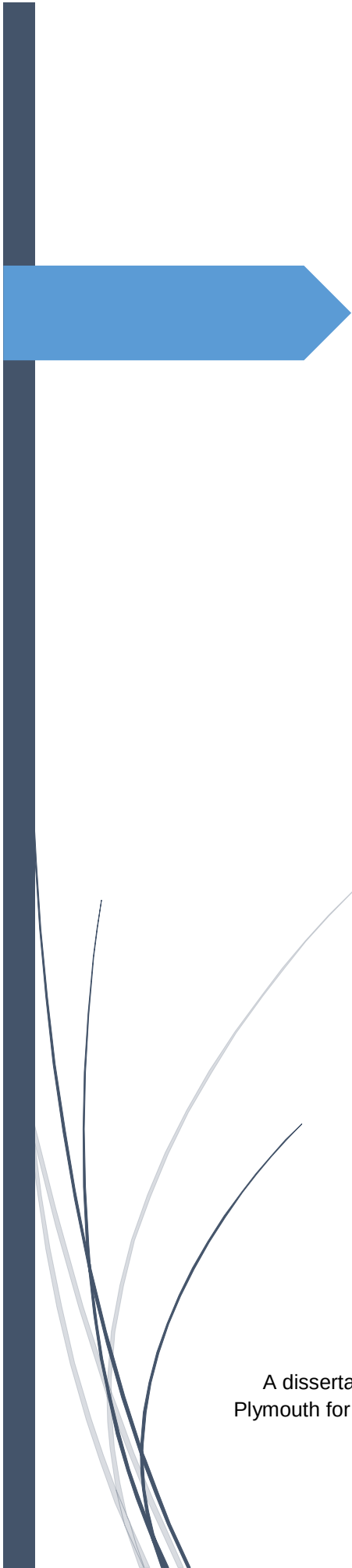




The impact of Internet of Things on Fresh Food Supply Chain visibility

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SEPTEMBER 2016

A dissertation submitted in partial fulfilment of the requirements of the University of Plymouth for the degree of Master of Science (MSc) in International Logistics and Supply Chain Management.

FACULTY OF BUSINESS WITH PLYMOUTH UNIVERSITY

- The impact of Internet of Things on Fresh Food Supply Chain visibility -

Master of Science International Logistics and Supply Chain Management

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Word count	14.611 words

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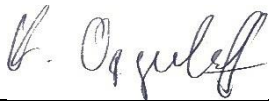
This is to declare that the present work titled “*The impact of Internet of Things on Fresh Food Supply Chain visibility*” was fully carried out and submitted to the Plymouth Post Graduate Business School, University of Plymouth, U.K. by the MSc student Hendrik Opgenhoff.

Herewith I confirm that this thesis is my own work, which was written without unauthorized assistance and that all references used are marked appropriately.

I, Hendrik Opgenhoff (10540889), declare that I am the sole author of this dissertation.

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Date



08.09.2016

Dr. Irina Neaga - Signature

Date



08.09.2016

Acknowledgements

This research is the final step of my Master of Science in International Logistics and Supply Chain Management. Therefore, I would like to thank everybody who supported me during the whole master degree, along Fontys International Business School in Venlo and Plymouth University.

Besides that, a special thanks to Dr. Irina Neaga who supervised me. She was available for questions every time and supported me during the whole process. She helped me from the very beginning until the very end.

Further, I would like to thank all participants of the research. Everybody who answered questions, shared thoughts, was open for a discussion, gave me a heads up for an interesting link or anything else which created more value for my dissertation.

Last but not least, I would like to thank my family and friends who supported me during the research process and guided me during my master degree.

Hendrik Opgenhoff

September 2016

Abstract

Background: Food becomes a more and more important topic in the daily life. Several food aspects like sustainability, health or transparency become more and more important and the customer emphasises this more and more. The market of fresh food is a fast moving, rarely predictable and very competitive market. Therefore, the importance of the visibility among the fresh food supply chain increases, since it offers more transparency for the customer and less uncertainty for companies among the chain.

Purpose: This research outlines the impact the Internet of Things has on the fresh food supply chain visibility. Therefore, the differences between a fresh food and a regular supply chain as well as the management of a supply chain are discussed. Additionally, a link to the Internet of Things is made.

Methodology: The research adopts the epistemology interpretivism and a critical realist ontology, which includes an objective view. The research methodology is mostly inductive with a qualitative driven mixed research approach. Data collection is primary and qualitative, based on a group interview and observations, supported by secondary qualitative data.

Findings: The analysis shows that the Internet of Things can have a huge impact on the fresh food supply chain visibility. The market of fresh food goods provides a basic structure the Internet of Things can improve. The result would be a more efficient and faster supply chain with less waste of time and resources. However, it might take some time until a successful implementation can be done. Restructuring only one company would have less affect than restructuring a whole supply chain, which is unlikely at the current state of Internet of Things.

Originality/Value: Due to the novelty of the Internet of Things, this study cannot provide a generalizable solution. However, it points out the practical usage of Internet of Things in the fresh food industry and considers the applicability of the technology. Therefore, it provides new insight into a less considered industry in regards to Internet of things. The research can offer a background for further, deeper research in this industry.

Keywords: Internet of Things, Fresh Food Supply Chain visibility, Supply Chain Management

Paper type: Master's dissertation

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List of abbreviations

3PL	Third Party Logistics
FFI	Fresh Food Industry
FFSC	Fresh Food Supply Chain
FFSCV	Fresh Food Supply Chain Visibility
IoT	Internet of Things
IT	Information Technology
Lbs	American pounds
SC	Supply Chain
SCV	Supply Chain Visibility

1 Introduction

The introduction provides an overview related to the research background, the company X used in order to demonstrate the research, and data collection, the aim, and objectives of the research. It also justifies the research, discusses the limitation and provides an overview of the structure of the report.

2 Background

There are several reasons why food becomes more and more important in everybody's daily life and why the importance of food production in general will rise in the future. First, people need to eat to survive. "Hunger and thirst" emerge leads to those basic physiological motives (Gabbott, 2008). Further, Alvensleben (1998) points out that the choice of food can depend on safety, diet, functionality and other health aspects. Also, social motives like friendship, religion or social norms affect the consumption of food. Based on this, food or food producer need to meet more and more demands to satisfy their customers demand. Additionally, the total amount of needed food will rise, hence the total world population is estimated to increase to 9.7 billion until 2050 (DESA, 2015). That means, food production must double until 2050 (United Nations, 2009).

The customer's awareness for food products recently increased (Jevšnik et al., 2008). The above mentioned physiological aspects are not the only reasons for the change. More and more elucidation about food borne diseases, like E. coli or salmonella and recent food scandals rise the customer awareness (Plaggenhoef, 2007). Well known food scandals are BSE, dioxin crisis or the recent horse meat scandal. The spread of such risks of food via media has a huge influence on customer's awareness, too.

Based on those developments, the customers are more demanding in regards to the food they consume (Morrison, 2016). They want to know where the food is coming from, how animals were treated, how the food was handled and what ingredients it contains (Morrison, 2016). Therefore, companies among the Fresh Food Supply Chain (FFSC) need to become more visible. Not only to the customers (Xie, 2015), but also to other companies among the supply chain (SC), hence they want to know what the customer receive and they need the information to ensure the quality of the product (Fair, 2016).

The impact of IoT on FFSCV

Sharing a large amount of information with companies and customers, which might be all over the world is not easy to do. However, IT can help to achieve a high degree of information sharing (Peng et al., 2016; Tseng et al., 2011). Zuckerman (2004) already identified the chances of a positive impact of IT on supply chain visibility (SCV). This was later supported by several other authors, e.g. Andel (2012).

A way of sharing information is the usage of Internet of Things (IoT) technology. IoT as presented in Figure 1 is the new era of Internet (Xia et al., 2012). It connects the physical and the online world at any time with anything (Goldman Sachs, 2014). Figure 1 shows an illustration of the scope of IoT, based on TechBlocks (2015).

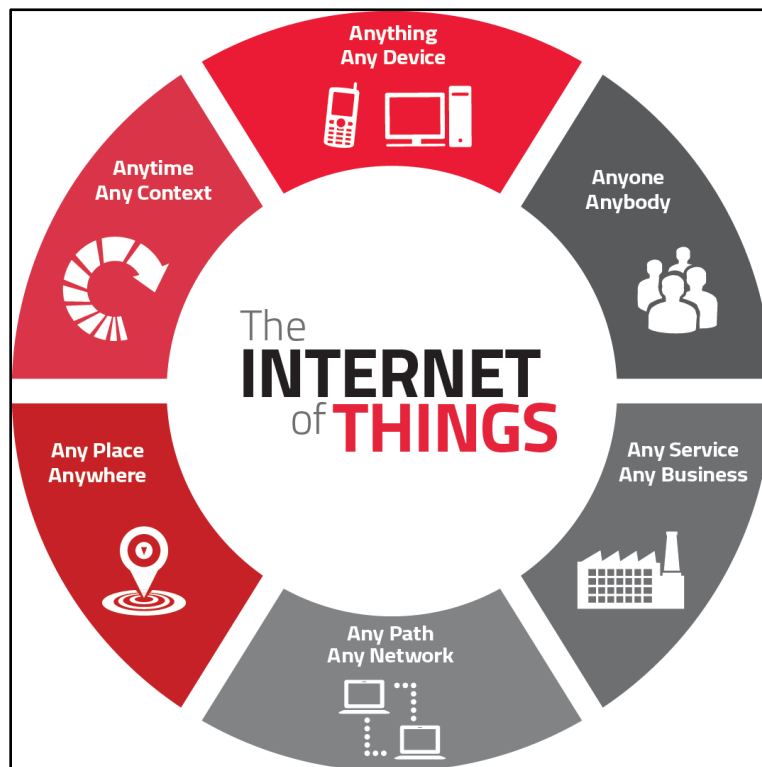


Figure 1: Overview IoT

Source: TechBlocks (2015)

According to Morgan (2014), the IoT connects everything with everything. This means, relationships “between people-people, people-things, and things-things” (Morgan, 2014) will be established.

2.1 Company description

This research is based on a case study in cooperation with company X. Due to the strong competition in the market, a variety of rules and regulations and as a protection for customer and supplier, the name cannot be displayed in this research. Therefore, the company is only named “company X”. To facilitate the understanding of this research, company X is shortly introduced and some background of company X is given.

Company X is a producer and supplier of ground beef to high profile accounts throughout the western United States. 140 employees produce and sale approximately 190 different quality ground beef items, branded and private label to retail and the foodservice industry. They produce an average of 1,000,000 pounds of ground beef per week. The annual sells are around 90 Million US-Dollars.

Planning is very important for company X, because the needed raw material is influenced by seasonal up and downs. Those up and downs influence the demand of the customers, too. Moreover, company X has a limited number of production lines and storage space. To satisfy all customers, the company must be able to react at short time changes of customer orders.

The company X passed the British Retail Consortium (BRC) certification with an A+ and their third party audits have been conducted by Silliker Laboratories for the last three years. They are HACCP compliant and an active member of the National American Meat Association (NAMA). They have their own in-house laboratory and online Foss analyser (Fat analyser). So, quality is highly important.

2.2 Aim and objectives of research

This research will focus on following research question, based on the background and identification of the associated gaps:

**“How could the Internet of Things have a positive impact on the
Fresh Food Supply Chain visibility?”**

To answer the research question, the following research objectives will be addressed during the project development:

1. Understanding the importance of the Fresh Food Supply Chain visibility.
2. Identifying the usage of IT in a Supply Chain.
3. Identifying the potential benefits of using IoT to support fresh food supply visibility in company X.
4. Evaluation the implementation of IoT in company X.
5. Definition of the potential solution for the general fresh food industry.

The answers to objective 1 and 2 are based on a literature review. Objectives 3 and 4 are answered by a combination of literature and a case study of company X. Objective 5 is answered only by analysing the secondary data. Further methodical design choices are discussed in chapter 5.

2.3 Justification, scope and limitations

The research establishes a relationship between the fresh food supply chain visibility (FFSCV) and the IoT. It identifies linkages between those variables and creates a causal understanding. Research is done on SCV and FFSC, as well as on IoT. However, there is a no research about the combination of SCV and IoT. Due to the relatively new concept of the IoT a research is required to identify possible further practical usage in the FFSC.

However, the scope of this research is limited to the degree of a case study and a short timeframe (5 month). Despite the limitation to only one company, the research identifies potential solutions that could be generalised for other companies in the food industry. The interview is limited to one, including six participants to guarantee enough time for other data collection methods such as observation and secondary data. Due to the novelty of IoT and a first link between the IoT and the FFSCV, this research cannot cover the topic in full depth. Further research will be proposed at the end of the research to indicate in-depth investigation to confirm findings or to achieve a generalisation for the food industry.

Further, the costs or time of implementing IoT are not evaluated in any detail due to the time and word limitations of this research. This research focuses on the possible impacts and mentions costs and other resources as influencing factors.

2.4 Outline of dissertation

To get an idea about the structure of this research, Figure 2 provides an overview about the different chapters.

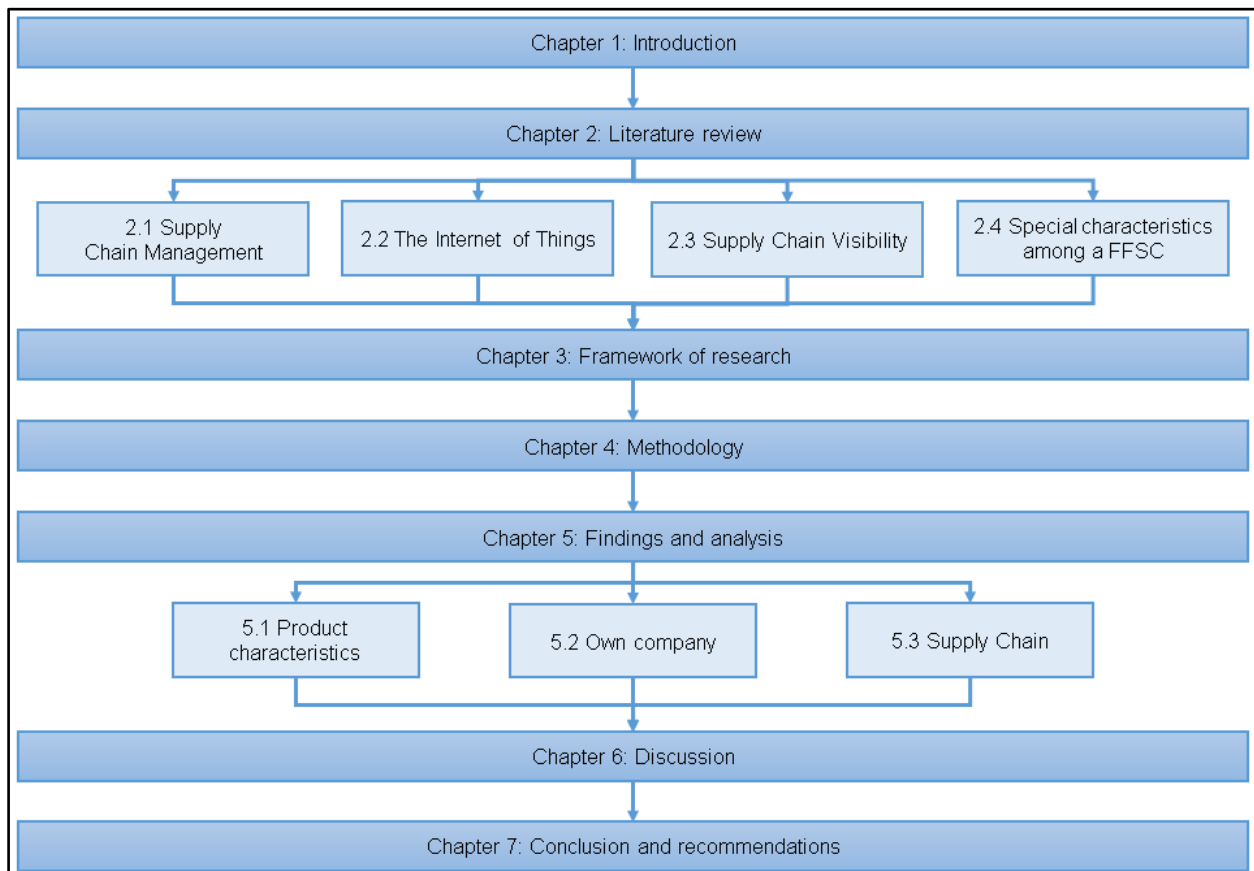


Figure 2: Outline of dissertation

Source: Author's own figure

Based on this overview, the report structured. However, some chapters contain further subchapters, which are not listed in the overview. Otherwise it would not be an overview anymore.

