply base rationalisation and just-in-time deliveries will be explained and discussed paragraph 4.3.3; the manufacturing process.
With the rapid development of innovative technologies, supply chain management generates a huge volume of data in different formats under various business scenarios. Big data, characterized with volume, variety, velocity, veracity, and value, has already been proven to be beneficial for forward supply chain management (Jabbarzadeh, 2018). The supply chain design develops in accordance with the changes in the supply chain. By optimizing the supply chain in developing ties with both customers and suppliers businesses can create significant benefits in the form of smaller inventories, reduced costs and improved response time (Melnyk, Narasimhan & DeCampos, 2014).
Supply chain design decisions are characterised by complexity , which is further complicated by the environment becoming increasingly turbulent. For these reasons, the assessment of supply chain design changes often reveals "hidden cost" and unexpected complexities, challenging the foundation of realized supply chain design changes. In addition, high supply chain complexity is associated with negative performance impact(Asmussen ,Kristensen & Waehrens, 2017).

In the food-sector the focus of consumers shifts to fresh and more value-added ready-to-eat products which has resulted in a significantly increased product variety (Grunow & van der Vorst, 2010). The shift to more fresh products has consequences for the design of the supply chain. To deliver the products as fresh as possible, transport time has to be reduced and this can be done by placing the locations of warehouses and stores as optimal as possible. To do this a business can use operations research. This problem is the same as the facility location problem only with a few other constraints. An extra constraint is minimizing transport time and time in storage. At the base of this fresh food supply chain (agriculture and dairy production), things tend to stay the same.

Characteristics of these businesses are that they are often family businesses where control stays within the family through the years (Touboulic, Matthews and Marques, 2018). This results in less flexibility upstream of the supply chain. These family owned businesses will not be closed or relocated as easily as a corporate owned business. Thus redesigning the supply chain at this part will be more difficult. A company anticipated to the shift to more fresh and ready to eat products is Albert Heijn[5]. Albert Heijn has introduced a food box where all the fresh ingredients are present to make a meal. These boxes are delivered as a whole to the store. These boxes are made up stream in the supply chain. The design of the supply chain has to be altered to this new product, because usually vegetables and meat are shipped separately to the stores.

4.3.2 Storage policy design

Due to developments in worldwide supply chains, design elements such as location of warehouses and the mode of transportation changes, this has a direct impact on both subprocesses (I) storage policy design and (II) manufacturing process design (Jabbarzadeh, 2018)(Beamon, 1998)(Fawcett et al., 2014). The fact that locations change due to the globalisation has an direct impact on storage policy design. The distances can get larger and perhaps it is wise to keep more inventory or design the storage facilities another way so that certain products are closer to a manufacturing facility. Due to the increasing distances between facilities the mode of transportation changes. When distances get larger it is common to use transport by air or by boat instead of by lorry. If one chooses to do transport by boat or airplane, then it can be beneficial to locate a warehouse close by the airport or harbour. An example of locating the facilities alternately is Apple. Apple is a great example of a worldwide supply chain and has facilities in China whilst the company is American.
The next part of figure 2 to be discussed is element 3 and that element is about storage. Especially in the food sector refrigeration is important to maintain the quality and safety of the products and enable this food to be supplied to the urbanised world (Meneghetti& Monti, 2014) This refrigeration of food products uses an estimated 15% of all electricity consumed world wide (Meneghetti & Monti, 2016). Due to increasing energy costs and the role of power generation in environmental pollution, businesses are seeking for energy efficiency to pursue a sustainable supply chain (Meneghetti & Monti, 2016). During the last decades, automated storage and retrieval systems (AS/RS) have been seen as facilitating sustainability. The most basic configuration involves aisle captive cranes serving unit load racks with single or multiple depth and completely unmanned operations (Meneghetti & Monti, 2014). These systems are able to store stock more densely than the standard warehouses and makes the storage more efficiently by eliminating the need for energy to cool, light and ventilate extra warehousing room (Meneghetti & Monti, 2016). These AS/RS are the major development in storage facilities, these systems are able to use the capacity of a facility more optimal than traditional systems, and don't need human interference with also leads to less labour costs. Another technology used in the supply chain is the use of RFID tags, that follow products around the supply chain. The tags carry exact information about the product and that way the quality and safety of the products can be maintained (Fawcett et al., 2014)

4.3.3 Manufacturing process

The manufacturing process is affected by the globalisation also. The manufacturing can take place in another country due to lower (labour) costs and higher availability of materials. Other developments taking place in the manufacturing process are those mentioned first in paragraph 4.3.1 : outsourcing, supply base rationalisation and just-in-time. Outsourcing is the principle where a business gives up a part of the production process to another business and pay them to do that part. Usually motivation for this is cost driven, the other business can do it cheaper for you(Fawcett, Ellram & Ogden, 2014). Other motivation is that it takes specialized skills to do that part of the manufacturing process and another firm is better equipped to do that. Supply base rationalisation is the optimisation and

[5] Albert Heijn is a Dutch supermarket chain

prioritisation of a business's supply base and how to manage them. This in relation to the number of suppliers you have or the prices they charge you(Fawcett, Ellram & Ogden, 2014). Just-in-time delivery is the distribution tactic whereby goods are delivered when they are needed, which means that there are no stocks(Fawcett, Ellram & Ogden, 2014).
Further developments taking place in element 1 of figure 2: the supplier element, are mainly that suppliers are getting bigger and that suppliers have customers around the globe or vice versa; businesses use suppliers located around the globe, this is also the case in food supply chains (Busse et al. , 2016). As explained above the biggest reason driving suppliers around the globe are labour cost advantages in emerging countries, where most often raw materials are amply present and sustainability-related conditions are poor (green, social and ethical attributes within the supplier's operational processes)(Busse et al. , 2016)(Li et al., 2014). Whereas in the past sustainability was of low importance to buyers, nowadays due to the buyer's stakeholders who exercise pressure on buyers to manage their global supply chains in a socially environmentally responsible manner (Busse et al., 2016)(Li et al, 2014). This results in the phenomena where buyers select their supply base partly by the suppliers sustainability, which results in suppliers being more percipient to sustainability. When these sustainability conditions are met, this can foster a cooperation between supplier and buyer leading to a close relationship (Busse et al., 2016). Following element 1 is element 2 and that is the manufacturing process. Manufacturing activities have become more scattered around the world (Zhang, Luo & Huang, 2013). The manufacturing process has mainly developed the quantity and location of production. For example in the chemical industry, a business invested 1.8 billion USD into a Toluylen-Diiscynaat production site in Shanghai, doubling the production capacity (Baumgartner, Fuetterer & Thonemann, 2012). This is not single example, this happens in supply chains across industries even the food sector. So manufacturing facilities are getting bigger and scattered around the globe searching for the lowest production costs (Li et al., 2014) Manufacturers today do not necessarily do all the steps of the manufacturing process at a single manufacturing facility. Businesses often ship semi-finished products to another facility for further processing or sales (Zhang, Luo & Huang, 2013). A large part of the current manufacturing process is characterised by the practice of dissecting the manufacturing process in different parts and doing each part in a different geographical location with as goal to achieve a competitive edge. These different geographical locations have different comparative advantages, but these different locations make the supply chain more complex and demands more of the logistics (Zhang, Luo & Huang, 2013).

