Opportunities and Challenges in the Implementation of Dynamic Shelf Life in a Food Supply Chain

– a Business Perspective

Lina Nord

Lina Olofzon

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Division of Packaging Logistics
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PREFACE

Our master thesis was written during the spring of 2014 and is the final part of the master in Industrial Management and Engineering at Lund University. The thesis is a part of DynahMat, which is an ongoing project at the Packaging Logistics department at Lund University that has the purpose to reduce food loss. The idea for the thesis was developed in collaboration with the DynahMat group. Bring Customer Solutions is involved in the project and was therefore chosen as a suitable company for the thesis.

We want to express our sincerest thanks to Jonas Karlsson at Bring Customer Solutions who have been very supportive and enthusiastic throughout this thesis. We would also like to thank the other employees at Bring Customer Solutions that have been interviewed and contacted for questions.

Finally, we would like to thank Malin Göransson, our supervisor at Lund University, for her valuable support and feedback, and Fredrik Nilsson for helping us designing the project.

Lund, May 2014

Lina Nord and Lina Olofzon

ABSTRACT

DynahMat is an ongoing project at the Packaging Logistics department at Lund University, which aims to reduce food waste by establishing the true quality and shelf life of chilled goods through a dynamic shelf life prediction (DSLP) service. The idea behind the service is, throughout the entire supply chain, to measure temperature and microbial growth using sensors attached to the package. The information will at certain points in the supply chain be sent to a cloud service that calculates the remaining shelf life by using prediction algorithms.

The aim for this study is, from a business perspective, to analyze the opportunities and challenges in the implementation of a DSLP service in a supply chain and also the effect it would have on the studied 4PL company's business model (Bring Customer Solutions). The method that is used is a single case study on one of the food supply chains that the case company coordinates. The data collection consists of literature findings, interviews and study visits. Six different areas of study are researched which has been put together into a theoretical framework that has served as a basis when developing an analysis framework to answer the research questions.

The findings show that there are many opportunities connected to the DynahMat project such as being able to guarantee the quality of the supply chain and the goods it delivers. Other opportunities are increased track- and traceability of the goods and also more visibility, collaboration and information sharing in the supply chain which can have a positive effect on its performance. In addition, the DSLP service offers the possibility to easier measure the supply chain performance. There are also challenges with the DSLP service. For example, it is important to convince all actors to cooperate and make the necessary investments. The increased visibility in the supply chain will also make the actors more exposed and accountable for their performance. Another challenge is the extended requirement on coordination and communication. Moreover, it can be determined that the 4PL's business model will change on several points. For example, the supply planning needs to be changed to a more reactive approach, new technology needs to be implemented and there will be a higher degree of transparency to the customer and to the logistics providers.

Key words: DynahMat, DSLP service, Dynamic Shelf Life, RFID, Biosensors, Supply Chain Management, Business Model, Coordination, Collaboration, Information sharing, Transparency, 4PL Company

SAMMANFATTNING

Bakgrund

DynahMat är ett forskningsprojekt på avdelningen för Förpackningslogistik på Lunds Universitet, vars syfte är att reducera matsvinn med hjälp av dynamiska hållbarhetsdatum. Målet är en tjänst som med hjälp av parametrar som mäts i försörjningskedjan skall kunna beräkna ett mer korrekt bäst-före-datum. Tjänsten kallas DSLP, vilket står för *Dynamic Shelf Life Prediction* (ung. prognos för dynamisk hållbarhet). Genom att mäta parametrar som temperatur, tid och bakterietillväxt när maten distribueras från producent till slutkund, kan ett mer korrekt bäst-före-datum än de statiska, förutbestämda beräknas. Parametrarna skickas via RFID-teknik till en molntjänst där beräkningar görs innan datumet skickas tillbaka till aktörer i kedjan eller slutkunden.

Problembeskrivning

Matsvinn är ett stort problem i dagens samhälle. Förhoppningsvis kan DSLP-tjänsten bidra till att minska detta i alla led: både i försörjningskedjan, i affären och hos slutkund. För att tjänsten skall lyckas krävs det att alla aktörer samarbetar och siktar mot detta gemensamma mål. Det är därför viktigt att alla aktörer har incitament att delta i implementeringen. Utöver detta behöver även kostnaderna för en implementering samt utmaningarna undersökas.