3 Literature Review

The literature review deals with the area of supply chain management in general, the new technology Internet of Things (IoT), the supply chain visibility and finally finishing with the specific characteristics of a fresh food supply chain.

3.1 Supply Chain Management (SCM)

To ensure a clear understanding of SCM, this chapter outlines the development of SCM and elaborates various definitions, mentions the different elements of SCM and discusses information technology among SCM.

3.1.1 Development and Definition

The need for managing a SC emerged hence companies moved from making decisions to be efficient within the facility (Thomas and Griffin, 1996) to a more integrated and coordinated decision-making among the SC (Tseng et al., 2011).

There are several definitions for SC's across the literature. La Londe and Masters (1994) define a SC as companies who move materials forward. Further, they define producers, assemblers, wholesalers, retailer and transportation companies as such companies among the SC. Later, the definition was generalised into an alignment of companies that provides services or products to the market (Lambert et al., 1998). However, those definitions are only discussing the movement of goods into one direction. Therefore, Christopher (2001) considers a supply chain as a network of involved companies, through upstream and downstream linkages, with different processes that produce value for the final customer. Figure 3 shows a SC as presented in the definitions.

The impact of IoT on FFSCV

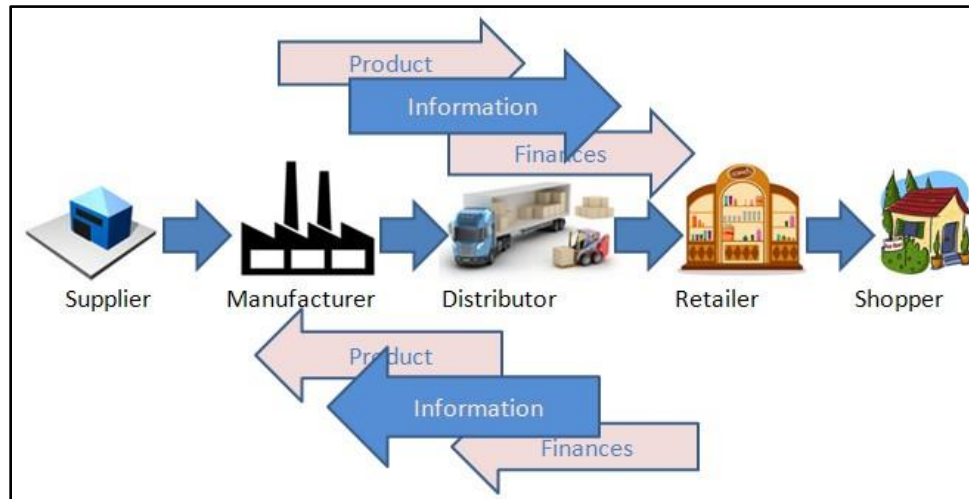


Figure 3: SC model

Source: Peterson (2016)

In 1985, Porter indicated a required change in thinking among a company. He stated that the value creation process has to spread beyond limitations of individual companies and need to include unified business processes among the whole chain. This was one of the first definitions of Supply Chain Management (SCM). It is further defined in several other ways. Monczka (2010) defines SCM as a concept “whose primary objective is to integrate and manage the sourcing, flow, and control of materials using a total systems perspective across multiple functions and multiple tiers of suppliers”. By contrast, La Londe and Masters (1994) are talking about strategies, including “[...] two or more firms in a supply chain entering into a long-term agreement, [...] the development of trust and commitment to the relationship, [...] the integration of logistics activities involving the sharing of demand and sales data [...]”. Stevens (1989), however, defines SCM by focusing on the objective, which is “to synchronize the requirements of the customer with the flow of materials from suppliers in order to affect a balance between what are often seen as conflicting goals of high customer service, low inventory management, and low unit cost”.

Based on the above mentioned definitions of SCM, it becomes clear that there is no general definition for the term SCM (Christopher, 2001). Due to several perspectives of definitions (concept, strategy, objectives), the definition focuses on different characteristics.

3.1.2 Elements of SCM

In the course of managing the SC, several principles or theories were developed. It started in the 1980's with the implementation of the Just-in-Time (Vokurka and Davis, 1996), Total Quality Management (Powell, 1995) or reengineering (Champy, 1995) and continued with supplementing strategies like flexibility (Hayes and Pisano, 1994) and customer response (Christopher, 2001).

To manage a SC, four elements need to be considered (Linton, 2015). Those elements are demand management, communication, integration and collaboration. In Heizer (2004) opinion, a fifth element needs to be added due to the recently increasing importance, which is sustainability.

Managing demand is crucial among the chain. By increasing the awareness of each member with the focus on customer's needs, a SC can stay competitive (Linton, 2015).

Communication among a SC is needed to share information, which is needed to achieve every member up to date and give them the possibility to adjust their processes to changing circumstances (Fiala, 2005). Further, information sharing reduces uncertainty and improves SC performance (Srinivasan et al., 1994).

Integration of various processes among the supply chain will help to work towards an objective of the SC, e.g. customer satisfaction (Handfield, 1997). Further, integration can mitigate risk and link major processes (Heizer, 2004).

Collaboration among a SC is essential to strengthen relationships and keep every member on board. Knowledge is offered among the chain and a common SC objective is followed, while everybody's individual business increases (Horvath, 2001).

3.1.3 Information technology in SCM

Information technology (IT) plays an important role in companies coordination (Handfield, 1997). In literature most authors outline a variety of advantages of IT in SCM. IT brings advantages to transaction processing, SC planning, SC collaboration, order tracking and delivery coordination (Varma and Khan, 2015). The advantages are reduced cycle time, higher efficiency, increasing SC agility and a faster delivery of products to customer (Radjou, 2013). IT has a huge impact in creating a demand market as well as in integration of companies (Gunasekaran and Ngai, 2004). Communication,

also known as inter-organisational information integration, has an increased importance in SCM (Frohlich and Westbrook, 2001; Narasimhan and Kim, 2002). Further, the Internet opens up communication to meet other communication needs, which go beyond transactions (Handfield, 1997). As described above, IT has a positive impact on the four main elements of SCM.

The fact that IT is becoming more and more important among the SC is underlined by the increase of SCM software. The revenue of SCM software raised by 7.2% in 2013 and is expected to raise further (Trebilcock, 2014). The software is mostly used in categories like enterprise resource planning (ERP), supply chain planning (SCP), procurement, warehouse management systems (WMS), TMS and manufacturing execution systems (Bond, 2015). However, he also mentions that cloud-based solutions and omni-channel gain grounds.

Radio frequency identification technology (RFID) is a method to identify, collect and track goods or materials (Want, 2006). Want (2006) also points out the difference of RFID compared to barcoding. If barcodes are used, the code must be in “a line of sight” (Finkenzeller, 2003). Hence RFID uses waves, a line of sight is not required to gather the information, saved on a RFID tag. “RFID databases associate tag-identifying data with arbitrary records. These records may contain product information, tracking logs, sales data, or expiration dates. Independent databases may be built throughout a supply chain by unrelated users, or may be integrated in a centralized or federated database system” (Weis, 2010). Based on this statement, it is possible to build web-based applications to share information gathered via RFID (Welbourne et al., 2009). This statement is supported by Gubbi et al. (2013) who identify that the usage of RFID and sensor network technologies will increase and information and communication systems will be invisibly embedded in the environment around us.

3.2 The Internet of Things (IoT)

This chapter discusses the relatively new term and concept of IoT. It shortly explains what the IoT is. Further, it describes the technology behind the IoT for an effective and efficient usage of IoT.

3.2.1 What is the Internet of Things?

The Internet of Things (IoT) is the next era in computing and will exceed the boundaries of the traditional desktop (Gubbi et al., 2013). It extends our everyday lives through a wireless network of uniquely identifiable objects, based on hundreds of billions of RFID-tagged objects (Welbourne et al., 2009). Through the usage of IoT technology, it is possible to report real-time data, which enables users to make quicker and more accurate decisions (Thrasher, 2014). Those statements are supported by Gardner (2014), the world's leading information technology research and advisory company. They forecast 25 billion connected “things” by 2020. This is a huge growth compared to 4.9 billion connected things in 2015 and underlines the importance of the IoT. The growth of connected things is also expressed in Figure 4.

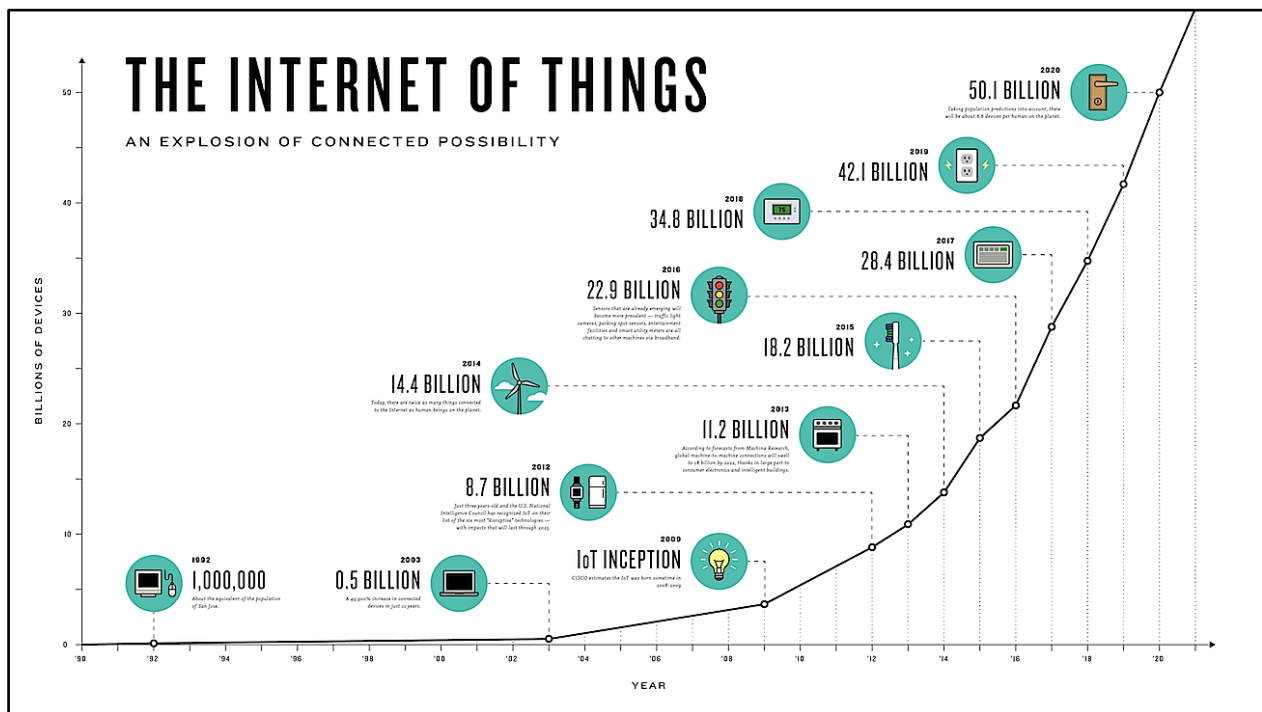


Figure 4: The development of IoT

Source: NCTA (2014)

A thing is “a physical object with embedded technology that enables the object to collect and exchange data” (Yeates, 2015). In industry, it can be a product itself, the equipment, transportation and everything else that participated in the product lifecycle. In

environment, it might refer to a building, devices or even trees. In the society, it can be a device or a human (Gusmeroli et al., 2009).

Networked televisions, networked loudspeakers, networked devices that let us find our lost keys as well as connected refrigerators and via smartphone controllable light systems (if you are not at home) are already connected things nowadays in everybody's daily life (Botelho, 2015). The growth is driven by the industries, especially the manufacturing and retail industry, hence they do not only produce and distribute connected devices, they also started to connect their own devices during the value creation process (Grau, 2013). Goldman and Sachs (2014) lists connected homes, wearables connected cars and cities as well as industrial internet as the main outputs of the IoT. The industrial internet offers real-time analytics, factory automatization, robotics and SC efficiency. Further, they point out that the relevant costs (sensors, bandwidth and processing) decreased over the past ten years, while smartphones, WIFI and Big Data became more and more popular. Those three element work as gateway, transmitter and storage of the IoT and turned out to be the key to the estimated success of IoT.

3.2.2 Technology behind the IoT

Some elementary technology behind IoT, like RFID, was already mentioned in the previous chapter. Lee and Lee (2015) point out the five essential technologies behind the IoT. Those are (i) RFID, (ii) wireless sensor networks (WSN), (iii) middleware, (iv) cloud computing and (v) IoT application software.

Using (i) RFID, information can be identified and captured, using radio waves, a reader and a tag, which can store more data as regular barcodes (Lee and Lee, 2015). Atzori et al. (2010) point out the advantages of RFID, compared to barcode and other sensor technologies. The advantages are low costs, a wide portfolio of devices, maturity, a large network and a lot services.

By using (ii) WSN, it is possible to monitor the environmental situation and material (in cooperation with RFID) to track information. WSN are independent devices with a sensor (Atzori et al., 2010). WSN enables the possibility to communicate and monitor

and is especially used in the cold chain to monitor temperature for sensitive products (Hsueh and Chang, 2010).

To use all the gathered information, (iii) middleware is required. Middleware helps to control programs (Lee and Lee, 2015) and it required (iv) cloud computing to work smooth, hence it combines things via the internet (Atzori et al., 2010). Cloud computing “is a model for allowing ubiquitous, convenient, and on-demand network access to a number of configured computing resources (e.g., networks, server, storage, application and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” (Mell and Grance, 2011). It has established itself in the next generation of IT industry (Hashem et al., 2015). Further, it provides hardware, software and services via the internet and data centres (Armbrust et al., 2010).

Platform as a Service (PaaS), Infrastructure as a service (IaaS) and Software as a Service (SaaS) are the three main models of cloud computing (Hashem *et al.*, 2014; and O’Driscoll and Daugelaite, 2013). Figure 5 shows the different models and shows solutions for the cloud technology system.