4.3.4 Distribution and logistics process

Logistics are element 4 of figure 2. The globalisation and slicing up the manufacturing process has resulted in a big increase in transportation volumes (Baumgartner, Fuetterer & Thonemann, 2012). In freight transportation there is an economies of scale in transportation quantities. For instance the freight rate between Europe and South America, decreases from 400 USD/m3 to 200 USD/m3 when transportation volume increases from 1000m3 to 10.000m3(Baumgartner, Fuetterer & Thonemann, 2012). The mode of transportation changes when distances get larger and one can use transport by air or by boat instead of by lorry. A supply chain that has not changed the mode of transportation is the dairy supply chain. This supply chain is still dominated by road transportation(Fathian, M. ,Jouzdani, J. ,Heydari, M. & Makui, A., 2016). Supply chains dominated by road transportation are battling the most with traffic congestion, especially food products with limited shelf life such as dairy and fresh food products. These products are transported by refrigerated vehicles and usually on a daily basis, thereby traffic congestion significantly affects both the transportation system and the businesses (Fathian et al., 2016). These problems are being solved by operations research by the use of computer programmes that use algorithms and meta-heuristics to calculate the most optimal planning (Fathian et al., 2016).

4.3.5 Emission and the environment

Another big topic in supply chain design is keeping in mind emission and pollution. In a world where the environment is becoming more of an issue every day, businesses are compelled to reduce their emission and on top of that are expected by consumers to consider the environment(Baud-Lavigne, Agard & Penz, 2012). Businesses are reacting to this expectation to reduce the environmental footprint of their supply chains to avoid damaging their brand value and to satisfy the customers who are conscious about the environment (Saif & Elhedhli, 2016). If environmental impact is considered in the supply chain design, then the term green supply chain design is used (Gestring, 2016). The general measure of environmental impact is carbon emission (CO2). But there are many more different gasses that have a bigger impact on the environment, these are gasses like: Methane, Nitrous and Sulphur hexafluoride. These gasses' impact are transferred to CO2 equivalents: CO2e(Gestring, 2016). Carbon dioxide (CO2), Methane (CH4), Nitrous (N2) and Sulphur hexafluoride (SF5) can be summarized as greenhouse gasses (GHG) At this moment in time, specialist are quite certain that these greenhouse gasses are the main cause of global warming. Multiple global businesses including IBM, Johnson&Johnson, and PepsiCo mandate their supplier to report or control their emissions (Saif & Elhedhli, 2016). Walmart for instance is taking control of its emission. Walmart had announced that they are on their way to reduce their emissions from its supply chain by 18 million tons (Saif & Elhedhli, 2016). UPS is an example of changing the design. UPS is investing heavily in electronic trucks and lorries. During december 2018 they have ordered 125 electric lorries. In American cities UPS is also using electric tricycles to deliver packages (Peters, 2018). These are investments and changes in the mode of transportation.

Pollution does not only exists in the form of atmospheric pollution, noise pollution, vibration, waste and accidents are other impacts of freight transport (Gestring, 2016). Reducing emission has an influence on SCD, distances have to be shorter, the mode of transportation can be altered and manufacturing facilities have to be up to governmental regulations. The strategic design of logistics networks deals mostly with the infrastructure and mode of transportation. By altering mode of transportation C02 emission can be reduced drastically. For example if goods are transported by airplanes first and now by train CO2 emission will drop significantly according to Gestring (2016). The downside of this change is that transportation duration increases and the flexibility of the supply chain decreases. The infrastructure is determined by the facility location problem as explained, this is a problem used in operations research. In this problem the number of facilities, the location and the capacity of an network are calculated (Gestring, 2016). It is possible to add constraints in that calculation to minimize the environmental impact and keep the costs as low as possible. But along with reducing the environmental impact comes big costs. The correlation between environmental impact and costs are shown in figure 3 and on a scale from 0 to 100, where 100 is to maximum amount possible and zero the lowest amount possible. The link of costs with the design is that when designing a supply chain one wants to keep the costs as low as possible, but in this case a balance has to be found between environmental impact and keeping the costs as low as possible.

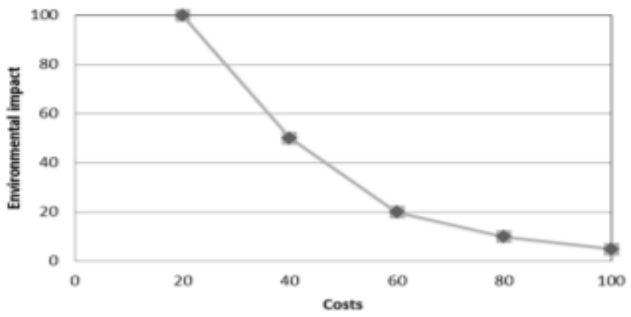

Figure 4 Trade-off between total costs and environmental impact (Gestring, 2016)

The developments above will be presented in table 4 in summarised manner and per element. The elements are the same as the paragraphs, so general developments, storage policy design etc. The new element in this table are the impacts of this developments on the specific supply chain design element.

Table 4 developments and impacts supply chain design specifically in the food sector

Element	Developments	Impacts
General developments	*1 In the food-sector the focus of consumers shifts to fresh and more value-added ready-to-eat products. *2 At the base of the fresh food supply chain often stand family businesses, where control stays within the family.	*1.1 This has resulted in a significantly increased product variety which adds complexity to the supply chain *1.2 Also to deliver the products as fresh as possible, transport time has to be reduced and this can be done by placing the locations of warehouses and stores as optimal as possible. *2. This results in less flexibility upstream of the supply chain.
Storage policy design	*1 During the last decades, automated storage and retrieval systems (AS/RS) have been implemented. These systems are able to store stock more densely and make the storage more efficiently by eliminating the need for energy to cool, light and ventilate extra warehousing room. *2 Another technology used in the supply chain is the use of RFID tags, that follow products around the supply chain. The tags carry exact information about the product.	*1 Lower energy costs and less environmental policy and thus a more sustainable supply chain. *2 Guaranties the quality and safety of the products by following the product and the environment of that product and brings more simplicity to the supply chain by not having the check the products itself in the supply chain but only data.
Manufacturing process	*1 Developments taking place in the supplier element of figure 2, are *Food suppliers are getting bigger *Food suppliers have customers around the globe. The biggest reason driving suppliers around the globe are (labour) cost advantages in emerging countries. *2 Sustainability becomes important due to the buyer's stakeholders who exercise pressure on buyers to manage their global supply chains in a socially environmentally responsible manner. *3 Manufacturing activities have become more scattered around the world. The manufacturing process has	*1.1 Less suppliers, but those are bigger, so dealing with less suppliers *2.1 This results in the phenomena where buyers select their supply base partly on basis of the suppliers sustainability *2.2. Results in suppliers being more percipient to sustainability. *2.3 When sustainability demands are met, this can foster a cooperation between supplier and buyer. *3.1 Larger distances between manufacturing facility and other facilities, which results in other kinds of transportations. *3.2 Bigger manufacturing facilities. *3.3 Lower manufacturing costs

	mainly developed the quantity and location of production.	
Distribution and logistics	*1 The dairy supply chain is still dominated by road transportation. Supply chains dominated by road transportation are battling with congestion. *2 The globalisation and slicing up the manufacturing process has resulted in a big increase in transportation volumes.	*1 Initiating manners to avoid traffic and congestions. *2 Using economies of scale to reduce transportation costs

Chapter 5 What are the changes in the supply chain operations between businesses in the food sector of the past two decades?