Syfte

Syftet med detta examensarbete är att, från ett affärsperspektiv, analysera möjligheter och utmaningar med en implementering av DSLP-tjänsten i en försörjningskedja, samt att undersöka hur affärsmodellen för ett 4PL-företag påverkas av en sådan implementering.

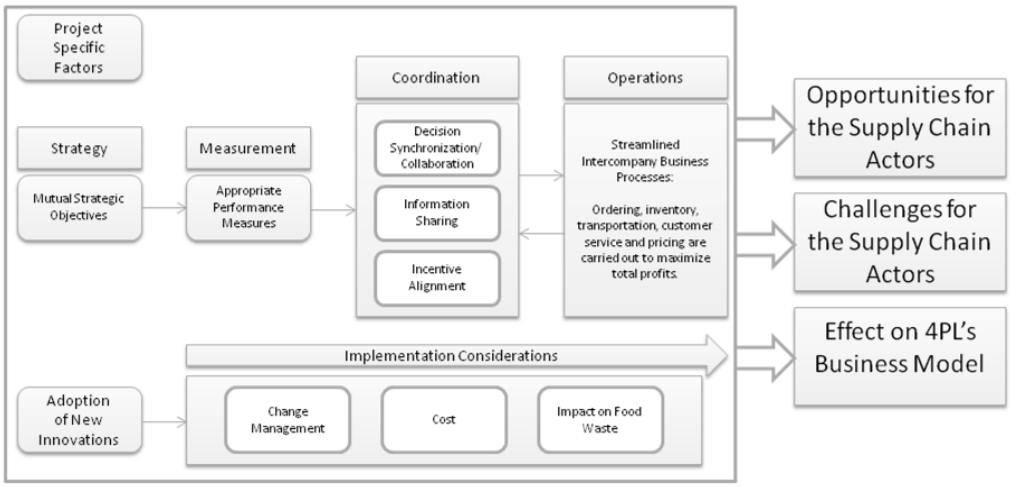
Följande forskningsfrågor skall besvaras i examensarbetet:

1. Hur fungerar försörjningskedjan i dagsläget?
2. Vilka möjligheter skulle skapas för aktörerna i försörjningskedjan i och med en implementering av DSLP-tjänsten? Vilka incitament finns för dem?
3. Vilka är de största utmaningarna om tjänsten skulle implementeras?
4. Hur skulle en implementering av dynamiska hållbarhetsdatum påverka 4PL-företagets affärsmodell?

Metod

Metoden som använts är en enfallsstudie på en försörjningskedja för mat som det studerade företaget, Bring Customer Solutions, koordinerar. Datainsamlingen har

bestått av litteraturstudier, intervjuer och ett studiebesök. Sex olika områden har undersökts och sammanställts i ett teoretiskt ramverk. Detta ramverk utvecklades sedan till ett analysverktyg, som använts för att besvara forskningsfrågorna.



Figur A. Analysverktyg

Empiri

Den försörjningskedja som studerats är för varmrökt lax, från Smögen i Sverige till Paris och Brest i Frankrike. Anledningen till att just denna produkt studerats är att den har ett högt värde och kort hållbarhet. Produkterna transporteras från Smögen till centrallagret i Staffanstorp. Därifrån transporteras laxen till distributionslagren runtom i världen, i detta fall till Bryssel. Därifrån går transporterna direkt till affären i Paris. Transporterna till Brest passerar en omlastningscentral, då sträckan till detta varuhus är längre. Hur Bring Costumer Solutions hanterar den varmrökta laxen skiljer sig från de andra produkterna, då detta är en värdefull produkt med kort hållbarhet. Av den anledningen skickas endast laxen direkt mot kundorder, det vill säga att den aldrig lagerförs. Datainsamlingen visar att mängden matsvinn i försörjningskedjan i dagsläget är försumbar, vilket troligtvis beror på att produkten följs noga genom hela kedjan och alltid levereras till en specifik affär som lagt en order på laxen. Bring Costumer Solutions ser ett införande av dynamiska hållbarhetsdatum som ett sätt att utveckla de tjänster de idag erbjuder sina kunder.

Slutsats

Resultatet visar att det finns många möjligheter kopplade till DynahMat-projektet där de främsta är att säkerhetsställa kvalitén på både försörjningskedjan och den mat som levereras. Andra fördelar är den ökade spårbarheten av produkterna, en

ökad transparens samt möjligheter till bättre samarbete och informationsdelning mellan kedjans aktörer. Dessa fördelar kan tillsammans bidra till en förbättrad försörjningskedja. Företaget kan också använda tjänsten för att skapa nya mätetal, såsom hur många leveranser som har levererats till affär med samma eller ett framflyttat bäst-före-datum som producenten beräknat.