Infrastructure-as-a-Service (IaaS) Examples	Platform-as-a-Service (PaaS) Examples	Software-as-a-Service (SaaS) Examples
The following is a sample of IaaS solutions from providers in the cloud technology ecosystem. • Amazon* Web Services • Citrix* CloudPlatform • Windows Azure* and Microsoft* System Center • OpenStack* software • Rackspace* • Savvis* • Verizon* Terremark* • VMware vCloud* Suite	The following is a sample of PaaS solutions from providers in the cloud technology ecosystem. • Force.com • Google* App Engine • Red Hat* OpenShift* • VMware Cloud Foundry • Windows Azure*	The following is a sample of SaaS solutions from providers in the cloud technology ecosystem. • Amazon* Elastic MapReduce • Cetas* by VMWare* analytics solutions • Google* BigQuery services • Rackspace* Hadoop* service • Windows Azure* HDInsight*

Figure 5: Different models in Cloud Computing

Source: Brief (2013)

Wireless networks and mobile devices support the trend towards Cloud Computing, because the accessibility is highly increased and they offer the usage of (v) IoT applications (Khan et al., 2014). Well known mobile cloud applications are Gmail, Apple’s iCloud, Microsoft’s OneDrive or Dropbox (Hashem et al., 2015).

Nevertheless, reliability of service and security of data are important considerations, using cloud computing. Those are crucial for running a business efficient and without loss of confidential data (Rouse, 2015).

3.3 Supply Chain Visibility (SCV)

In this chapter, SCV is further discussed. After a definition, the integration of information sharing is further discussed. Before finishing with the challenges of SCV, the benefits of SCV are outlined.

3.3.1 Background and Definition

Xie (2015) mentioned that the FFSC must become more visible to satisfy customer, while Fair (2016) mentions visibility in regards to an increase of quality among the SC. Monczka et al. (2009) add reduction of uncertainty as benefits of visibility among the SC. Since the globalisation leads SC to become more and more international, uncertainty is an increasing problem (Johansson and Melin, 2008). The goal of SCV is to (i) reduce business and supply chain risk, (ii) improve lead times and performance, (iii) identify shortage and quality problems along the chain (Weiner, 2014). Since, demand management, communication, integration and collaboration is crucial for SCM, more visibility can help to manage a supply chain. This is also emphasised by the fact that “three out of four companies want to achieve Web-based, real-time data visibility through their supply chains” (Klikauer, 2016). Lee (2004) supports Klikauer’s (2016) statement since he found out that “the biggest pain points faced by them [shippers] are uncertainties and lead time in customs and transit, as well as the visibility of their products on route from origin ports to the destination ports”.

However, defining SCV is not that easy. On the one hand, most vendors, like 3PLs or transportation companies, claim to offer SCV in their software. On the other hand, companies mention achieving SCV as one of their top goals (Francis, 2008). Therefore, there must be a difference between the offered SCV and the needed SCV. Briggs and Cecere (2003) point out that “there is confusion between capabilities of existing supply chain systems and the need for visibility systems. Likewise, many confuse “track and trace” with “visibility solutions” and they go on with the fact that “software vendors have used the term “visibility” in many different ways to describe different supply chain technologies”.

This leads to several definitions in literature. Tohamy and Orlov (2003) define SCV as “capturing and analysing supply chain data that informs decision-making, mitigates risk, and improves processes”. Other definitions, like Cecere (2005) focus on the process: “[...] visibility is a business process, not just a supply chain process” or on the information where “visibility means that important information is readily available to those who need it, inside and outside the organisation, for monitoring, controlling and changing supply chain strategy and operations, from service acquisition to delivery” (Klikauer, 2016).

Based on several definitions and points of view in regards to SCV, Francis (2013) proposes the following definition: “Supply chain visibility is the identity, location and status of entities transiting the supply chain, captured in timely messages about events, along with the planned and actual dates/times for these events”. This definition is the basis for this report.

3.3.2 Integration of information sharing

SCV is strongly connected to information sharing (Caridi et al., 2014), which enables the identification, location and status of entities among the supply chain (Francis, 2008). Even though, the benefits of information sharing are identified in literature by several authors, Williams et al. (2013) identified a lack of valuable information, which are shared. He adds that information must be valuable to other companies not just some information. Therefore, the structure of the SC, the intention of sharing information and the applications in the industry as well as the evaluation of shared information are the key drivers to figure out the valuableness of information (Bahroun et al., 2015). Information can be shared in several directions. In literature, upstream, downstream and synchronous sharing is discussed. Sharing information upstream includes order quantity, lead time or capacity (Jia et al., 2007), while downstream sharing includes information about customer demand (Byrne and Heavey, 2006) and is discussed most in literature (Chu and Lee, 2006). Recently, the topic of synchronous sharing is reviewed more and more. Especially by Chengalur-Smith et al. (2012) in regards to web-applications and by Yu et al. (2010) in a more general way.

The integration of information in a SC can facilitate mutual value creation among the chain (Schloetzer, 2012). In 1993, Miller already discussed the usage of the internet to share information in the agricultural industry. Two years later, Cimino et al. (1995) used the same idea to share clinical information via the internet. The first linkage of the IoT and information sharing was made in 2011 by van Lier, and Yue (2011). The internet is identified as important technology for the integration of information among the SC as well as essential as tool to share information (Prajogo and Olhager, 2012; Ye and Wang, 2013). Later, the IoT was identified as improvement of the internet due to the new chances and possibilities which opens up with the IoT (Nativi and Lee, 2012; Shamir, 2012; Zhang and Chen, 2013).

As identified by Welbourne et al. (2009) RFID is the base of a successful IoT usage. Myerson (2007) already identified the chances of combining RFID with a web-centric SC. A SC, using the IoT would be such a web-centric SC. She identified the following functions within the SC which are supported through the web-centric network:

- Electronic Procurement Standardization (EPS)
- Materials Markup Language (MML)
- Product Life Cycle Support (PLCS)
- Production Planning and Scheduling (PPS)
- Universal Business Language (UBL)

However, she also identified challenges, combining a web-centric network with RFID technology. Those are namely:

- How do employees handle the RFID-tagged items?
- Are the items loss protected?
- What happens if RFID-tagged items are not recorded properly?
- What are improvements for a RFID based SC?

Those thoughts, made in 2007, point out the possible usage of IoT among the SC. They also increase the visibility. However, it needs to be considered if they also increase the

useful visibility in regards to shared information. Is it e.g. also possible to share information about wrongly recorded items?

The advantages and disadvantages of SCV will be discussed further in the following chapters.

3.3.3 Benefits of SCV

Advantages of SCV can be found from different viewpoints among the SC in literature. This expresses the importance and variety of SCV in a SC. Generally spoken, the overall aim is to increase the business performance of all participating businesses (Wang and Wei, 2007). It further supports the decision-making processes due to a variety of supporting information. More specific benefits of visibility are e.g.: it helps producers to anticipate their demand and plan supply, while the retailers do not need to track their inventory levels anymore and do not need to place orders in a VMI program (Taylor, 2003).

Caridi et al. (2014) did a research on the benefits of SCV. Table 1 summarizes their introduced benefits,

Type of SC relation	Performance affected by visibility
Two tier SC One supplier and one buyer	• Service level • Stock out costs • Shortage costs • Inventory cost
Two tier SC Multiple Supplier and multiple buyers	• Quality (supplier quality level, internal quality level) • Total cost • Service level (product availability) • Inventory costs • Backorder penalty costs • Flexibility • Responsiveness
Multiple tier SC	• Inventory costs • Product availability • External quality level

Table 1: Benefits of SCV among a SC

Source: Caridi et al. (2014)

However, inventory costs were mentioned multiple times and can be found in every SC relationship. Therefore, there must be an importance to it. This importance is also pointed out by Zhang et al. (2011), who point out that Inventory visibility optimises the whole SC by providing them real-time data from inventory.

3.3.4 Challenges of SCV

Besides all the benefits of SCV, there are also some challenges which need to be faced. First, the SCV is limited to the extent of cooperating companies. If companies among the SC do not participate and keep information hidden, it lowers the performance of the SC (Småros et al., 2003). Secondly, costs of implementing software systems and adjusting processes occur. For big companies it might be affordable, but for medium and small sized companies it can be critical due to its costs (Zuckerman, 2004). Thirdly, even though companies would like to share information and have enough money, it still can be problematic if there is no possibility to change the current system. Last but not least, security should be a concern. Not all information of a company needs to be shared and all shared information among the SC must be protected against external attacks due to the sensitive information (Caridi et al., 2014).

3.4 Special characteristics among a FFSC

Due to the special characteristics of Food, a FFSC faces several specific challenges. Food, especially fresh food, are goods which need to be treated in a special way. Fresh Food is food, which has a short shelf life, which can range from a few days up to a maximum of 2 or 3 months (Luetke Entrup, 2005). Hence, typical fresh food products are:

- Dairy and bakery,
- Fresh and processed meat,
- Fish, or
- Fruits and vegetables.

Most of them must be chilled and all of them need to be moved around fast to offer the customer a longer shelf life (Xie, 2015). Besides those general characteristics of a food product, Jha et al. (2014) outline further, external regulated impacts. Governmental

regulations and climate conditions impact the FFSC enormous. Governmental regulations can differ from country to country, which makes it harder for a global FFSC to comply with all regulations. Further, climate conditions can impact a local or global FFSC due to severe weather somewhere around the world. This could impact the crop of farmers, which is the base for most food products. This can lead to scarcity of certain raw materials. However, some resources are scarce by nature and / or only available in certain places over the world. This leads to a competition for those resources.

Besides the restrictions and challenges given by law or nature, the industry needs to face the aspect of consumer demand (Jevšnik et al., 2008). Gerbens-Leenes et al., (2010) point out a fast changing demand for several products. More and more consumers are aware of what they eat. A lot different diet plans are offered and trends like vegan or vegetarian became more and more popular. The food industry need to provide a higher variety of products and widen their product portfolio. This leads to a less specialised production and might end in a loss of quality. The pressure made by the market and competitor can drive a company to their limits until they do not focus on their quality and service, just to stay competitive in market.

However, this leads to a further problem. The problem of trust. The customers want to trust the producing companies. If consumers eat their food, they do not want to get sick (Xie, 2015). Xie (2015) continues that consumer want to buy, high quality products, which include what it is supposed to include and what is on the label.

The special characteristics of a FFSC let's participants among the chain face several challenges. Uncertainty about supplier's quality and customers demand, linked with the risk of changes in law or natural disasters issues are challenges for food producing companies, as well as for other companies among the FFSC.

3.4.1 Typical FFSC

There are not that many differences between the basic patterns of a FFSC in Figure 6 with the earlier shown SC model (Figure 3). Hence, the basic structure of the FFSC is similar to a regular SC. Nevertheless, the FFSC changed over the past years. In earlier centuries, a more direct SC (Farmer – Consumer or sometimes with a middleman) was dominant.

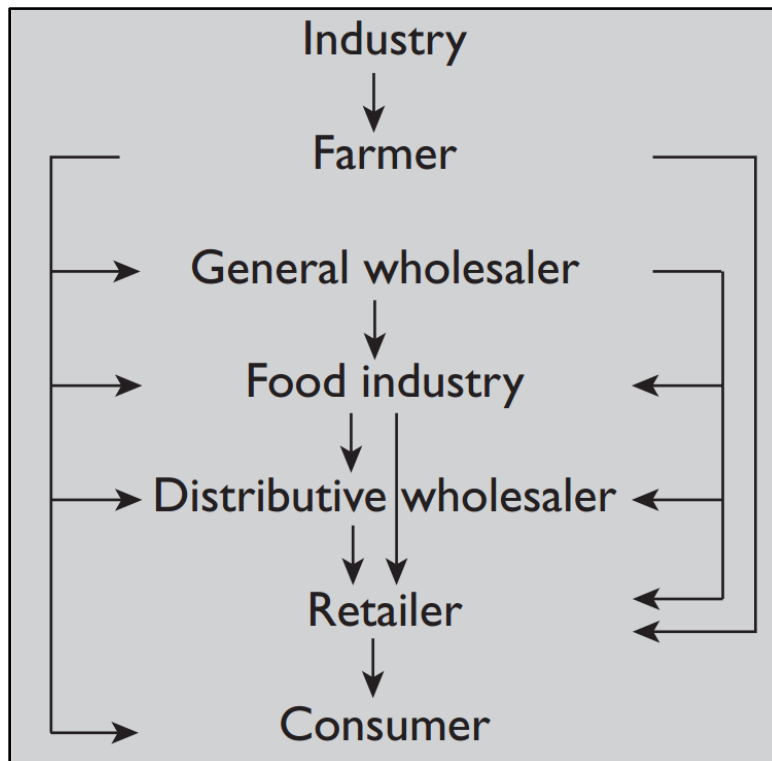


Figure 6: Basic patterns of FFSC

Source: Jongen and Meulenbergh (1998)

Nowadays, the SC got more and more complex and could contain all six basic patterns, shown in Figure 6.

3.4.2 Future challenges

Dani (2014) point out several future directions of the FFSC. Several years ago, the food industry looked very different. A lot small and local farmers were the base of the industry. Nowadays, there are only a few and very big farmers. Further, the impact of technology, laws and other developments can change the future of the FFSC. Progress in IT and communication already changed the FFSC in recent years and is still changing it. Further, the demand might change and maybe we will have a totally different thinking about food in the future.

3.5 Summary of the literature review

SCM became increasingly important in recent years. Companies started to work together to increase their efficiency. Therefore, SCM was used and a variety of tools were developed and processes improved. Managing demand as a SC, increase the communication and integration among the SC as well as collaboration among the chain became the main elements of managing a SC. All this progress was supported by IT. IT offers a variety of advantages for managing a SC and was used from all companies for their development among the SC.

The IoT is already part of our daily life. Many “things” are already linked to each other and communicated. However, the amount will heavily increase in the next years. Based on RFID chips, working together with clouds and WI-FI and new, developed applications, IoT will take a huge part in everybody’s daily life, due to advantages like real time information or regulation things from distance.

SCV is a widely misused or miscommunicated term. Hence everybody is looking at SCV from a different point of view. It has no clear definition. However, in this report SCV will be defined as the “identity, location and status of entities transiting the supply chain, captured in timely messages about events, along with the planned and actual dates/times for these events” (Francis, 2008). Based on this definition, information sharing is strongly connected to SCV. A higher degree of information sharing among a SC has great positive effects on the performance of the SC. Nevertheless, some disadvantages like safety and costs need to be considered, too.

A fast changing consumer demand and the sensitiveness for food products creates some specific challenges among the FFSC. Some products have such a low shelf life, that a slow information exchange increases the uncertainty and lowers the quality of the food. Further, a lot of external influences (government, climate, resources) impacts the FFSC. Trust became an elementary role for the final customer. They want to know as much as possible about the product they buy. Therefore, special characteristics of the FFSC let participants among the FFSC face challenges. Uncertainty, linked with risk or natural disasters issues are a challenge for companies.

4 Framework of Research

This chapter deals with the conceptual model of the research process, a definition of the research question and lists the research objectives, which are discussed during the research. The demonstration of the aspects in the research framework help the reader through the research. It provides the structure for the research stage and links the literature with the original work.