5.1 Introduction

In this chapter the supply chain operations will be discussed. The supply chain operations are just as the design a specific element of the supply chain. The operations and design go hand in hand, due to the fact that design is the outline of the supply chain and the operations are the planning, execution and control of the supply chain. First supply chain operations will be discussed further in paragraph 2, this will be done by dividing the supply chain in two processes. In paragraph 3 the developments in supply chain operations of the last twenty years will be discussed.

5.2 What is Supply Chain Operations?

Supply chain operation (SCO) is defined as:" *the planning, execution and control of the movement and placement of people and/or goods and of the supporting activities related to such movement and placement within an system organized to achieve specific objectives.''* (Gleissner & Femerling, 2013). Just as done in chapter 4 with supply chain design, we can divide SCO into two basic integrated processes: (1) the Production Planning and Inventory Control Process and (2) the Distribution and Logistics Process (Beamon, 1998). (1)The Production Planning and Inventory Control Process includes the sub- processes of manufacturing and storing. To be more specific, production planning describes the management of the whole manufacturing process. Production Planning includes:

- (1) scheduling and acquisition of (raw) materials
  This element describes the scheduling of raw materials and acquisition of materials in order to optimize production.
- (2) manufacturing process scheduling
  Manufacturing process scheduling is planning the different inputs in order to minimize the output time and costs and through that optimizing the manufacturing process (Argeneto et al. , 2008).
- (3)material handling control (Beamon, 1998).
  Material handling is about the movement of products within a building or between a building and a transportation vehicle as stated in chapter 4. Material handling control focusses on the movement of these products and if these movements are going as they should be.

These are the operations elements in this part of the supply chain. Specific questions related to (1)scheduling and acquisition of (raw) materials are questions about what kind of acquisition schedule is to be used. For example one can use the Just in Time principle (Fawcett, Ellram & Ogden, 2014). When JIT is used inventory levels are minimized and the flow of materials are synchronized. When one product leaves a particular part of the manufacturing process another product flows in just when the other flows out. This puts pressure on the scheduling of raw material acquisition, because one has to consider traffic congestions, quality control, food safety, price fluctuations and natural calamities these factors all have an impact on the availability of raw materials and these factors make the risk of production interruptions bigger. Usually organisations that use this principle carefully manage the inventory items, simplify product design, streamline production flows, work with fewer suppliers and pursue the development of information systems (Fawcett et al., 2014). Another example is the FIFO method, this method stands for first in first out (Wee & Widyadana

,2013). When using this method businesses still have inventory but the oldest inventory is sold first. This method is mostly used in industries where a inventory is desired, but the products also have an expiration date. A good example of such an industry is the supermarket industry.
(2) Manufacturing process scheduling is about planning human resources, machines and raw materials in such a manner that costs and time are minimized and that the output is as high as possible. Thus the goal is to work as efficiently as possible. The ability to manage the production capacity is one of the most key factors for a firm acting in a volatile demand sector to maintain long term success (Argeneto et al. 2008). Specific questions belonging to production planning or manufacturing process scheduling are questions about the amount of human resources per production unit. How much are we going to produce? Are we going to sell all that we have produced or are we going to have a buffer? Manufacturing process scheduling is not only operational as can be seen in the exemplary questions, it is also tactical. Keeping buffers and maybe not producing as much as possible are examples of tactical decisions. Not producing as much as possible can be thought of when there is lower demand and that's why one uses lower inputs to keep costs lower.
(3) Material handling control is about managing the materials going through the warehouse or DC (Fawcett et al,, 2014). These processes can be automated, manual or semi-automated as stated in chapter 4. Control systems of these flows can differ per sector and per manner of process. Control systems can be fully electronic, but can also be manual in the form of address number in racks and stickers on pallets corresponding to those numbers. The key in material handling control is that the right product is at the right place at the right time.

Inventory control describes:

- (4) the management of storage protocols for raw materials, work-in-process-inventories and final products (Beamon, 1998)

The management of storage protocols for raw materials, work-in-process- inventories and final products is about keeping the protocols up to date, according to government rules and seeing to the execution of these protocols. Specific products have specific protocols such as cooled products have to be stored no warmer than 10 degrees Celsius and can be removed from such a climate for a limited amount of time. Acids can't be exposed to most other products than they are used for. These products have to be in a secluded area. Managing these protocols means that they are really exercised. Specific questions about the management of storage protocols are: can these products be in the same area? Are the employees following these protocols? Is there anything missing is the protocols? Can the protocols be altered to be more efficient?

The second process (distribution and logistics) defines how products are transported from warehouse to supply chain partners (Beamon, 1998) The transportation can be transported directly to retailers or can be transported to distribution centres first and from there to retailers. This process encompasses the management of all transportation, retrieval, transportation to retailers and final product delivery (Beamon, 1998). To give an overview of these processes figure 3 is inserted.

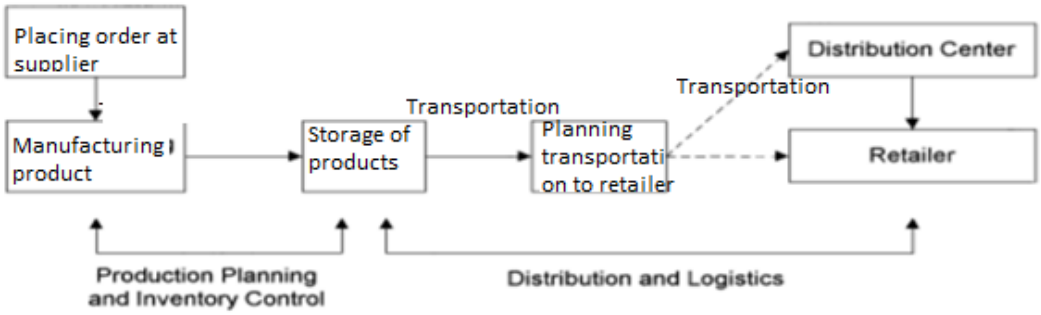

Figure 5. The supply chain operations process altered version, original from Beamon (1998)

There are multiple reasons to send the product via the DC (Fawcett et al, 2014).