Givetvis finns det även utmaningar med en implementering. För det första är det av stor vikt att övertyga alla aktörer i kedjan att det är värt att samarbeta kring och göra investeringar i den nya tjänsten. Att installera själva tjänsten i kedjan och få tekniken att fungera som tänkt kommer också bli en utmaning. Vidare så kommer den ökade transparensen att leda till att de enskilda aktörernas prestationer blir enklare att följa och därmed blir ansvariga om maten försämras eller förstörs under den tiden de hanterar den. En annan utmaning är de ökade kraven på koordinering och kommunikation mellan aktörerna. Även 4PL-företagets affärsmodell kommer att påverkas av en implementering. Bland annat kommer planeringen av matflödet att ändras – man kan inte längre planera mot fasta bäst-före-datum. Detta beror på att datumen kommer att ändras vilket kan innebära att nya beställningar måste göras eller att de beställningar som redan ligger bör senareläggas. Dessutom kommer en implementering att kräva ny teknik, närmare bestämt RFID-teknik i form av etiketter och läsare samt integrering av de nuvarande datasystemen med DSLP-tjänsten. Även den ökade transparensen kommer att påverka affärsmodellen, då transparensen ökar mot både företagets kunder och mot dess leverantörer.

Nyckelord: DynahMat, DSLP-tjänst, dynamiska hållbarhetsdatum, RFID-teknik, biosensorer, Supply Chain Management, affärsmodell, koordinering, samarbete, informationsdelning, transparens, 4PL företag

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ABBREVIATIONS

BBD	*Best Before Date (swe. Bäst före dag)*
Bring CS	*Bring Customer Solutions*
CW	*Central Warehouse*
DC	*Distribution Center*
DO	*Distribution Order*
DOE	*Date of Expiry (swe. Sista förbrukningsdag)*
DSLP	*Dynamic Shelf Life Prediction*
EDI	*Electronic Data Interchange*
ERP	*Enterprise Resource Planning*
FEFO	*First Expiry First Out*
FSC	*Food Supply Chain*
GPS	*Global Positioning System*
PO	*Purchase Order*
RFID	*Radio Frequency Identification*
SC	*Supply Chain*
SCM	*Supply Chain Management*
TTI	*Time and Temperature Indicators*
WSN	*Wireless Sensor Network*
4PL	*Fourth Part Logistic*

1 INTRODUCTION

In this first chapter the areas that define the thesis are presented. Firstly, the background is described, which together with the problem discussion motivates why the study is of interest. The purpose and goals of the report are then presented. Thereafter the delimitations are defined and motivated. A business description of the company involved in the thesis is presented, as well as which readers the thesis targets. Finally, the structure of the thesis and the content of the chapters are briefly described.

1.1 Background

Food waste is a serious and vast problem that has been given more attention in the last couple of years. Globally, one third of all the edible food for human consumption is wasted which approximately corresponds to 1.3 billion ton per year (Gustavsson, et al., 2011). Moreover, households are responsible for the largest part whereas the food industry stands for the second largest part of the food waste (Jensen, et al., 2011). There are also economical drawbacks that come from food waste, which concerns the households, the industry as well as the community. There is a lot of economic potential in reducing the food waste, which should give the food industry and the household's incentives to do so. For example, if the total food loss were reduced by 20 percent, the economic gain for society would be about 9.6 – 15.9 billion SEK per year (Swedish Environmental Protection Agency, 2012).

In developed countries food loss mainly is a consequence of consumer behavior and lack of coordination between the actors in the supply chain (Gustavsson, et al., 2011). There is also a lack of knowledge of best before dates both from the consumers and the wholesalers and food stores. They misinterpret the legislation as well as the actual state and shelf life of the food, which often is perfectly eatable even though the best-before date has passed (Swedish National Food Agency & Swedish Environmental Protection Agency, 2013).

There have been several projects and initiatives dealing with food waste as well as efforts to inform the population about the damaging environmental and economic effects, e.g. the CHILL-ON project and the Pasteur project. An ongoing study at the Packaging Logistics department at Lund University is called DynahMat and has the purpose of reducing food loss by introducing a dynamic shelf life prediction (DSLP)

service to determine the actual shelf life of individual food products (Packaging Logistics, 2013).