4.1 Conceptual Model

To ensure a successful way of research, the conceptual framework in Figure 7, shows the conducted way of research. First, a literature review has been chosen as starting point. It helps to provide a certain base of knowledge about relevant topics. In the given research, the topics are SCM, IoT, SCV and the special characteristics of a FFSC.

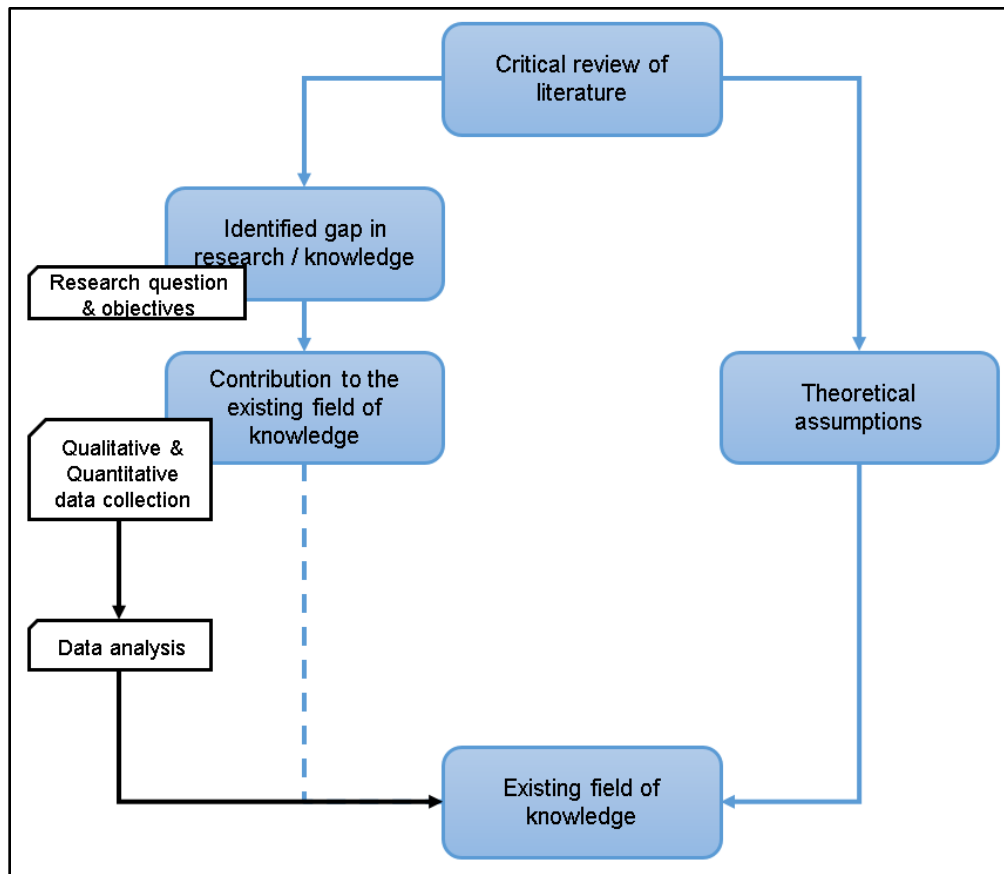


Figure 7: Conceptual model - research framework

Source: Adopted from Monash University (2009)

Some of the presented information, such as SCM, are relevant for the general understanding and not highly important in further discussion. Nevertheless, they are still fundamental and therefore required.

Due to the underlying mixed method approach in this research, the data collection and analysis methods refer to qualitative and quantitative data, as shown in the conceptual model in Figure 7. In this research, a group interview and observations are primary and qualitative data, while secondary data is quantitative and qualitative. For a more detailed list, refer to Figure 8. Since the group interview and observations are the main data input, this research is quality driven.

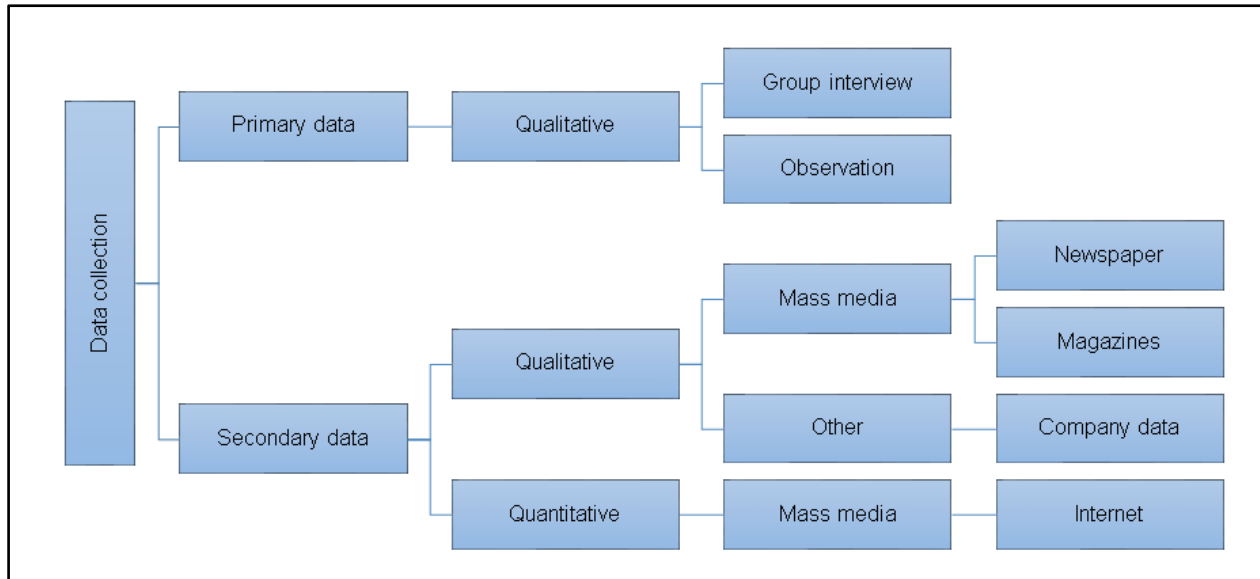


Figure 8: Primary and Secondary data

Source: Author's own figure.

The aim of this research is to answer the research question, which is defined in the next chapter. While answering the main research question, several objectives will be discussed, too. Those objectives support the process of going through the research process and to achieve a valid and reliable result. Further, the objectives set boundaries for the research to ensure the focus and avoid to fly off the tangent while doing the research.

4.2 Definition of research question and objectives

There is a high volume of published literature on SCM and SCV. However, and due to the novelty of IoT, the published information about the IoT is limited. The published literature mostly deals with the general advantages or disadvantages of IoT, without linking it to certain industries or companies. However, the positive impact of the IoT is outlined all the way and weights more than the disadvantages. Therefore, this research considers a positive attitude and discusses the following question:

“How could the Internet of Things have a positive impact on the Fresh Food Supply Chain visibility?”

The importance of the FFSC increases more and more in recent years and is facing daily chaining challenges. Some of them are predictable and some are unpredictable. Nevertheless, those challenges make the FFSC a SC with fast moving, extremely sensitive products. The fact that food products are essential in everybody's daily life increases the importance of those goods and a good management of the FFSC. Since, visibility became more and more important to customer and between companies among the chain, this research focuses on the possible positive impact of the IoT on the FFSCV.

For a more detailed definition, the following objectives are set. Those objectives ensure a thorough development of the research and provide some preliminary results and needed knowledge:

1. Understanding the importance of the Fresh Food Supply Chain visibility.
2. Identifying the usage of IT in a Supply Chain.
3. Identifying the potential benefits of using IoT to support fresh food supply visibility in company X.
4. Evaluation the implementation of IoT in company X.
5. Definition of the potential solution for the general fresh food industry.

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Focusing on company X during the research ensures a deep insight into a food manufacturing company. The cooperation with company X, helps to achieve an in-depth qualitative view on the topic.

5 Methodology

This chapter gives an overview about the methodology of the research itself. First, the meaning and purpose of research is explained. Secondly, various research philosophies are introduced. Followed by the research approach, the nature of research, including the research design and strategy. After this, sample selecting and data collection are discussed. The introduction of various data analyses is followed by the research ethics. Finally, this chapter will end with a short summary about the applicable methodology.

5.1 What is research?

Walliman (2011) identified that the term “research” is widely used wrong. He states that data collection, without a purpose or recording facts without interpretation is often claimed as research, which is wrong. Research has three main characteristics (Saunders et al., 2012), which are:

- Data are collected systematically.
- Data are interpreted systematically.
- There is a clear purpose: to find things out.

Therefore, Saunders et al. (2012) define research as “something that people undertake in order to find out things in a systematic way, thereby increasing their knowledge”. The emphasis in this definition is on “systematic” and “to find out things”. The importance of a systematic way is also pointed out by Ghauri and Gronhaug (2010). They state that a systematic research is not based on beliefs. It is based on logical relationships. “Finding out something can have different purposes (Saunders et al., 2012). However, they must be of use at some time (Becker, 1998). Such purposes can be describing, explaining, understanding, analysing or criticising (Ghauri and Gronhaug, 2010).

Business and Management is a distinctive focus for research, since manager and researcher draw knowledge, managers are educated, draw advantages of research and use the practical consequences of research (Easterby-Smith et al., 2008). The fact that research helps to solve managers’ problems was also identified by Wilson (2014).

After describing the nature and importance of research itself, the next chapters give more insight into the concepts of research.

5.2 Research Philosophy

Johnson and Clark (2006) highlight the need for the researchers to commit and adopt a philosophical point of view. Therefore, the following chapters will give an overview about epistemology, ontology and axiology and explains their relevance for this research.

5.2.1 Epistemology

Epistemology can be divided into three various philosophies. Those are: positivism, realism and Interpretivism (Saunders et al., 2012). In positivism, information about the reality are collected. Those data are used to find regularities and causal relationships (Johnson and Clark, 2006). This means, the researcher is totally independent to the research with less interaction with the participants (Wilson, 2014). Realism suggests, that “[...] there is reality quite independent of the mind” (Saunders et al., 2012, p. 136). It also deals with the collection and understanding of data. The last philosophy, the Interpretivism, includes the understanding of the role of humans as social actors (Saunders et al., 2012). Further, it conducts research among people, not data or objects. “Social actors” indicates the role of humans in this theory. Human act with their own social interpretation in their daily life, which can lead to different results. Further, the world is seen as complex and open to interpretation (Saunders et al., 2012). Merriam and Tisdell (2015) add that this epistemology concept seeks to understand how people interpret, construct or make any meaning from the world around them.

This research deals with employees of the company and their opinions, viewpoints and thoughts. They bring in their own interpretation of things. Therefore, the **Interpretivism philosophy** is adopted.

5.2.2 Ontology

According to Saunders et al. (2012) the ontology refers to the nature of the research. They differ between two main contrasting approaches: subjectivism and objectivism. Adopting the subjectivism, the researcher analyses the interaction of respondents, including their motivation. It is mostly linked with to the interpretivist philosophy (Wilson,

2014). However, objectivism portrays that “[...] social entities exist in reality external to social actors concerned with their existence” (Saunders et al., 2012, p.110). Objectivism is often linked to positivism (Wilson, 2014). Even though, this research focuses on a certain company and collects data within the company and employees, the research tries to be independent. Therefore, published data will be used to outline independent thoughts and knowledge of the existence. However, it is interpreted through social conditioning. Such a view is called a **critical realist ontology, which includes an objective view** (Tashakkori and Teddlie, 2010).

5.2.3 Axiology

Axiology deals with the ethics and values of the research itself. It “[...] studies judgments above value” (Saunders et al., 2012, p. 137). Especially the process of social enquiry is a concern for Saunders et al. (2012). Mingers (2003) points out the freedom of interest groups and the independence of the research in regard to monetary support. Therefore, opinions of employees from different departments are included. Further, the researcher can be seen as part of the research, and ensures valid results with in-depth research. Additionally, literature and online published surveys are used to collect independent information. Research ethics will be discussed later in chapter 5.8.

5.2.4 Philosophical perspectives

To sum it up, the research adopts an interpretivism philosophy and the ontology approach is an objective critical realist. Referring to Saunders et al. (2012), the review of literature is already a qualitative data analysis. Further, the case study itself is qualitative. Pragmatism is another research philosophy for a mixed design of research. However, the core data collection is qualitative, supported by quantitative. Therefore, Interpretivism is the best philosophy.

To comply with the axiology, sources and the research approach are used in an appropriate way. This includes the acceptance of the researcher as part of the research as well as the best behaviour of employees and researcher in favour of the research.

5.3 Research approaches

A research approach is required to match the chosen research philosophy and data collection methods. It ensures the correct usage of such collection methods (Saunders et al., 2012). The research approach can be deductive or inductive (Ghauri and Gronhaug, 2010). However, Saunders et al. (2012) also add an abductive research approach.

The deductive approach aims at testing a the specific given theory, using a hypothesis or a general statement (Ghauri and Gronhaug, 2010). The inductive approach builds the theory, based on gathered and examining data (Wilson, 2014). While choosing one approach in theory, the “research is likely to combine elements of both” (Saunders et al., 2012, p. 549). The abductive approach deals with the development or modification of new theory and a subsequently test of the build theory. It basically moves back and forth (Saunders et al., 2012).

Hence, the IoT is a quite new topic and barely connected with the FFSC, this research aims to build new theory. However, published data (surveys and literature) is used to provide a richer theoretical perspective. Therefore, the **research approach is mainly inductive** but contains some deductive elements. It is not abductive, because the built theory will not be tested.

5.4 Nature of research

The nature is divided into two main topics. First, the research design, differing between qualitative, quantitative and multiple methods research design. Secondly, research strategies, discussing the wide variety and selecting an appropriate strategy to achieve the research aim.

5.4.1 Research design

Saunders et al. (2012) differ between three research designs. Those are quantitative, qualitative or multiple methods research design. In a quantitative way, the research is mostly linked with positivism, structured data collecting techniques like surveys and a deductive approach. A qualitative design is associated with an interpretive philosophy, less structures data collection like semi-structured interviews and an inductive approach.

A multiple methods design deals with a combination of qualitative and quantitative data collection. It further can have a mixed approach, too. The multiple methods research design is often used by pragmatism or realism philosophies. Especially the critical realist, who believes “that whilst there is an external, objective reality to the world in which we live, the way in which each of us interprets and understands it will be affected by our particular social conditioning” (Saunders et al., 2012, p. 164). Therefore, this design combines the (critical) realist ontology with the interpretivist epistemology (Tashakkori and Teddlie, 2010). Since, qualitative and quantitative methods are mixed throughout the research, the chosen research design is **mixed method research**.

According to Saunders et al. (2012), there are three main strategies available to choose to conduct a research. However, the selection should depend on criteria like the question, defined objectives, scopes or knowledge. The first strategy is an exploratory study. The aim is to ask new questions, find new insights and assess topics with a different view. Secondly, the descriptive study is a strategy for a purpose with the aim to deliver a representation of situations, events or persons. Third, the explanatory study aims to focus on the relationship between two variables and tries to study a situation or a problem and explains the correlation of the variables (Saunders et al., 2012).

Based on the given definitions, an exploratory study fits best to the given research topic. The research tries to identify the impact of the IoT on the FFSCV. Therefore, it tries to establish a qualitative relationship between two variables, the IoT and FFSCV. To achieve this, a current picture of the situation must be described, before gathering data about that situation. Therefore, the **approach is descripto-explanatory**.