- Optimal usage of capacity of transportation vehicle
- Retailer needs multiple products that can't be shipped directly
- Products have to be repackaged before send to the retailer.

Optimal usage of capacity of transportation vehicle has to do with the shipments to retailers. It is probable that a shipment to a store from a manufacturing facility won't fill the lorry to its optimal value. If the same lorry delivers a shipment from a manufacturing facility to a distribution centre it's probable that the lorry is filled to its optimal value due to the fact that a DC breaks down this shipments and sends it to multiple retailers. The same DC has multiple products and then it is possible to combine a route between retailers or fill the lorry with multiple products for the same retailer.
Specific questions relating to this process are which lorry are we going to use for this route? How many chauffeurs do we need this week? Is there any maintenance done on specific roads? In this process the goal is also to work as optimal as possible. The question which lorry are we going to use for which route has to do with mileage on the specific lorry and with the capacity of the lorry. It is desired to use to capacity of the lorry to its fullest. The question in relation with chauffeurs is about planning, because one does not want to use more man hours then necessary. The last question: is there any maintenance done on certain routes?, has to do with planning the route. Planners have to look if the road is still accessible and if there are any congestions around this road and if it is necessary to plan another route.

5.3 What are the changes in the in the supply chain operations between businesses in the food sector of the past two decades?

5.3.1 general developments

The globalisation does not only have an impact on the design of the supply chain, but also certainly on the operations of the supply chain. As stated in chapter 4 the last two decades the economy has attained a global character. The modern global economy has developed interconnected and complex supply chains (Jabbarzadeh, 2018). In the food sector Manning and Baines (2004) state that the globalisation has led to lower food prices and more choice for consumers. Manning and Baines (2004) also say that operating globally has led to increasing opportunities to increase the size of the market where a business is trading while simultaneously reducing operating costs. On the other hand there are also risks tied to globalisation, it is not so that one business is the only one fishing in a foreign pond, foreign businesses are also able to compete with a business in its domestic market. Globalisation has also led to an increase in global governance. An example of an international and

global governance institution is the World Trade Organization (WTO). This is the only global institution negotiating with countries to enhance the free market situation.

When a business is settled in multiple countries it is harder to use a centralized point of operation. The more decentralized points of decision making are established the more complex the data sharing and the operation becomes. It could be that different headquarters are making different decisions whilst being the same business. If different entities are compelled to react the same, this can lead to slower reactions in the market and leads to less flexibility. Due to the fast development of technologies, supply chain management produces a lot of data in different formats (Jabbarzadeh, 2018). This contributes also to the complexity of SCO because the data has to be analysed. If it is a lot of data it is hard to analyse it manually and due to the fact that some of the data is in other formats it is complex to use analytical software. The data has to be transformed in one format before analysing. The development of technology has mainly been a positive thing in SCO. The quick developments in computer technology are responsible for easier and quicker processing and communication but more on that in chapter 7.

5.3.2 Scheduling and acquisition of (raw) materials & the management of storage protocols.

The increase in global governance has showed itself in the complexity of institutions, global and local arrangements (Manning & Baines, 2004). This brings complexity to the SCO, managing different regulations across countries. The management of these regulations mean that one has to plan in advance to deal with customs, different time zones and different habits across countries and continents. This has led to developments in subprocesses 1 and 4. The first subprocess is scheduling and acquisition of (raw) materials, due to the fact that the economy attained a global character, materials can be bought around the globe. This has, as explained above, consequences dealing with customs and different time zones. This brings more complexity in the scheduling and acquisition of materials. The fourth subprocess is the management of storage protocols for raw, in progress and finished products. Organisations have to research if it is beneficial to store the raw materials acquired in a foreign land in a facility or to ship them directly to the manufacturing facility. Another issue are the regulations when trading overseas it could be wise to stock up on supplies, so that there are enough raw materials available for production. If a organisation is also selling finished goods overseas it could be wise to stock those products also in available facilities in stead of shipping them directly from the manufacturing facilities. The globalisation has consequences for all of these subprocesses.

5.3.3 Manufacturing process scheduling & material handling control

The second subprocess: manufacturing process scheduling develops differently in different industries. Production processes that are labour intensive will move to countries where labour is cheap, see Apple. Production processes that are capital intensive will move to production sites not necessarily cheap in labour but somewhere there is knowhow to maintain the production machines. It is quite common for businesses to move their production facility to the part of the world where the needed resource is amply present. The relocation is mainly supply chain design, but it can be linked with supply chain operations. By placing the facilities near the location where the needed input is amply present, the operations become less complex. The planning and scheduling simplifies due to the fact that transportation of these inputs is local instead of global. The third subprocess: material handling control changes with the change in mode of transportation. Due to the globalisation the mode of transportation changes accordingly. If products now are shipped by boat, products will most likely leave the facility in sea containers. This requires a different sort of loading than lorries, unless these lorries were already carrying these containers. The control systems used in the warehouses will have developed according new technologies like the internet and new software, but the products stored in a warehouse can alter due to the larger distances between warehouses

and it may be possible that one warehouse specializes in storing one product and another warehouse in another.

To get into more detail figure 4 will be used. If we look at figure 4 and take the first element: suppliers. We see that buying businesses are investing in supplier development. The buying firm then tries to improve either supplier performance, supplier capabilities or both and to meet the buying firm's short and or long term needs (Busse et al., 2016). Normally the focus of supplier development lays with economic performance and capabilities which relate to quality, cost and delivery (Busse et al., 2016). Buyers also try to develop the supplier's environmental and social goals. All of these supplier developments are for the buyers own interest (Busse et al., 2016). The economic goals are quite obvious and explained above; to meet the buyer's needs, but social and environmental development is also self-interested due to corporate social responsibility and the damage it can do when consumers feel that a business is not acting the right way. Element 2 of figure 4 is the manufacturing process. In the manufacturing process smart manufacturing systems (SMS) have been developed. These systems are enabled by the existence of new technologies that stimulate quick and widespread information flow within the systems (Jung, Morris, Lyons, Leong & Cho, 2015). Along with these systems comes the need of ability to respond to this information rapidly and effectively. It does mean that ongoing processes are disrupted due to this information. SMS need to be flexible and able to respond to situations by using precise data for smart decision-making as well as predicting and preventing failures (Jung et al., 2015). To maintain the quality of SMS it has to meet performance requirements where performance measures accurately and effectively establish targets and make sure that these targets are achieved (Jung et al., 2015). The main development in the second element of figure 4 is an automated manufacturing process that is able to predict failures and achieve performance goals.