The idea behind the DSLP service is to communicate and predict food quality and safety with a dynamic shelf life instead of the static best before dates that exist today (Packaging Logistics, 2013). This will be accomplished by using sensors and information systems that can be integrated and implemented throughout every part of the food supply chain. There are two sensors that can be used. One is a sensor that can measure the temperature in real time and communicate this to the information system. The other is a biosensor, currently a work in progress, which will be able to measure the microbial growth and other quality parameters. The goals of changing the static best before dates to the dynamic are to reduce food loss and increase consumer trust in the real shelf life of a food product. Another goal with DynahMat is to increase the supply chain actors' awareness of how their operations affect the shelf life of the product, which will act as an incentive to improve these.

The DynahMat project will be able to make most impact if every actor in the supply chain collaborates (Packaging Logistics, 2013). The benefits of having dynamic shelf life are fewer if the actors in the supply chain do not perform at the same level since it only takes one mistake to decrease the shelf life of the product. Moreover, there are challenges connected to the project, which need to be overcome if it is to succeed. Investments need to be made both in the sensors and the information system but also in educating the employees and collaborating in the supply chain. The opportunities and profitability of the project needs therefore to be known from the start to create motivation and incentives for the supply chain actors to participate.

1.2 Problem Discussion

DynahMat is a project with the objective of reducing food waste in the supply chain by introducing a DSLP service on the market. However, the service is still in progress and its prerequisites need to be established. An essential part of making the project succeed is to coordinate the whole supply chain and make the actors work together towards the common goal. For this to happen the opportunities and incentives for the participating actors needs to be established since an implementation will put requirements on all actors involved. Also, it is important that the challenges connected to the project are identified in order to prepare the supply chain for an implementation and examine the value of the project.

1.3 Purpose and Goals

The purpose of the master thesis is, from a business perspective, to analyze the opportunities and challenges in the implementation of a DSLP service and also the effect it would have on the operations and the business model.

More specific, the goal is to answer the following questions:

1. How does the chosen supply chain currently function?
2. What opportunities does the implementation create for the supply chain, including incentives for the actors?
3. What are the largest challenges for implementation in the supply chain?
4. How will an implementation of a dynamic shelf life change the 4PL company's business model?

In addition to answering the research questions in the thesis, a recommendation for Bring CS whether to implement the DSLP service or not will be provided.

1.4 Delimitations

The thesis focuses on how the supply chain and the 4PL company's business model are affected when implementing dynamic shelf life. How the sensors work will be covered briefly, but this is not the main area for the study. A case study will be conducted on a specific supply chain that is coordinated by the 4PL company, to analyze how an implementation of a DSLP service would change the current operations and the 4PL company's business model. The study is focused on chilled food since it is important to maintain the correct temperature throughout the supply chain, and these products are the ones that have the most to gain from using dynamic shelf life and temperature readings. The case study will be focused on hot smoked salmon, 200g packages, in the supply chain for the Southern Europe region, starting with the producer and ending with the 4PL company's customer, i.e. the retailer. More specifically, the stores that have been chosen are two stores in France: one in Paris and one in Brest. Furthermore, legislation and rules concerning labeling of food will be covered briefly, but this will not be a large part of the study.

It should also be mentioned that the 4PL company's customer has asked not to be described in the thesis, and have not participated in interviews or studies. The logistics suppliers to the 4PL company have not participated either. Some information about the actors has been taken from their websites, but since they are anonymous, the websites cannot be found in the thesis.

1.5 Originality and Value

There are several projects that are similar to the DynahMat project (described in chapter 3.4.2). The CHILL-ON project follows cod in a supply chain to examine different types of methods and criteria to establish alerts for support systems (CHILL-ON, 2012) (Haflidason, et al., 2012)The Pasteur project examines multiple-capability sensor platforms, where more parameters than temperature are measured (Guillory & Standhardt, 2012). There have also been studies on challenges of applying Wireless Sensor Network technology in logistics (Becker, et al., 2009). Even so, none have the same objectives of studying the opportunities and challenges for the actors in the supply chain and how a 4PL company's business model will be affected. The study that has been done on what challenges there are when implementing WSN in logistics has a more technological approach, concerning ICT. The CHILL-ON project partly has a SCM approach, but not as specific as in this study. The specific study on cod is primarily to examine which method of measuring that is the best and how to set suitable criteria's, which is out of scope for this study. On the other hand, their study does not concern what the overall management of the supply chain can gain from this service. Furthermore, none of the other studies are done from the viewpoint of a 4PL company.