5.4.2 Research strategy

The research strategy is “a plan of actions to achieve a goal” (Saunders et al., 2012, p. 173). This definition should outline the importance of a suitable research strategy. Denzin and Lincoln (2011) define the research strategy as the methodological link between the chosen philosophy and method to collect data. Saunders et al. (2012) and Wilson (2014) identify various research strategies. This chapter will not discuss all strategies in detail. Some of them are self-explaining, anyway. Nevertheless, relevant

strategies will be explained more detailed. All mentioned research strategies are: experiment, survey, archival Research, case Study, ethnography, action Research, grounded Theory and narrative Inquiry.

Since this report is written in a company, the research strategy is a **single and holistic cases study** and **uses triangulation of multiple sources of data**. It is holistic embedded, because the whole company is seen as one. The interest of the research is in the whole SC, not only in the company. Therefore, a sub-division of the company itself would not suit. Triangulate multiple sources of data mean, that various data collection methods are used to ensure a wide range of data to achieve a valid result. Data collection methods are a semi-structured group interview, observation, literature and company data as qualitative data, as well as published surveys as qualitative data. It is a single case study, because only one company is used as a case. This provides a better opportunity to observe and analyse, which is important, considering the new topic IoT. A further aspect of a single case study is the time restriction.

Hence, the time is limited to a short period (5 month), the research can be described as **cross-sectional research**. The usage of surveys, interviews and multiple research strategies is typical for such cross-sectional studies (Saunders et al., 2012).

5.5 Sample selecting

A sample must be selected due to time and budget constraints and the impracticability to include the whole population. Based on Saunders et al. (2012), the sampling technique can be either probability or non-probability. Probability sampling is mostly linked to surveys other numerous methods. Non-probability provides a range for alternative sampling. It is often used in market surveys, case studies, in-depth analysis or any other small number cases.

In order to give the best answer to the research question, a purposive, heterogeneous sampling is used. This method let the researchers choose participants with required characteristics. This provides the maximum variation. Due to the researcher's knowledge of employees in this company, the knowledge of each employee is known and participants can be chosen wisely. Those participants will be interviewed in a semi-

structured group interview and further data will be collected by observing their daily work routine.

Criteria	Position in company	Short form
Needs a general overview about the company. Must be able to see the “whole picture”.	CEO	CEO
Needs to be in contact with customer.	Customer Service	CS
Needs to be in contact with supplier.	Purchase Manager	PM
Needs to deal with production processes.	Production planner	PP
Needs to deal with product availability.	Inventory manager	IM
Needs to know the specific product characteristics	Quality Manager	QM

Table 2: Sample selection criteria

Source: Author's Own table

Besides the qualitative sample selection, a quantitative decision need to be made. A quantitative decision ensures the validity of the sample size. Referring to Patton (2014) that a small sample size needs to cover the “key themes”. Therefore, sample selection criteria should be defined to cover those themes. By choosing participants with a certain level of knowledge, the key themes are covered. This is already shown in Table 2.

5.6 Data collection

As mentioned in the previous chapters, the data will be collected with various methods. Therefore, this chapter provides a short overview about the used methods. Figure 9 shows a model about used data collection methods.

The main data collection is qualitative, using a semi-structured group interview and participants' observations. Those data collection methods are primary data.

Besides primary data, secondary data is used, too. Therefore, journals, books or other published literature is combined with internal company databases and communications.

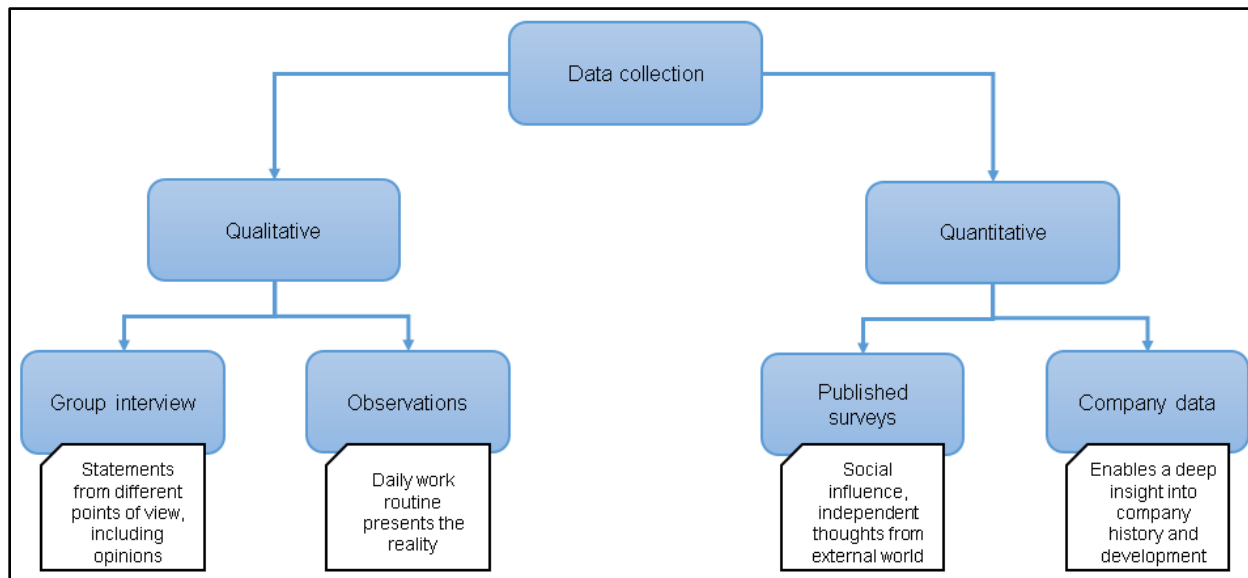


Figure 9: Data collection methods

Source: Author's Own figure

External, secondary data is used to ensure a valid result of the research. Using the critical realist ontology, the research keeps the distance to the research. However, the researcher is aware of the social conditioning, impacting the participant. To value the results, external, secondary data is used to proof weather the result is reasonable or not.

5.7 Data analysis

Since the main content is qualitative data, based on an inductive approach, there is a variety of possible ways to analyse data (Wilson, 2014). Saunders et al. (2012) outline the importance to use a proper method to do so. This could be a breakdown of interviews, document and texts into different categories. Those categories should help to link topics and find similarities and discrepancies.

Yin (2014) deals with the analysis of case studies and proposes a general strategy. The general strategy can either be relying on (i) theoretical propositions, (ii) working your data from the ground up, (iii) developing case descriptions or (iv) examining rival explanations. Regardless the chosen strategy, an analytic technique must be chosen. Considering the inductive research design and aim of this research, a strategy of working data from the ground up suits best. This means, given data are used to build up theory or identifying relationships.

According to Saunders et al. (2012) a way to analyse qualitative data is to categorize and unitize them. Therefore, categories are developed. The development is based on the purpose of the research, which is expressed through the research aim and objectives.

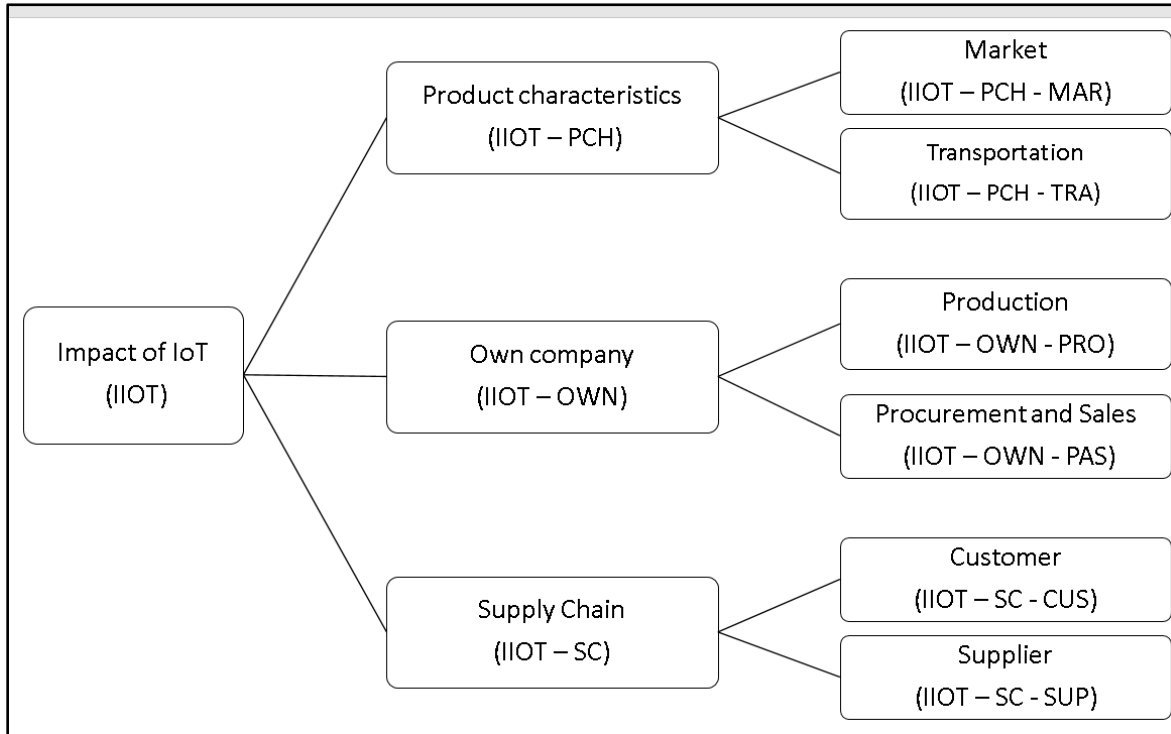


Figure 10: Categories for data analysis

Source: Author's own figure

After defining the categories, the data needs to be unitized. This means, the collected data need to be attached to the categories. This structure of categories is used to analyse primary qualitative data, based on the group interview and observations, as well secondary qualitative data, such like company documents or literature.

5.8 Research ethics

Ethics of research appeal to the standards of behaviour during the research in regards to individuals, collect, analyse, manage and report your data (Saunders et al., 2012). It is important to respect others who are (somehow) involved during the research process. Saunders et al. (2012) mention the following ethical principles: integrity and objectivity of

the researcher, respect for others, avoidance of harm, privacy of those taking part, voluntary nature of participation and right to withdraw, informed consent of those taking part, ensuring confidentiality of data and maintenance of anonymity of those taking part, responsibility for the analysis, compliance in the management of data and ensuring the safety of the researcher.

To meet the research ethics, all participants were informed about the process, the purpose and aims. After that they had to decide whether they participate or not and were informed to withdraw anytime, without mentioning any reason. Further, all names (companies and humans) were anonymised. Also the confidentiality of data was ensured. Based on this, all participants contributed voluntarily to the topic to get new insight into the IoT impacting the FFSCV, which should help the company to improve, since this is a collaboration.

5.9 Summary of research methodology

To sum up the research methodology, the research onion of Saunders et al. (2012) is used. The bold words outline the applicable characteristics of this research. The two outer layers refer to the research design. Besides the epistemology interpretivism, this research adopts a critical realist ontology, which includes an objective view. Even though, the research methodology is mostly inductive, some parts, based on secondary literature can be deductive, too.

The impact of IoT on FFSCV

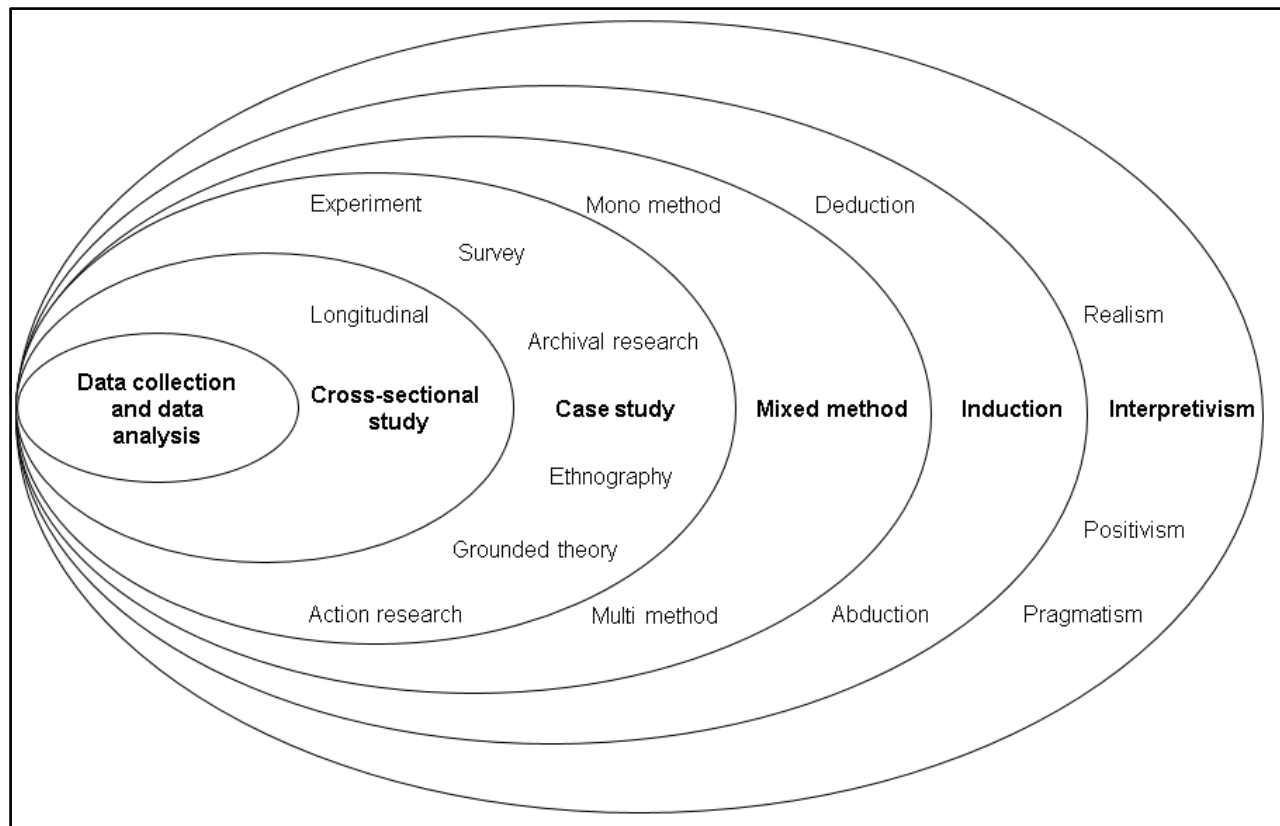


Figure 11: Customised Research onion

Source: Adopted from Saunders et al. (2012)

The inner four layers refer to the tactics. Using a mixed methods research (qualitative and quantitative data), this research follows a descripto-explanatory approach. With this approach, a current situation will be described (company X) and used as initial position to establish linkages between two topics (IoT and FFSCV). A single and holistic cases study is used and a triangulation of multiple sources of data is given in a cross-sectional time horizon. Data collection and analysis will build the core. Therefore, data will be collected with a group interview, observations, published surveys, published literature and internal company data. The analysis of those data is based on the template analysis approach.