5.3.4. Storage & transportation

The third element is the storage part of figure 4. As explained in chapter 4, the main developments have been made in storage technologies (Meneghetti & Monti, 2016). These storage technologies cut out human interference and can work more efficiently than traditional systems. The operation becomes automated or semiautomated. The biggest part of the operations are now to measure the performances of these automated or semi-automated systems and decide if they are the most optimal system available or if they need to shift to a new system. The fourth element is the transportation. The transportation element in operations is more often than not done by an intermediary (Lai, Ngai & Cheng, 2002). The goal of these transportation firms is to satisfy the customers in the chain with greater effectiveness and efficiency than the competitors (Lai, Ngai & Cheng , 2002). During the last two decades not a lot has changed in the transportation element, most of it is still outsourced and technology in transportation modes has not changed drastically. For the operation computer systems are used to calculate the most optimal planning as explained in chapter 4. Further internet based technologies have sparked a faster and easier way for businesses to make transportation arrangements and can be done even in an automated manner, due to technologies like EDI.

5.3.5 Corporate social responsibility and the environment

Another big issue that has developed the last twenty years, is the feeling that businesses have to take their responsibility. This is described as corporate social responsibility (CSR). CSR is a strategy to ensure that businesses keep in mind social and environmental concerns in their operations. Multinationals are being asked access to information which demonstrates the performance of a business against social and environmental measures (Manning & Baines, 2014). Take for example Apple and Nike, who both got slapped on the wrist due to the feeling of consumers that Apple and Nike were exploiting the local workforce to keep costs down. If consumers get this feeling this will affect a business's brand value. The impact the social and welfare regulations have on the costs and

competitiveness of businesses is large factor in the development of a global (food) market (Manning & Baines, 2014). CSR becomes increasingly important to consumers and corporations have to be responsive to this trend will they not lose brand value.

The environment and carbon emission do also play a big part in the developments and changes in the supply chain operations. Governments have agreed in multiple action plans and projects to reduce carbon emission and have made it their goal to make the global warming temperatures not rise more than two degrees before 2050 (He et al, 2016). Governments are bound to make regulations for businesses and consumers to be able to achieve this goals. Businesses are considering the environment because of two reasons:

*(1) Government regulations
*(2) Brand value

(1) The government regulations are made to protect the environment and to ensure that businesses are doing what is expected of them. The regulations are enforced through laws and inspections. Most of the times these regulations are about greenhouse gas emissions, pesticides and pollution.
(2) As stated above, consumers are increasingly aware of the environment and the impact of businesses on the environment. If a business knowingly pollutes or does nothing about it, chances are that these aware customers will shy away from these businesses, which in turn damages a business's brand value. A part of considering the environment by businesses is self-interest. Businesses are dealing with the environment in multiple ways. For example: Puma developed an approach where the environmental profit and loss were measured in the form of water use, greenhouse gas emissions, land use, air pollution and waste and this approach showed the costs of these measures (Scott, 2013). Puma's report showed that these measures costs about 145 million (Scott, 2013) Puma's idea with this approach is get to know the value of these eco-system services and if one knew the true value one could make well-chosen decisions about managing the environmental risks. Another example is the Rabobank, the Rabobank does not send paper account overviews anymore unless you opt in. This saves the Rabobank costs and is better for the environment because of the paper that is saved by doing it this way.
In table 5 the developments of SCO above will be discussed per Supply Chain Operation element. In the third column of this table the impact of the developments on the Supply Chain Operation element will be discussed.

Table 5 Developments and impacts supply chain operations specifically in the food sector

Element	Developments	Impacts
General developments	*1 The globalisation of the food sector. *2 Settlement of businesses in multiple countries..	*1.1 Increasing opportunities for businesses to increase the size of their markets while reducing operating costs. *1.2 There are risks for businesses, due to the fact that foreign businesses have access to the home market of other businesses due to the globalisation. *2.1 More difficulty establishing a central point of operation. This may lead to

		more decentralized points of decision making which makes data sharing and operation more complex. *2.2 Different headquarters can make different decisions, if they are compelled to make the same decisions, this can lead to less flexibility.
Scheduling and acquisition of (raw) materials & the management of storage protocols.	*1 The increase in global governance. *2 Procurement of products around the globe.	*1.1 Leads to more complexity of institutions, global and local arrangements. *1.2 Results in a more complex SCO due to managing different regulations across countries. *2.1 Having to plan more in advance to make sure that the products are received on time *2.2 Businesses now have to make the decision to store the product in the country where they bought it or transport it to the manufacturing country. *2.3 Keeping a stock to anticipate for different regulations, to keep enough materials for manufacturing
Manufacturing process scheduling & material handling control	*1 A phenomena where production moves to countries where the inputs needed cost the least. *2 Due to the globalisation the mode of transportation changes accordingly. If products now are shipped by boat, products will most likely leave the facility in sea containers. This requires a different sort of loading *3 We see that buying businesses are investing in supplier development. *4 In the manufacturing process smart manufacturing systems (SMS) have been developed. These systems are enabled by the existence of new technologies that stimulate quick and widespread information flow within the.	*1.1 Lower production costs, which enhances the competitiveness. *1.2 The planning and scheduling simplifies due to the fact that transportation of these inputs is local instead of global. *2.1 The control systems used in the warehouses have developed according new transportation modes and technologies like the internet and new software. *3.1 supplier performance, supplier capabilities or both improve. *3.2 Suppliers environmental and social goals also improve due to the buyers. *4.1 More efficient manufacturing process *4.2 Efficient performance measures have to be

		established for the SMS for it to know what to do.
Storage & transportation	*1 Developments in (semi) automated storage technologies. These storage technologies cut out human interference and can work more efficiently than traditional systems. *2 The transportation element in operations is more often than not done by an intermediary (Lai, Ngai & Cheng, 2002). *3 For the operation in logistics computer systems are used to calculate the most optimal planning . *4 Internet based technologies have sparked a faster and easier way for businesses to make transportation arrangements.	*1 Lower (labour) costs due to automation and the efficient work of these systems. But these systems do cost quite a lot to purchase. *2. Lower transportation costs, otherwise the businesses would do it itself. *3 More optimal utilisation of inputs (labour and capital) due to these computer programs. *4 Less hours needed to make transportation arrangements, thus cheaper and sometimes even without human interference (EDI).

Chapter 6 How has E-commerce changed the supply chain design and operations of businesses in the food sector?

6.1 Introduction

In chapter 3 E-commerce is explained in its broadest sense. In chapter 4 supply chain design and the way it has developed is discussed. In chapter 5 supply chain operations is discussed. In chapter 6 those three topics will be brought together. There is no denying that E-commerce has had an influence on the supply chain. In chapter 6 the explained developments in SCD and SCO will be presented and there will be a link made between this development and specific E-commerce technologies.

6.2 Recap one the E-commerce systems

Below table 6 were the three E-commerce systems will be presented in a summarised manner.