6 Findings and analysis

Related to the research aim, objectives and the defined categories, this chapter will focus on the following three main topics: product characteristics, case study company and supply chain. These topics will be analysed to identify the possible positive impact of the IoT on the FFSCV. Mostly, the analysis is based on the group interview and observations. However, secondary literature is used to support the findings within the company and develop a richer picture of the context.

6.1 Product characteristics

As introduced in the literature review, products in the FFSC underlie a variety of special characteristics. Therefore, the market of fresh food products is discussed first. Further, the transportation of fresh food products and external impacts are analysed.

6.1.1 Market

The average weight of packaging decrease in the last years. From an average of 0,4 lbs two years ago, the average weight of a product moved to 0,32 lbs. Also, the demand of consumer can change and would affect the production, too. This is also by Eilander (2002) point out that the average household size decreases and women participate more in work environment. This would increase the demand of “ready-to-cook” food. Further, smaller packaging sizes and longer opening times are demanded.

Another big influence is promotion. “Even though promotions are communicated with our customers, we don’t know the impact of it. If the promotion runs a week, we’ll get an estimated amount for the promotion. But depending on weather, people buy a lot or less. But we need to plan with the estimation” (Appendix 1, ll. 153-156). According to the PP, it is hard to react to changes during promotion. Changing the production schedule will take two days until the affect takes place. During this time, the trend could have gone in the other direction again.

Further, consumers want more transparency. That is why company X needs to label the exact ingredients and their origin (Appendix 1, ll. 13-15). This is also stated in literature. Gelski (2016) outlines that “consumers will keep wanting to find out what’s in their food”. Currently, that information might be provided on the label or at the website of

companies, but in future most of the information might be digitally available via codes on the package to speed up the process of gathering the information. Therefore, data and information can be collected during the whole production process and stored in a cloud. Relevant data (customer's viewpoint) can be saved and provided via QR Code on the package itself. Checking that information would cost the customer less than a minute.

6.1.2 Transportation

Chapter 3.4 deals with the specific characteristics of the FFSC. As mentioned by Xie (2015), fresh food must be kept on a certain temperature and needs to move through the chain as fast as possible to provide a long shelf life for the customer. This is also stated by the QM: "There are so many rules, guidelines and regulations we have to comply with. The quality of the food is set high if you are a certified food manufacturer... which is what we are" (Appendix 1, ll. 11-13). Those special characteristics include a variety of product testing, including temperature when they receive their raw material, testing the composition of lean and fat, and the temperature of the finished product. Recording devices in the truck measure the temperature while the truck is on the road.

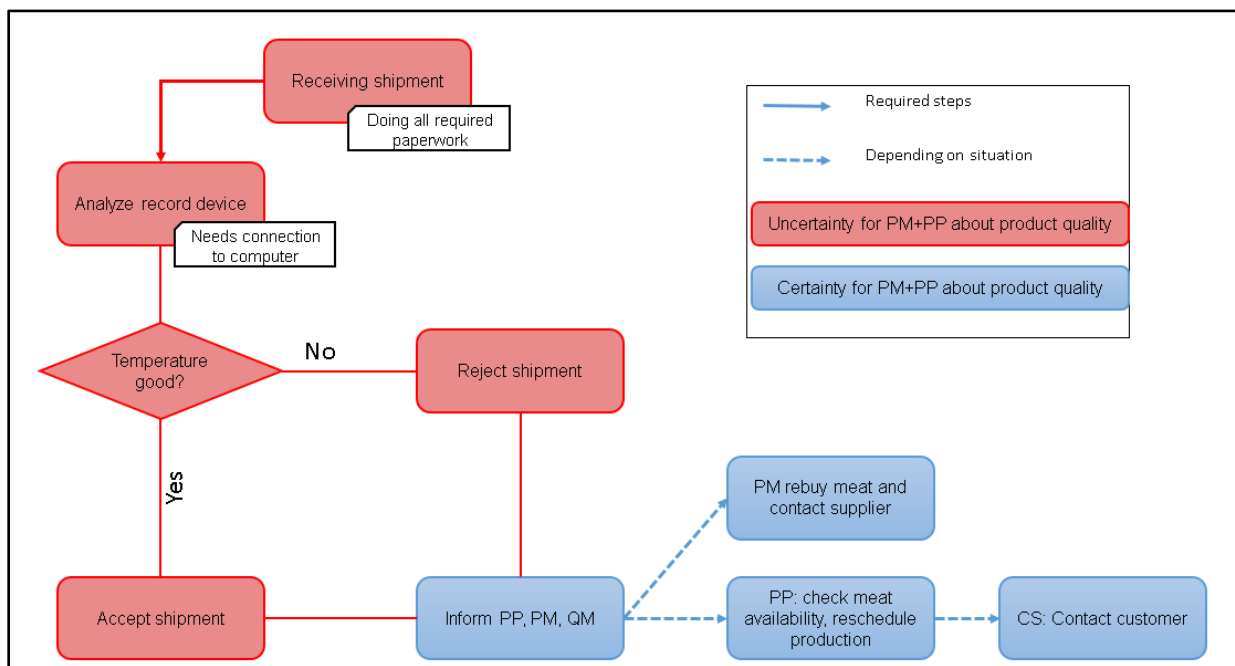


Figure 12: Checking raw material nowadays

Source: Author's own figure

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However, they need to be connected to a computer, which is installed in company X. Therefore, the recording device need to be at the facility and connected via cable or WIFI. Figure 12 shows the current process.

There is no “real-time” information about the condition of the product during the transport. Analysing the results of the temperature, takes some additional time before deciding whether to accept the shipment or not. If there were problems with the temperature during transport, company X cannot accept the shipment and reject it. This could lead to missing raw material for production. Real time information, sharing the temperature data in a cloud and let company X access those data could avoid the required measurement after receiving the shipment.

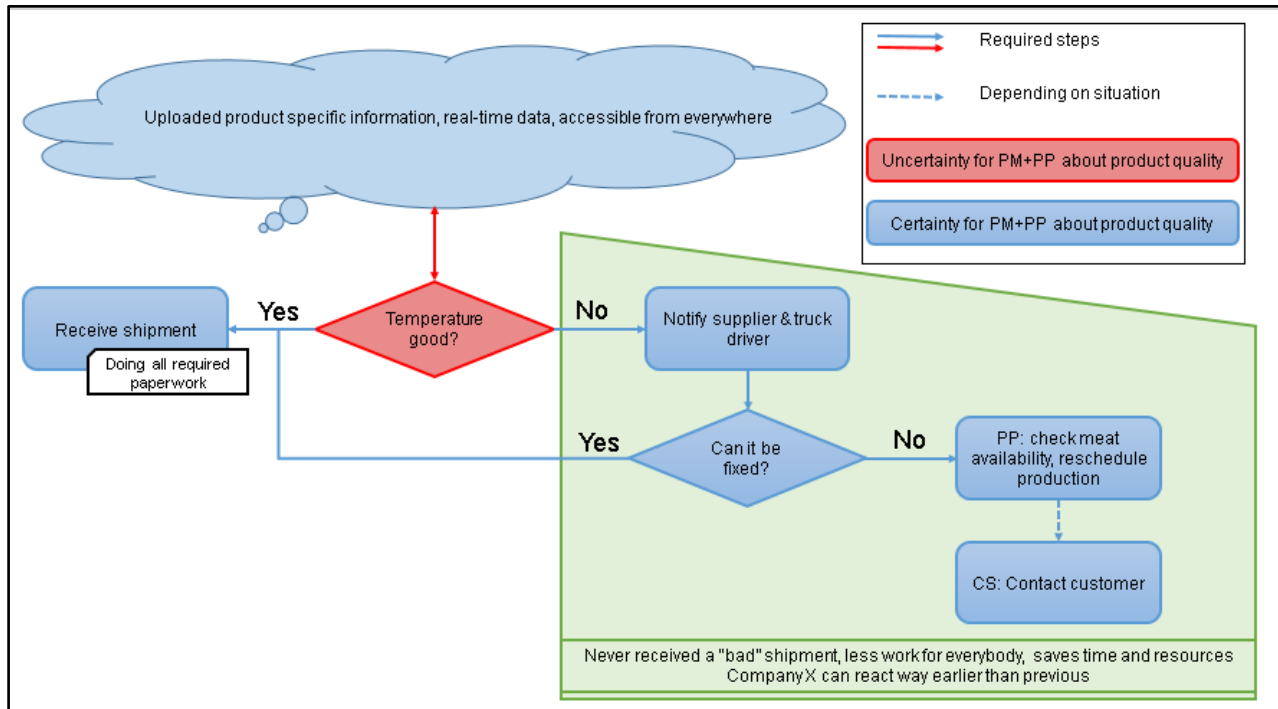


Figure 13: Impact of IoT on raw material testing

Source: Author's own figure

If the temperature is wrong, while the truck is still on the road, and the driver cannot fix the problem immediately, they can react and reject the truckload and order new meat. This saves a few hours and reduces the uncertainty since they know that the condition of the meat.

6.1.3 External impacts

It is challenging to keep track of the condition of highly sensitive products among the FFSC, because there are plenty of external impacts. As noted by the CEO, governmental rules and regulations need to be met (Appendix 1, ll. 20-22). Especially in a global FFSC, different regulation for different countries make it harder to meet all requirements. Besides that, some customer specifically defines the origin of the raw material used in their finished product. "Going along with all the specific demands of certain customers in regards to the origin of the meat and the composition, makes it hard to keep a higher stock or prepare yourself for changes and errors in forecast. That just doesn't add up like this" (Appendix 1, ll. 126-129). Further, the PM adds, that they are depended on logistic service provider since most of their supplier do not have an own fleet (Appendix 1, ll. 139-142). Most of those external impacts cannot be impacted by the IoT, since they are decided by governments or other higher powers, like weather.

6.2 Case study company

Since the main focus of this research is on company X, the company is described in a more detail way. Therefore, three of the main departments will be evaluated more closely, hence they play an elementary role in SCM. The production department is the main part of company X, producing the products, creates additional value and interacts with the purchase and sales department. The purchase department deals with the suppliers and communicates with suppliers and the production department. The sales department is the connection with the customers and company X. They receive orders and exchange information with customer.

6.2.1 Production

It is important to guarantee an ideal production environment while producing fresh food. This includes a low temperature (in case of meat around 0 degrees Celsius) in the production facility as well as clean and sanitised production machines. Employees need to meet certain standards hence they are in contact with the product. "All of our employee need to provide us a certificate of a medical examination before they start. Besides this, they have to wash their hands before they enter the rooms of production

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and they need to wear white coats, gloves and a hairnet which are not allowed to be moved out of the production room to avoid contamination” (Appendix 1, ll. 26-31). This statement is immediately followed by a statement of the CEO who respond to the statement of the QM, without being asked. This outlines the importance of the topic and special challenge, manufacturing fresh food products: “Yes, it is highly important for us to avoid contamination and provide a high quality product. Otherwise people get sick from our products, which is not what we want. Not only related to lawsuits and money, also related to their health. I wouldn’t handle it easily if people die because of our product. We carry a high responsibility” (Appendix 1, ll. 33-37). The temperature is measured randomly a few times a day. A constantly measurement, including real time reporting could ensure the right temperature and help to maintain the best environment for fresh food production. The setup would be similar to the truck situation as shown in Figure 13.

Further, burger and ground beef are products, which are consumed on a daily basis. Therefore, the PP notes “Our food products are kind of special in regards to consumption. If the weather is good for a couple days, they gonna buy more. If it’s bad, they buy less. They won’t do a BBQ in the rain. That is pretty unique and challenging for food manufacturing since the demand is unpredictable” (Appendix 1, ll. 144-149).

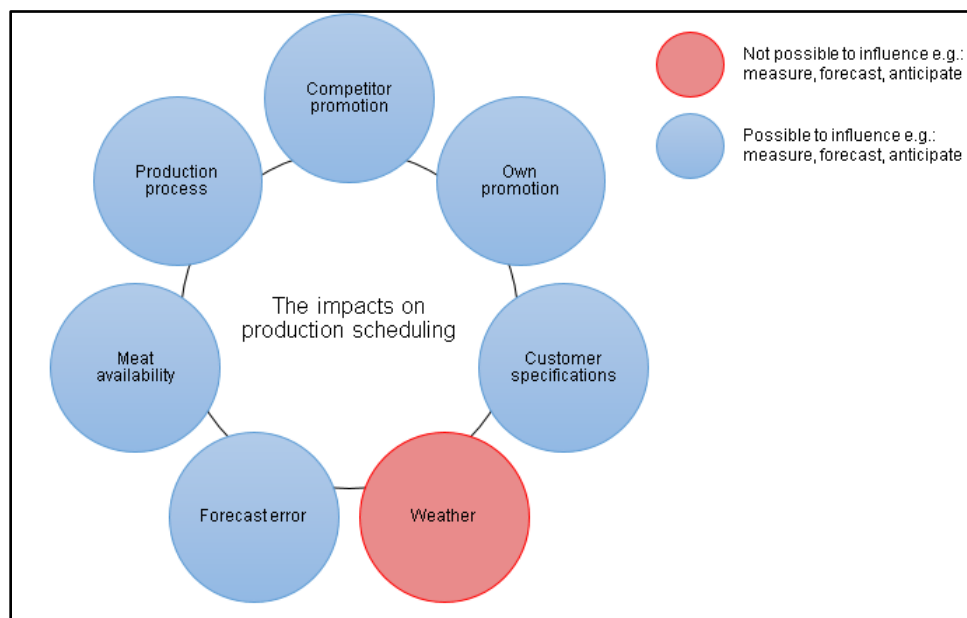


Figure 14: Impacts on production scheduling

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Source: Author's own figure

Including the uncertainties brought in by promotion, scheduling becomes a real struggle. Those influencing impacts on production scheduling are shown in Figure 14.

Due to the unpredictability of the demand, the production scheduled is based on a forecast. The forecast is a mix of the expected sales volume of the customer and the own experience of the PP. To schedule production, a rough production schedule for the whole week is made and adjusted (daily) after receiving the actual orders for the production day.

After the sales department communicated a change in order volume, the PP needs to communicate with the PM and decide whether they can fulfil the order or not. In both cases he needs to notify the sales department in order that they can notify the customers.

Besides the availability of raw material, operational aspects can influence the decision process, too. If the product is scheduled later the day, there is no issue. However, if the product is already finished before they receive a change in order, they need to consider a few things. First, they need to find time to produce it without a delay for other products, they need to consider additional costs for producing mostly a small batch. Especially the changeover costs and overhead costs get expensive. Further, the process to communicate to all relevant persons that the schedules changes costs time. "Sometime we don't make profit with those small reorders or order adjustments "(Appendix 1, ll. 43f.). This statement underlines the impact of those adjustments. However, he continues with "But we have to fulfil the customer orders. That's what they want, so it's what we make. Satisfy the customer, otherwise you lose him" (Appendix 1, ll. 44f.) This statement outlines the priorities company X has and lowers the importance of the decision making process wheatear to produce or not. However, it increases the importance of working with less or low uncertainty. Knowing exactly what to produce can save a lot costs. Even knowing it a few hours earlier can have an impact since the product might not be produced at this point. Therefore, an immediately communication of variation of the forecast can help the process. Currently the information needs to go through a lot people and steps. This is time consuming and lengthy since sometimes people are not available right away. The current process of scheduling is shown in Figure 15.