Table 6 Recap E-commerce

- (1) EDI
  - Closed system
  - Replaces postal mail, fax and email between supply chain partners
  - The data exchange is done in a automate computer-to-computer style

- (2) E-hubs
  - Electronic redistribution
  - Two kind of relationships
    - Spot sourcing (short term)
    - Systematic sourcing (long term)
  - Two type of inputs
    - Direct (directly used in production process)
    - Indirect (not used directly in production process)
  - Four types of E-hubs
    - MRO hubs
      - Indirect inputs
      - Systematic sourcing
    - Yield managers
      - Indirect inputs
      - Spot sourcing
    - Catalog hubs
      - Direct inputs
      - Systematic sourcing
    - Exchanges
      - Spot sourcing
      - Direct inputs

- (3) E-auctions
    - Electronic version of normal auction
    - Two types of auction most often used
        - Forward auction
            - Seller offering product, buyers bidding on it against each other in a upward fashion
        - Reverse auction
            - Buyer posting initial contract price, suppliers bid against each other in a downward fashion until the price floor is reached

6.3 Developments of the supply chain design in the food sector of the last twenty years.

This paragraph is a recap of the developments discussed in chapter 4. The developments will be presented the same manner as in chapter 4, so general developments, storage policy design, manufacturing process and distribution and logistics. The developments will be presented in a very summarised manner in table 7.

Table 7 developments of the supply chain design

General developments:

- The focus of consumers shifts to fresh and more value-added ready to eat products.
- At the base of the (fresh) food supply chain often stand family businesses, where control stays within the family.

Storage policy design developments:

- Automated storage and retrieval systems have been implemented
- The use of RFID tags

Manufacturing process developments:

- Suppliers are getting bigger
- Suppliers have customers around the world
- Sustainability becomes increasingly important
- The manufacturing process and its activities are becoming more scattered around the globe.

Distribution and logistics developments:

- Certain food supply chains like the dairy supply chain are still dominated by road transportation, these supply chains are mainly battling with increasing traffic and traffic congestions.
- The globalisation and slicing up the supply chain has resulted in a big increase in transportation volumes.

6.4 What part did the individual E-commerce technologies have in the developments of the supply chain design in the food sector?

In table 8 the developments in SCD will be discussed and the impact that EDI had on these development will be discussed.

Table 8 Influence of EDI on the developments in the supply chain design

Development	Logistical impact	Impact EDI on logistical impact
*1 During the last decades, automated storage and retrieval systems (AS/RS) have been implemented. *2 RFID tags being implemented	*1 Lower energy costs and less environmental pollution and thus a more sustainable supply chain. *2 Guaranties the quality and safety of the products by following the product and the environment of that product and brings more simplicity to the supply chain by not having the check the products itself in the supply chain but only data.	*1 EDI gives the AS/RS its information. EDI is thus responsible for the lower costs and less environmental pollution, due to the fact that EDI facilitates the AS/RS *2 EDI delivers the infrastructure for the information the RFID tags supplies. Therefore EDI contributes to the quality and safety of the products. And so brings EDI also more simplicity in guarantying the quality and safety of these products
Food suppliers are getting bigger Food suppliers have customers around the globe.	Less suppliers, but those are bigger, so dealing with less suppliers.	EDI makes it easier for businesses to exchange data and thereby facilitates this growth of the suppliers. It gives them a decent infrastructure to base this process on. It works the same with having customers around the globe. EDI makes it significantly easier to communicate with supply chain partners. In some EDI networks there are purchasing programs integrated which results in automate ordering. This automation makes it possible for suppliers to get very big without having to increase staff to process these orders.
Sustainability becomes increasingly important	This results in the phenomena where buyers select their supply base partly on basis of the suppliers sustainability Results in suppliers being more percipient to sustainability. When sustainability demands are met, this can foster a cooperation between supplier and buyer.	EDI does not have a impact on the process of supplier picking. If there arises a cooperation between buyer and supplier than the possibility of data interchange arises.
The manufacturing process and its activities are becoming more scattered around the globe.	Larger distances between manufacturing facility and other facilities, which	EDI facilitates the communication between these facilities and can deliver the

	results in other kinds of transportations. Bigger manufacturing facilities Lower manufacturing costs	information needed for shipping. EDI facilitates the growth of the manufacturing facilities by automating a big part of the buying processes and data interchange. By facilitating this all, EDI attributes to lower manufacturing costs.
Certain food supply chains like the dairy supply chain are still dominated by road transportation. The globalisation and slicing up the supply chain has resulted in a big increase in transportation volumes.	Initiating manners to avoid traffic and congestions. Using economies of scale to reduce transportation costs	EDI provides the infrastructure to exchange data like where lorries are driving now (GPS) to the computer of a transport planner. EDI provides the data needed for shipping.

In table 9 the developments in SCD in the food sector will be discussed and the impact of E-markets, E-Hubs and E-auctions on these developments will be described.

Table 9 Influence of E-hubs, E-markets and E-auctions on the developments in the supply chain design

Development	Logistical impact	Impact E-hubs, E-markets and E-auctions on logistical impact
During the last decades, automated storage and retrieval systems (AS/RS) have been implemented. RFID tags being implemented	*1 Lower energy costs and less environmental pollution and thus a more sustainable supply chain. *2 Guaranties the quality and safety of the products by following the product and the environment of that product and brings more simplicity to the supply chain by not having the check the products itself in the supply chain but only data.	Due to E-markets, E-hubs and E-auctions businesses have customers and suppliers around the world and due to that their network has increased. Therefore to work as efficiently as possible the AS/RS systems have been implemented. Which results in lower energy costs and less environmental pollution, but E-markets etc. have a very indirect impact on this logistical impacts. RFID tags are not introduced specifically due to E-markets, E-hubs and E-auctions. So the E-markets etc have no impact on these logistical impacts
Food suppliers are getting bigger Food suppliers have customers around the globe.	Less suppliers, but those are bigger, so dealing with less suppliers.	That suppliers are getting bigger can largely be attributed to E-markets, E-hubs and E-auctions. These online markets have made it easy to come in contact with buyers around the world and

		that has increased the network of suppliers drastically.
Sustainability becomes increasingly important	This results in the phenomena where buyers select their supply base partly on basis of the suppliers sustainability Results in suppliers being more percipient to sustainability. When sustainability demands are met, this can foster a cooperation between supplier and buyer.	Buyers find it more important that their suppliers are being sustainable. E-markets, E-hubs and E-auctions put more pressure on these suppliers to become more sustainable due to the fact that suppliers can quite easily switch from supplier. On the other side it is for buyers easy to search for suppliers due to these technologies and chances become greater to find sustainable suppliers.
The manufacturing process and its activities are becoming more scattered around the globe.	Larger distances between manufacturing facility and other facilities, which results in other kinds of transportations. Bigger manufacturing facilities Lower manufacturing costs	These E-commerce technologies play a big role in the globalisation of the manufacturing process. On these online markets inputs are offered including labour and it is quite easy to find the location with the lowest cost for a certain part of the manufacturing process. So these E-commerce technologies are partly responsible for the larger distances between facilities and the lower manufacturing costs.
Certain food supply chains like the dairy supply chain are still dominated by road transportation. The globalisation and slicing up the supply chain has resulted in a big increase in transportation volumes.	Initiating manners to avoid traffic and congestions. Using economies of scale to reduce transportation costs.	Partly due to these E-commerce technologies the globalisation and slicing up the supply chain has increased and is facilitated by these technologies and has resulted in a need to using economies of scale to reduce transportation costs.