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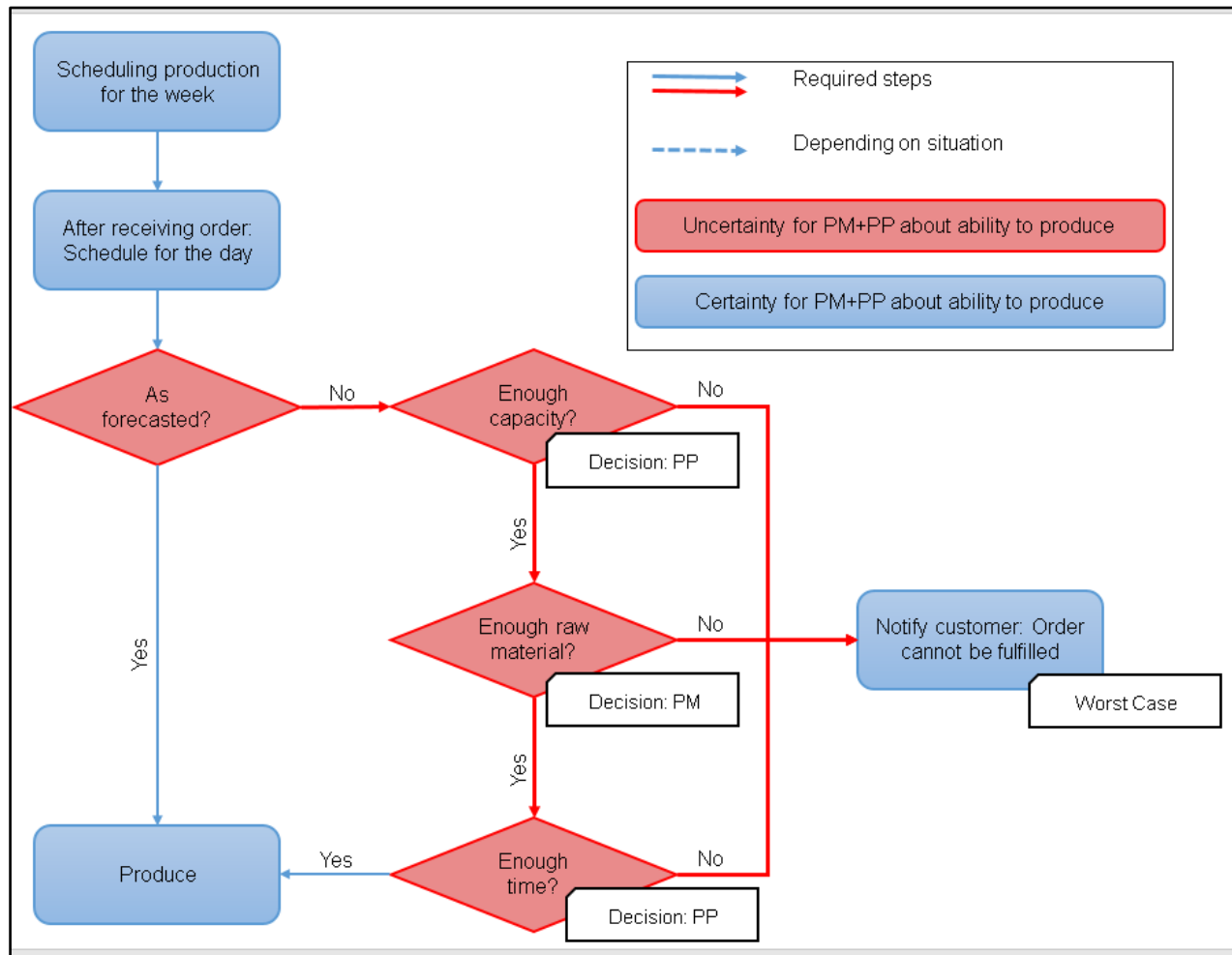


Figure 15: Current production scheduling process

Source: Author's own figure

Using IoT would affect the production scheduling in many ways. First, it would be possible to connect the counter of the supermarket with a system which uploads information about a sold product as soon as it was scanned. This will not replace the forecast but can give an indicator about the need volume. It should indicate if the forecast is way too high, too low or correct. A next step would be VMI, where company X and the customer agree to a certain level of stock. If they do so, no orders would be needed. All company X has to do is to fill up the products to the agreed stock level. Since fresh food has a short shelf life, a lot waste is generated (not sold products). Around 30 percent of food (in the U.S) is wasted between production and consumption

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(Scott, 2016). To overcome this issues, a new packaging method could be used. Since food is tied to chemical reactions, the “intelligent packaging” would measure those reactions to ensure freshness. It can measure the change of colour and aging of products (Scott, 2016). Similar to the recording devices in trucks, it can immaterially upload results of spoiled food and add it to the order or the VMI system. Figure 16 shows a IoT improved process of scheduling production.

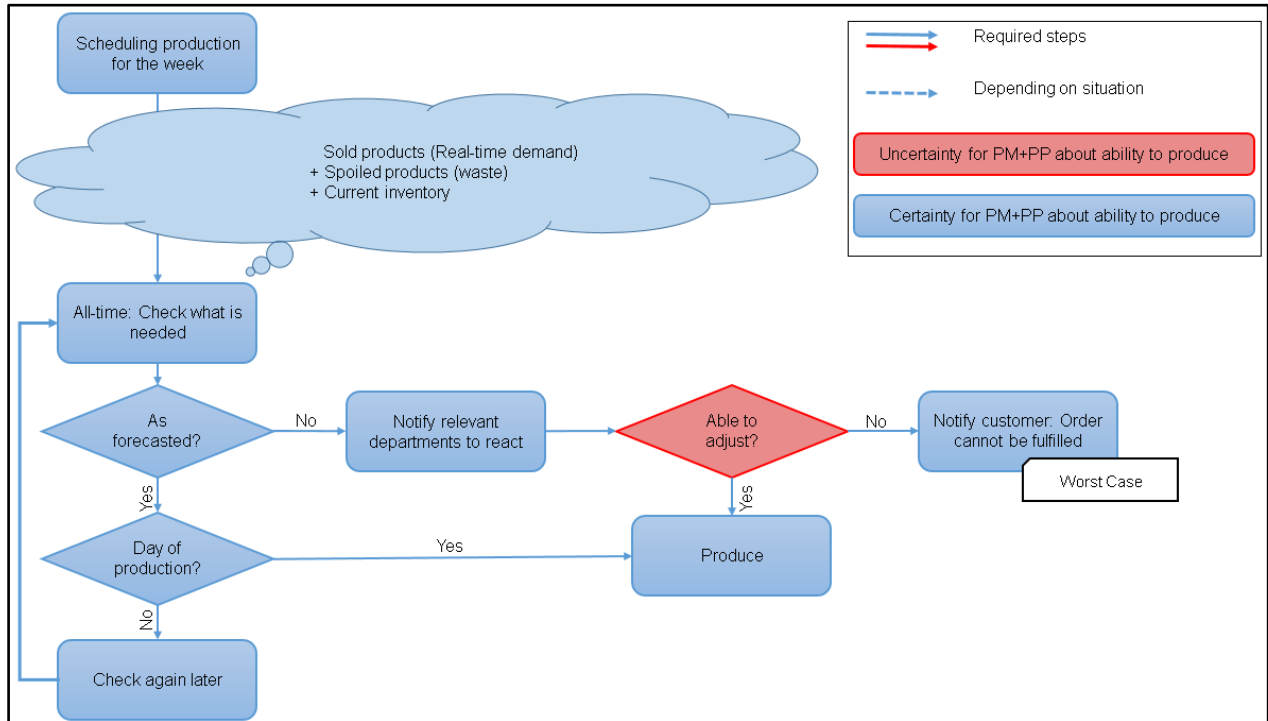


Figure 16: Production scheduling with the impact of IoT

Source: Author's own figure

Even though, the production scheduling process of Figure 16 looks more complex, it highly reduces the uncertainty. There are many affects the IoT can have on the impacts of Figure 14. Therefore, Table 3 provides an overview about the impact on IoT.

The impact of IoT on FFSCV

Impact	Without IoT	With IoT
Competitor's promotion	No information at all, maybe a head's up from their customer that there is a competitor's promotion, including an estimation.	Can see their own actual sales and have an indicator how the competitors promotion impacts their own sales. Real-time data are way more accurate than estimations.
Own promotion	Success of promotion is only estimated. Can vary a lot. Depending on other impacts.	Real-time data about sales volume can provide a precise information and helps to reduce the uncertainty in scheduling.
Forecast error	Noticeable after receiving the order of the customer.	Real-time information about the sales volume can give an indicator about the accuracy of the forecast.
Customer specifications	Requirements for the finished product. Given by the customer, mostly non-negotiable.	Same than without IoT.
Weather	Unpredictable and unmanageable.	Same than without IoT.
Meat availability	Cannot be ensured, due to high uncertainty about the demand. Need to be bought very flexible, sometimes with higher costs.	Demand gets more predictable, reduced uncertainty, increases the meat availability.
Production process	Regulated by humans, humans need to set up machines. Long process of communication.	With SMART manufacturing, machines would communicate with each other and report to humans.

Table 3: Influence of IoT on production scheduling

Source: Author's own table

Table 3 and Figure 16 outline the impact IoT could have on the production process. Mostly, those impacts are based on a higher transparency and more provided data by customers and suppliers. It refers to the exchange of information is closely related to the visibility among the SC, at least to their direct customers and suppliers.

6.2.2 Purchase and sales

The **purchase department** strongly interacts with the production departments, since they receive information about needed raw material. Based on those information, they need to ensure meat and packaging material is available all the time. Based on a weekly forecast, raw material is bought and provided for production processes. After exchanging the weekly information, a daily update is made with the production department. The main focus in this meeting is on the actual received orders and changes in demand. If raw material is missing, it need to be determined if they need to

order new raw material or if there is something available which is planned for a later (maximum one day later) production. However, this raw material need to be replaced, too. But it has a lower importance due to a larger timeframe. “Those meetings to ensure we have everything we need are very important and we really have to do them every day” (Appendix 1, ll. 107f.). Every time, the demand differs of the forecast, PM and PP need to sit together and discuss the availability and possibilities for further processing. This is time consuming but they can offer a high flexibility to their customers, hence they can change orders on a daily base.

Whilst dealing with fresh food, it is hard to keep a high stock to overcome uncertainty. The uncertainty of the PM is strongly connected to the uncertainty the PP has to face. An improvement of the production scheduling will automatically affect the PM, as shown in Figure 12 to Figure 16.

In charge for the customer orders and communicating the demand with the PP, the **sales department** is the interface between company X and customers. Receiving customer orders and forwarding them to the PP is one part of their job. The other part is to improve the relationship. It is always a good base, if the customer is satisfied with the performance, hence this is the main priority of company X, this condition is given. However, they need to find solutions for a change in agreement and or late delivery, which can also occur due to external impacts.

“Some customers give us a forecast, which is 100% reliable. But those are only two out of 23.” (Appendix 1, ll. 78f.). Besides those two customers, the demanded amount varies mostly from the forecasted. To overcome this fluctuation, faster communication would be a starting point. “Our customers wait until the end of the day until they know exactly what they need. After that we receive a new order.” (Appendix 1, ll. 80f.) Since most of the customer have own product specification and further differentiation between a private label and company X’s label, it is not that easy to use an over-produced product (due to shortenings) to balance an under-produced product. “Due to our recent performance our customer know that we do everything to fulfil their orders and they understand it if we can’t do it one day. But this shouldn’t happen too often” (Appendix 1, ll. 82-84). Knowing the customers best, the sales department can estimate the importance of the order and

the customer itself best. Therefore, their opinion about customers and orders is valued, too. If somebody needs to be shortened, they can evaluate best, who should be shortened.

6.3 Supply Chain

This chapter provides a wider view on the SC. Company X is linked with their suppliers and customers. In general, all orders are placed via e-mail, irrespective of getting an order of a customer or sending an order to the suppliers. To manage a SC successfully, the four elements of SCM must be fulfilled (managing demand, communication, integration, collaboration). This was already introduced in the literature review. To fulfil those elements, company X needs to cooperate with their suppliers and customers.

6.3.1 Customer

All customers of company X are located in the U.S. Most of them are located on the mainland, one of them is located in Hawaii. They receive deliveries via truck or ship in chilled or frozen condition.

Some customers, even though they are already a long-time customer just order their demand and are not interested in a further cooperation. Other customers are interested in a further cooperation to improve processes. This is also outlined by the CS: “Some customers just order what they need. I assume they won’t even be angry if we need to shorten¹ them. However, there are some, which are more cooperative and there is customer A², who is pushing for an improvement in cooperation” (Appendix 1, ll.88-91). Company X and customer A have a strong relationship. This leads to a wide exchange of information about production and market specific topics. Based on this, they test different things and discuss how the market would react. Those tests can go from a smaller product size or different flavours to different packaging materials. During those tests, everything they do is communicated in a very open way. This leads to transparency between them, which is required for a good evaluation.

¹ “To shorten a customer” means to deliver less products than he ordered.

² “Customer A” is used as a synonym to protect the real name of the company.

Some customers are not interested in an improvement of cooperation. Others are highly interested, as long as there is a benefit on their side. Therefore, it only works out, if both sides benefit and that is the way it is supposed to be. However, nobody can be forced to improve the cooperation. “Depending on your position in the market, our customers have a very different viewpoint about us. If we deliver only 1% of their good, they consider us to be a kind of unimportant or too small to put effort in improving” (Appendix 1, ll. 99-101). This statement outlines the different viewpoint of company X’s customers regarding the type of relationship. Obviously, it is the other way around if company X is a big supplier (above 20%) of the customer. If that is the case, the customer is more willing to deal with occurring situations and problems. Those different viewpoints of customers make it harder to implement concepts like the usage of IoT and force them to change their processes and adjust them to changes company X made. It is more likely that company X gets cut off and the customers looks for a different supplier.

6.3.2 Supplier

Company X has around 24 different suppliers in the U.S and around eight global suppliers. In this context, a supplier is defined as somebody who delivers raw meat or packing material. Thus, only things which are directly related to the product.

There are different relationships with each supplier and therefore, the degree of cooperation with each supplier is different. “We’ve got some supplier who are more likely to do us a favour than others would” (Appendix 1, ll. 59f.). In this context, doing a favour is related to be open to talk about something, discuss something, evaluate problems and exchange information, which are helpful for each other. “If we ask for information from a long time supplier, they put more effort into the process to provide us that information than a relatively new supplier would do” (Appendix 1, ll. 60-62). It was observed, that there is a strong correlation between the existence of partnership and trust among the companies and the degree of cooperation. “Degree of cooperation” can be understood as the willingness of supplier to share information and their investment in doing so, as well as the sensitiveness of shared information.

Especially in the fresh food environment, where production is mostly based on forecast, a good cooperation is required to overcome forecast errors and satisfy customers.

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“Sometimes I have to call suppliers to ask them for a delivery in the next few hours. Not all of them would do that, some of them cannot do this due to distance. I’m limited on my options but that makes cooperation even more important” (Appendix 1, ll. 53-55). Nevertheless, it was observable that it takes some time to call multiple supplier and get their demands. Besides that, during this process, most of the employees are stressed, due to the uncertainty. Nobody knows what to plan and what to tell their customer. Therefore, a real-time exchange of information and communication as far as less error in forecast could have a positive impact on the buying process. This can be achieved with IoT. Delays in exchanging information can crucial affect the performance of company X. However, the CEO states “There is no certain supplier we have a really good relationship with. Not that they are bad, but there is no extraordinary we need to point out. There is a lot of room for improvements” (Appendix 1, ll. 68-70). This, however, is in contrast to the previous statement of the PM and indicates different viewpoints of the situations.