6.5 Developments of the supply chain operations in the food sector of the last twenty years.

This paragraph is a recap of the developments discussed in chapter 5. The developments will be presented the same manner as in chapter 5, so general developments, scheduling and acquisition of (raw) materials & the management of storage protocols , manufacturing process scheduling and material handling control, storage and transportation and lastly corporate social responsibility and the environment. The developments will be presented in a very summarised manner.
General developments:

- The globalisation of the food sector.

- Settlement of businesses in multiple countries

Scheduling and acquisition of (raw) materials & the management of storage protocols developments:

- The increase in global governance.
- Procurement of products around the globe.

Manufacturing process scheduling & material handling control developments:

- A phenomena where production moves to countries where the inputs needed cost the least. Production processes that are labour intensive will move to countries where labour is cheap. Production processes that are capital intensive will move to production sites not necessarily cheap in labour but somewhere there is knowhow to maintain the production machines.
- Due to the globalisation the mode of transportation changes accordingly. If products now are shipped by boat, products will most likely leave the facility in sea containers. This requires a different sort of loading
- We see that buying businesses are investing in supplier development.
- In the manufacturing process smart manufacturing systems (SMS) have been developed. These systems are enabled by the existence of new technologies that stimulate quick and widespread information flow within the chain.

Storage and transportation developments

- Developments in (semi) automated storage technologies. These storage technologies cut out human interference and can work more efficiently than traditional systems.
- The transportation element in operations is more often than not done by an intermediary (Lai, Ngai & Cheng, 2002).
- For the operation in logistics computer systems are used to calculate the most optimal planning .
- Internet based technologies have sparked a faster and easier way for businesses to make transportation arrangements.

Corporate social responsibility and the environment

- Consumers feel that businesses have to take responsibility for sustainability (CSR).
- Government regulations to insure that businesses live up to environmental agreements.

6.6 What part do the individual E-commerce technologies have in the developments of the supply chain operations in the food sector?

This question will be answered in table 10 and 11 by presenting the development and explaining the impact of the E-commerce technology and this development. In table 10 the impact of EDI will be discussed and in table 11 the impact of E-hubs, E-markets and E-auctions will be discussed.

Table 10 Influence of EDI on the developments in the supply chain operations

Development	Logistical impact	Impact EDI on logistical impact
*1 The globalisation of the food sector. *2 Settlement of businesses in multiple countries	*1.1 Increasing opportunities for businesses to increase the size of their markets while reducing operating costs. *1.2 There are risks for businesses, due to the fact that foreign businesses	*1 EDI does have the same impact here as with the SCD, namely: that EDI facilitates the globalisation making it possible for businesses to operate in different time zones. EDI interchanges the data automatically so it is accessible

	have access to the home market of other businesses due to the globalisation. *2.1 More difficulty establishing a central point of operation. This may lead to more decentralized points of decision making which makes data sharing and operation more complex. *2.2 Different headquarters can make different decisions, if they are compelled to make the same decisions, this can lead to less flexibility.	whenever the data is interchanged without needing someone at another facility to authorize it. So by facilitating globalisation EDI plays a part in increasing opportunities for businesses and reducing their operating costs. But along with these opportunities comes risks in the form of foreign competition. *2 EDI makes it easier for businesses to use decentralized points of decision making by having the same data available for all decision points
*1 The increase in global governance. *2 Procurement of products around the globe.	*1.1 Leads to more complexity of institutions, global and local arrangements. *1.2 Results in a more complex SCO due to managing different regulations across countries. *2.1 Having to plan more in advance to make sure that the products are received on time *2.2 Businesses now have to make the decision to store the product in the country where they bought it or transport it to the manufacturing country. *2.3 Keeping a stock to anticipate for different regulations, to keep enough materials for manufacturing	*1 EDI does not have a notable impact on this development. *2 EDI facilitates the data sharing belonging to the planning of the shipment of these products and thus contributes to simplifying this process.
*1 Relocation of production sites *2 Change in mode of transportation	*1.1 Lower production costs, which enhances the competitiveness. *1.2 The planning and scheduling simplifies due to the fact that transportation of these	*1 On the phenomena itself EDI has relatively less impact. But it makes it easier for the businesses to do so. Due to the fact that interchanging data is a lot easier with EDI. EDI attributes by simplifying and making it able

*3 We see that buying businesses are investing in supplier development. *4 Development of smart manufacturing systems (SMS) *5 Developments in (semi) automated storage technologies. *6 The transportation element in operations is more often than not done by an intermediary. *7 For the operation in logistics computer systems are used to calculate the most optimal planning. *8 Internet based technologies have sparked a faster and easier way for businesses to make transportation arrangements.	inputs is local instead of global. *2.1 The control systems used in the warehouses have developed according new transportation modes and technologies like the internet and new software. *3.1 supplier performance, supplier capabilities or both improve. *3.2 Suppliers environmental and social goals also improve due to the buyers. *4.1 More efficient manufacturing process *4.2 Efficient performance measures have to be established for the SMS for it to know what to do. *5 Lower (labour) costs due to automation and the efficient work of these systems. But these systems do cost quite a lot to purchase. *6. Lower transportation costs, otherwise the businesses would do it itself. *7 More optimal utilisation of inputs (labour and capital) due to these computer programs. *8 Less hours needed to make transportation arrangements, thus cheaper and sometimes even without human interference (EDI).	to operate in multiple countries to lower production costs. *2 EDI facilitates the information needed for the transportation and the control systems so again it facilitates the development. *3 EDI does not have an impact on the supplier performance. *4 This is an example of an EDI system, so EDI has full impact on this development. The EDI infrastructure makes it possible to add this kind of application. And thus is responsible for a more efficient manufacturing process. *5 In the developments of automated storage technologies EDI plays also a significant role. Without EDI these systems would not have the information needed to process orders and supplies. EDI is thus responsible for lower labour costs due to automation and the efficiency. *6 If the intermediary is included in the supply chain and granted access to the applications and technologies , then EDI plays again a role. It gives the intermediary the necessary information, like orders, quantities and dates. On the lower transportation costs EDI does not have an influence. *7 These programs are not a result of EDI. So EDI does not have an impact. *8 If this arrangements and information are shared via EDI, than EDI is responsible for lower costs and less time. But only if this is automated.