7 Discussion

This chapter will discuss the findings of this research in regards to the applicability to the fresh food industry (FFI). The discussion will focus on the literature, analysis and the discusses wheatear it can be transferred to other fresh food companies.

The analysis pointed out that the importance of managing a SC became more and more important. Especially in the FFI, where fast moving goods and a high uncertainty is given. These findings confirm the literature, which underlined the importance of SCM and outlined the four important elements of managing a SC. Those are demand management, communication, integration and collaboration. The importance of demand management is already given. Further, communication among members of the SC, as well as integration and collaboration support the interaction of members, decreases uncertainty (on all sides) and improves the whole SC.

Managing the SC successfully can be achieved, using IT as support. Especially the new technology IoT can help to successfully improve the management. Using IoT to manage a SC, can provide an easy way to exchange information and increase transparency of the whole process. It shortens processes and makes information available in real-time. It cuts off processes to gather information, since everybody can access information at anytime from anywhere. Besides many advantages, IoT needs to face some challenges. Security is probably the biggest challenge, since a lot information are shared. This is also mentioned in literature. However, literature does not refer to the usage of IoT among a whole SC in regards to cover the whole SC. Surely, a producing company can implement IoT and some supplier and customer would adjust their own processes and use IoT, too. However, it is not likely that all companies, involved in the SC, will do the same. Therefore, the IoT is not established enough.

As described in literature, SCV became more and more important in recent years. This is confirmed by this research, since customers require more and more transparency and companies exchange more and more information with each other. They reveal and share more and more information. This leads to an extended SCV. It and IoT support the processes to achieve a higher SCV, since information sharing is essential for SCV and IoT automatically shares information. However, some challenges are already mentioned in literature (cooperation of companies, financial restrictions, implementation and

security) and confirmed through the research. Not all members of the SC are interested in more visibility and hence they are not willing to put resources into improvements. Further, small companies need to face a financial investment, which might pay off after a few years, but requires a lot restructuring which is also related to resources they might not have.

Managing a FFSC and increase the visibility of it with the support of IoT can impact all participating companies. As shown in the analysis, company X would benefit from it among all departments. Further, their supplier and customers would benefit, too. The general potential of IoT in the FFI is relatively high. IoT is basically an upgrade of current processes used in the industry. This assumption is based on the characteristics of the market (unpredictable), the consumer (changing demand) and the product (fast moving, short shelf life, make to stock). However, it varies from case to case, since the current structure of every company differs. Nevertheless, the main tendency is and improvement of current processes via IoT. Since IoT is an improvement itself of gathering, exchanging and analysing information it should offer the possibility to improve all companies in the FFI.

A survey made by eft (2016) confirms the findings. The survey was held with more than 600 manufacturer, retailer and logistic service providers. Most of them are looking for information about location, security, temperature and speed. Further, the main goal is to improve customer service and provide more information to the customer. 59% would use IoT as alarm and real -time monitoring, while 41% would use it as optimisation and prediction. As shown during the research, both ways are very useful. However, most companies only collect data from their own places like other stores or warehouses. This confirms the lack of standardisation among the whole SC. Further, only 5% see cyber security as “no threat”. The last two issues were addresses during the research, too. In general, the survey mostly confirms the findings of the research, which makes it interesting to apply the findings to a different industry to confirm those.

Summing it up, the initial objectives were fulfilled. This research provides an insight into the impact of IoT on FFSCV and discusses the relevant points. Therefore, the approach of this research was chosen correctly. For a more certain generalization, a second and

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third company would have been useful to confirm the findings of this research. Nevertheless, the main objectives are fulfilled and the research aim is answered.

8 Conclusions and recommendations

During this research, a linkage between the IoT and the FFSCV was made. As mentioned at the beginning of the research, some research objectives and a research question should be answered during the study.

The **first research objective**, understanding the importance of the FFSCV, is discussed in the literature review and further backed during the analysis. The literature, as well as the analysis outlines the specific product characteristics of fresh food and the specific handling. The analysis outlines the uncertainty of the market and the demand many times, while the literature focuses mainly on the general characteristics of the product, like low shelf life or special handling. Since this study is based on company X, the uncertainty of markets and demand might become important due to the real life context. However, the uncertainties result from the specific product characteristics among a FFSC. Therefore, this difference is understandable and comprehensible.

Identifying the usage of IT in a SC is the **second research objective** and answered during the literature review. Irrespective of managing a SC or increasing the visibility of the SC, IT always plays an elementary role. The review outlines the importance of IT. Not only software, like ERP Systems or other planning tools are important. Also hardware, like RFID play an essential role. Further, RFID provides the base for the current “industrial revolution 4.0” IoT. This is based on the strong growth of the internet during the last years in business and everyday life.

The **third research objective**, the identification of potential benefits, using IoT to support fresh food supply visibility, is discussed during the analysis. Summing it up, there are many positives way, the IoT can impact the SC of company X. It shortens the information processes, makes processes more efficient, reduces the uncertainty, increases the opportunity to always fulfil customers’ orders and ensures a smoother process among the SC due to real-time information.

However, as the **fourth research objective** points out, the implementation of IoT in company X will not be that easy. Even though, there many advantages for company X, their supplier and their consumer, an implementation will be difficult. First, it is high likely that some customer and supplier will not be interested to share information among the chain, due to resources they need to put into changes. For some it is not worth it, others

do not have the capability to do so. Nevertheless, an implementation of IoT with a few suppliers could be possible. However, the benefit of this need to be carefully evaluated, since the old structure will be still part of the company.

Finally, **research objective five** deals with a solution for the general FFI. As mentioned above, implementing IoT will bring advantages to a company and the SC. This is not only applicable for company X, but also for other companies in the FFI, since they all face the same circumstances of the specific product characteristics and markets. The usefulness of an implementation in only one company is still debatable. More companies need to be willing to change their current processes and implement IoT. Since this technology is quite new, not well known and requires many resources (money, time, human), most companies in the FFI are not ready for the change. Even the big companies in the markets just started to implement parts of IoT and are far off from implementing the whole concept.

To sum it up, the following research question is answered:

“How could the Internet of Things have a positive impact on the Fresh Food Supply Chain visibility?”

First, to answer if a positive impact is possible at all, it is important to point out that the IoT is able to have a positive impact on FFSCV in general. Secondly, to answer the how, the following aspects have a positive impact on the FFSCV using IoT:

- Real-time data about
 - transportation
 - demand
 - effect of promotions (own and competitor)
- reduction of uncertainty
- shorter processes among the SC
- more efficient SC
- cheaper SC

However, it need to be pointed out, that an implementation of IoT by the current state is relatively unlikely. The positive impact increases with the number of involved companies in the SC. Due to the novelty of the technology, some challenges which still need to be faced and the needed resources, an implementation in many companies is expected to be unlikely.

In future, the IoT can have a huge impact on any company among the FFI. Therefore, company X and other companies in the FFI should not ignore the IoT. They should keep themselves up to date about the progress of the technology and evaluate whether it is time to discuss an implementation of IoT or not. This, obviously, varies from company to company and a timeframe cannot be determined.

8.1 Validity and reliability

To ensure the validity and reliability of this research, several action had been done. Based on Yin (2014), validity can be tested by using external validity. To ensure validity, theory should be used among a single case study. Since this research deals with a single case study and uses secondary literature, which is mainly theory, the validity of this research is given.

The reliability of a case study can be achieved with a case study protocol or a case study data base. During this research, a case study protocol has been developed. A table of content of the case study protocol is in appendix 2.

8.2 Future Research

Due to some limitations and the novelty of IoT, this research cannot cover every aspect. Therefore, some recommendations for further research are given:

1. Since costs and resources are not discussed in depth, further research could focus on
 - 1.1. the costs of implementing the IoT, or
 - 1.2. the required resources to restructure companies processes and implement IoT.
2. This research is only based on one company. A further research could test, whether the findings of this study are also applicable to different companies, considering

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- 2.1. companies also located in the U.S, or
 - 2.2. companies located in a different country.
3. Further, the research can be used and findings can be tested in a different industry, while differentiation between
- 3.1. a different industry, but in the U.S, or
 - 3.2. A different industry and a different country.

The first recommendation has a more practical approach, since it discusses the economic feasibility and viability of the IoT. The second research focuses on confirming the introduces findings, while the third recommendation tries to generalise the findings. Hence, the IoT is a new topic, all three future research recommendation need to take into account that the IoT itself can dilate. The scientific discovery of the topic is in the beginning and new discoveries can change the presented findings.

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Appendix 1 – Group interview

Participants	Shown as
Researcher	RES
Chief executive officer	CEO
Customer Service	CS
Purchase Manager	PM
Production Planner	PP
Inventory Manager	IM
Quality Manager	QM

1 **RES: Welcome to this group interview about company X. Just for the**
2 **records, you are all employed at company X and work here for at least 2**
3 **years, aren't you?**

4
5 *(Everybody confirms by nodding)*

6
7 **RES: Alright, let's start. Since company X is a food manufacturer, they**
8 **need to face certain circumstances in regards to handling the food. What**
9 **makes food production so special?**

10
11 QM: That's right. There are so many rules, guidelines and regulations we have
12 to comply with. The quality of the food is set high if you are a certified food
13 manufacturer... which is what we are. Further, consumers want more
14 transparency. That is why company X needs to label the exact ingredients and
15 their origin.

16
17 PP: For me, it is an unpredictable market. That makes it hard to forecast the
18 production.

CEO: Especially governmental rules and regulations are hard to meet. You need to be prepared to get checked every day. That's what we are and that's what they want.

RES: What do you do to achieve this?

QM: All of our employees need to provide us a certificate of a medical examination before they start. Besides this, they have to wash their hands before they enter the rooms of production and they need to wear white coats, gloves and a hairnet which are not allowed to be moved out of the production room to avoid contamination. Besides that, we have plenty of samplings in regards to all kinds of guidelines we need to fulfil.

CEO: Yes, it is highly important for us to avoid contamination and provide a high quality product. Otherwise people get sick from our products, which is not what we want. Not only related to lawsuits and money, also related to their health. I wouldn't handle it easily if people die because of our product. We carry a high responsibility.

RES: So, you feel responsible for your customer? Is customer satisfaction is very important for you?

CEO: Yes, not only for our direct customer, but for everybody who eats our meat. We always try to fulfil everything. Sometimes we don't make profit with those small reorders or order adjustments. But we have to fulfil the customer orders. That's what they want, so it's what we make. Satisfy the customer, otherwise you lose him.

RES: What is the biggest challenge, dealing with different suppliers?

PM: Sometimes I have to call suppliers to ask them for a delivery in the next few hours. Not all of them would do that, some of them cannot do this due to distance. I'm limited on my options but that makes cooperation even more important.

RES: Why is that?

PM: Well, I have to call them if our adjustments in production are big. We've got some suppliers who are more likely to do us a favour than others would. If we ask for information from a long time supplier, they put more effort into the process to provide us that information than a relatively new supplier would do.

RES: So I assume you have a really good relationship with your supplier?

PM: Yes

CEO: In my opinion there is no certain supplier we have a really good relationship with. Not that they are bad, but there is no extraordinary we need to point out. There is a lot of room for improvements.

RES: And what about the customers?

CS: As already mentioned, customer satisfaction is our highest priority.

RES: Is it hard to fulfil their orders every time?

CS: Some customers give us a forecast, which is 100% reliable. But those are only two out of 23. In those cases, it is not hard. But if the forecast is way off, we get into trouble. Our customers wait until the end of the day until they know

82 exactly what they need. After that we receive a new order. After receiving it, we
83 need to figure a way out to adjust our production. But due to our recent
84 performance our customer know that we do everything to fulfil their orders and
85 they understand it if we can't do it one day. But this shouldn't happen too often.

86
87 **RES: What happens if you cannot fulfil the orders?**

88
89 CS: Some customers just order what they need. I assume they won't even be
90 angry if we need to shorten them. However, there are some, which are more
91 cooperative and there is customer A, who is pushing for an improvement in
92 cooperation. Therefore, it is unlikely that we gonna shorten them. Some
93 customers are not interested in an improvement of cooperation and are more
94 likely for a cut, since they are not that important for us. But often it is depending
95 on the situation.

96
97 **RES: Why is there a difference in interest of improving among the**
98 **customers?**

99
100 CEO: Depending on your position in the market, our customers have a very
101 different viewpoint about us. If we deliver only 1% of their good, they consider us
102 to be a kind of unimportant or too small to put effort in improving.

103
104 **RES: What happens after you receive the order and notice it is way off the**
105 **forecast?**

106
107 PP: We need to figure out a way to solve the problem. Therefore, I have a
108 meeting with the PM every day. Those meetings should ensure we have
109 everything we need. They are very important and we really have to do them
110 every day. We discuss the availability of meat we can use for further processes.
111 Where we use which meat and if we need more meat. Further it's depending on
112 the question if we can get more meat and after all this, we still have to talk with

CS about “what is important to make and who can be shorten”. CS has the closest contact to our customers and can is closest to the customer. So they can evaluate this situation best.

How often do you need to make those adjustments?

PP: We have to do them on a daily basis. It’s a log and annoying process we go through day after day after day. But at the moment, there is nothing we can do about it.

RES: Can’t you keep a higher stock?

IM: We do that with our packaging material but we can’t do that with our meat. That makes it more challenging. Additionally, it is hard to do so, due to the specifications of the customer’s final product. Going along with all the specific demands of certain customers in regards to the origin of the meat and the composition, makes it hard to keep a higher stock or prepare yourself for changes and errors in forecast. That just doesn’t add up like this.

PP: If we could do this it would be very good. But the maximum age of meat we process is six days after slaughtering. If they keep it on stock for a day and it takes two or three days until we receive it, we can keep it on stock for only 2 or three days.

RES: So the forecast accuracy has the biggest impact on planning and production?

PM: No, not only. We are also depending on logistic service providers. Most supplier don’t have an own fleet. That makes it harder to contact them and ask them where they are. And if they don’t deliver on time, it’s our problem and we have to find a solution for it.

144
145 PP: Besides that, our food products are kind of special in regards to
146 consumption, too. If the weather is good for a couple days, they gonna buy
147 more. If it's bad, they buy less. They won't do a BBQ in the rain. That is pretty
148 unique and challenging for food manufacturing since the demand is
149 unpredictable. So, this is also an impact. But that's what you have to deal with if
150 you dealing with make-to*stock products.

151
152 CS: Promotions are also impacting. Of course, they are related to the forecast
153 error, but they are also a kind of predicable, if communicated in the right way.
154 Even though promotions are communicated with our customers, we don't know
155 the impact of it. If the promotion runs a week, we'll get an estimated amount for
156 the promotion. But depending on weather, people buy a lot or less. But we need
157 to plan with the estimation. Further, promotions of competitive companies are
158 not communicated at all. That's also very bad for us.

Appendix 2 – Table of content: case study protocol

1. Overview of the Case Study
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4. Guide for the Case Study Report
 - 4.1. Provide a short background
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