Table 11 Influence of E-hubs, E-markets and E-auctions on the developments in the supply chain operations

Development		Impact
*1 The globalisation of the food sector. *2 Settlement of businesses in multiple countries	*1.1 Increasing opportunities for businesses to increase the size of their markets while reducing operating costs. *1.2 There are risks for businesses, due to the fact that foreign businesses have access to the home market of other businesses due to the globalisation. *2.1 More difficulty establishing a central point of operation. This may lead to more decentralized points of decision making which makes data sharing and operation more complex. *2.2 Different headquarters can make different decisions, if they are compelled to make the same decisions, this can lead to less flexibility.	*1 E-hubs etcetera play a significant role in this development. Due to these technologies businesses can sell their product via these technologies and reach more customers and can buy cheaper products via these technologies and reduce costs. These technologies bring along foreign competition and thus also risks. *2 E-hubs etcetera does not have an impact on this development.
*1 The increase in global governance. *2 Procurement of products around the globe.	*1.1 Leads to more complexity of institutions, global and local arrangements. *1.2 Results in a more complex SCO due to managing different regulations across countries. *2.1 Having to plan more in advance to make sure that the products are received on time *2.2 Businesses now have to make the decision to store the product in the country where they bought it or transport it to the manufacturing country. *2.3 Keeping a stock to anticipate for different regulations, to keep enough materials for manufacturing	*1 E-hubs and the other technologies don't have a notable role in the increasing global governance and the complexity that brings. *2 On the procurement of products these technologies play a big role. Products from all over the world are being adverted on the online marketplaces and buyers from all over the world are buying them. The logistical impacts that this development brings along is not impacted by E-hubs and the other technologies.
*1 Relocation of production sites *2 Change in mode of transportation	*1.1 Lower production costs, which enhances the competitiveness. *1.2 The planning and scheduling simplifies due to the fact that transportation of	*1 These technologies are making it easier for businesses to find the places where the costs of the needed production inputs are the lowest. *2 These online marketplaces and auctions makes it also easier to find transportation businesses that can

*3 We see that buying businesses are investing in supplier development. *4 Development of smart manufacturing systems (SMS) *5 Developments in (semi) automated storage technologies. *6 The transportation element in operations is more often than not done by an intermediary. *7 For the operation in logistics computer systems are used to calculate the most optimal planning. *8 Internet based technologies have sparked a faster and easier way for businesses to make transportation arrangements.	these inputs is local instead of global. *2.1 The control systems used in the warehouses have developed according new transportation modes and technologies like the internet and new software. *3.1 supplier performance, supplier capabilities or both improve. *3.2 Suppliers environmental and social goals also improve due to the buyers. *4.1 More efficient manufacturing process *4.2 Efficient performance measures have to be established for the SMS for it to know what to do. *5 Lower (labour) costs due to automation and the efficient work of these systems. But these systems do cost quite a lot to purchase. *6. Lower transportation costs, otherwise the businesses would do it itself. *7 More optimal utilisation of inputs (labour and capital) due to these computer programs. *8 Less hours needed to make transportation arrangements, thus cheaper and sometimes even without human interference (EDI).	handle the new kind of transportation. But the logistical impact is not impacted by E-hubs, E-auctions and E-markets. *3 Nothing to do with E-markets *4 No impact of E-markets *5 No impact *6 This can also be attributed to the online technologies. It makes it very easy for a business to find a transportation company that is able to do the transport and on top of that it is easy to compare them with each other. Which results in lower transportation costs due to these technologies. *7 No impact *8 No impact

Chapter 7 Conclusion and Discussion

7.1 Conclusion

This thesis has distinguished three main elements:

- E-commerce
- Supply chain design
- Supply chain operations

In the thesis the relation between E-commerce and supply chain design was researched and the relation between E-commerce and supply chain operation was researched.

These elements were researched further at which there was a framework build to answer the research question. The sub elements per main element are:

- E-commerce
  - EDI
  - E-hubs
  - E-auctions
  - E-markets
- Supply chain design
  - Storage policy design
  - Manufacturing process design
  - Distribution and logistical design
- Supply chain operations
  - Scheduling and acquisition of (raw) materials & the management of storage protocols
  - Manufacturing process scheduling and material handling control
  - Storage and transportation

On the basis of these sub elements the developments per element were researched and described. To answer the main question: *"What have been the effects of E-commerce on the logistical structure in Business to Business supply chain in the food sector?"*, table 12 is introduced. This table shows the developments in supply chain design and supply chain operations and marks the E-commerce technology that has influenced this development.

Tabel 12 Overview developments and technologies

Developments SCD	EDI	E-hubs, E-markets and E-auctions	Developments SCO	EDI	E-hubs, E-markets and E-auctions
Automated storage and retrieval systems have been implemented	X	(X)	The globalisation of the food sector.	X	X
The use of RFID tags	X		Settlement of businesses in multiple countries	X	
Suppliers are getting bigger	X	X	The increase in global governance.		
Suppliers have customers around the world	X	X	Procurement of products around the globe.		X
Sustainability becomes increasingly important		X			
The manufacturing process and its activities are becoming more scattered around the globe.	X	X			
Certain supply chains are mainly battling with increasing traffic and traffic congestions.	X		Relocation of production sites	X	X
			Change in mode of transportation	X	X
The globalisation and slicing up the supply chain has resulted in a big increase in transportation volumes.	X	X	We see that buying businesses are investing in supplier development.		

			Development of smart manufacturing systems (SMS) Developments in (semi) automated storage technologies. The transportation element in done by an intermediary. For the operation in logistics computer systems are used to calculate the most optimal planning. Internet based technologies have sparked a faster and easier way for businesses to make transportation arrangements.	X X (X) X	X

So to answer the main question: : *"What have been the effects of E-commerce on the logistical structure in Business to Business supply chain in the food sector?"* E-commerce in the broadest sense has effected every single development in the supply chain design and in supply chain operation almost every development. The most notable influences of E-commerce are that it facilitates the globalisation of the production process and facilitates the automation of the production process and that it causes more efficiency. EDI makes it able to interchange data globally without interruption and human interference. E-hubs, E-auction and E-markets make it able for businesses to find suppliers with the lowest prices and makes it attractive for businesses to locate the production facility nearby this supplier. EDI also makes it possible for businesses to automate the acquisition process and production process in the form of smart manufacturing systems and an automated buying processes. These smart manufacturing systems and automated storage and retrieval systems have as a result that it increases efficiency. It can be concluded that E-commerce attributes to globalisation, automation and efficiency in production and storage.

7.2 Discussion

This thesis has researched the effects of E-commerce on the changes in the supply chain. There has been much written about E-commerce and retail, but not many papers about business to business E-commerce in relation to the supply chain. The same can be said about the supply chain, there is much written about supply chain (management) and the developments of this topic, but there are not many papers which dissect the supply chain in this detail and in relation with B2B E-commerce. This thesis gives insights in how E-commerce effects the supply chain, in design and operations. This is a subject not researched by many and is an attribution to the research about E-commerce and the supply chain in the food sector. For future research it can be interesting to collect data from businesses itself and see numbers collected with quantitative research. This thesis is most often based on peer reviewed articles and the links made between the developments in the supply chain and the developments in the E-commerce technique could be supported more by real data. Especially because this is quite new ground. The developments in the supply chain and the developments of the E-commerce technologies are quite well documented, but the specific influence the E-commerce technologies have on the supply chain developments are not that well documented.

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