1.6 Business Description

Bring, which is the brand for the Norwegian Post in other countries than Norway, consists of nine different companies specialized in mail services, logistics and communication. One of these is Bring Costumer Solutions (Bring CS), which is a fourth part logistic company (4PL). The role of this company is to administrate and coordinate the supply chains of their customers. It is called 4PL because of four independent roles in the chain: the seller of the product, the buyer, the warehouse and transportation suppliers and the administrating and coordinating part.

Bring CS´s connection to the thesis is that they have customers within the food industry, and an implementation of a dynamic shelf life would influence the administration and coordination of the FSC. However, this study is not limited to their specific case, but rather for all 4PL companies active within the food industry.

1.7 Target Group

The target group for this thesis is mainly the companies that are a part of the DynahMat project or are considering implementing the dynamic shelf life technique.

Even though the study mainly is concerned with the 4PL company's perspective, there is also information and considerations that other actors in the supply chain can benefit from reading. Furthermore, the thesis could be of interest to authorities working with food waste reduction. Finally, students within the supply chain management field are also encouraged to read the thesis.

1.8 Structure of the Report

The thesis consists of seven chapters and the structure can be seen in Figure 1. Chapter 1 'Introduction' defines the thesis and its structure while Chapter 2 'Methodology' discusses the approach that has been used in the project in order to meet the goals. Chapter 3 'Frame of Reference' contains all relevant theory connected to the study while Chapter 4 'Empirical Study' contains new information and the collected data. Chapter 5 'Analysis' analyzes the possible opportunities and challenges connected to the implementation as well as the effect on the 4PL company's business model. In Chapter 6 'Recommendation', advices regarding the implementation of the DSLP service for the 4PL company are given. Chapter 7 'Future Studies' provides a discussion of new aspects that can be of interest for others to study. The thesis ends with Chapter 8 'Conclusion', which summarizes the results of the study.

Furthermore, Goal 1 is met in Chapter 4 since the chapter contains all information needed to provide an answer to how the supply chain currently functions. The information gained from Goal 1 will then assist in meeting Goal 2 and Goal 3, which is to discover opportunities and challenges connected to the implementation of the DSLP service. The analysis in Chapter 5 provides the thorough answers to the goals while a summary can be found in Chapter 8. Moreover, the analysis of Goal 2 and 3 will contribute to meet Goal 4, which is to analyze the effect on the 4PL company's business model. This is also done thoroughly in Chapter 5 and summarized in Chapter 8.

1 | Introduction

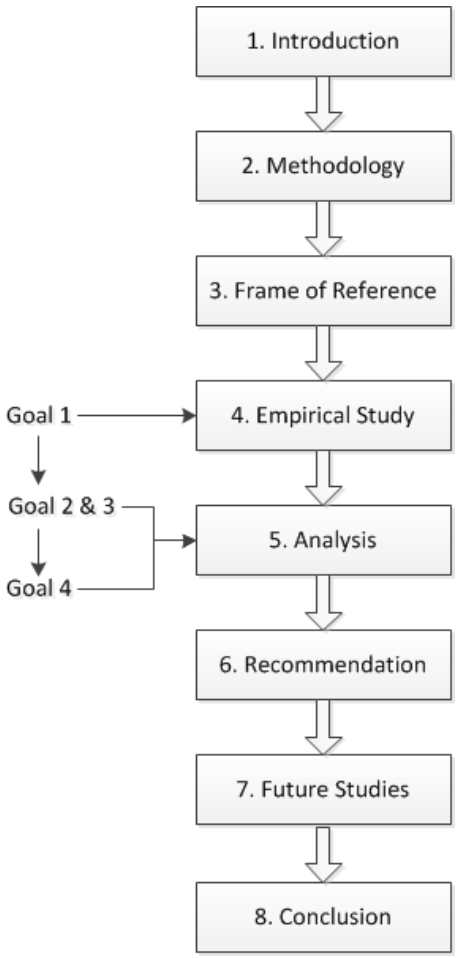

Figure 1. Structure of the Report

2 METHODOLOGY

The methodology chapter describes the process of the thesis research; starting with the choice of scientific approach, thereafter the research process and the choice of research studies. The different methods used are discussed and some more practical descriptions of how the research is conducted are provided. Finally, there is a section describing how to ensure research credibility. In each section, the theory is described and the approach chosen for this thesis is presented and motivated.

2.1 Scientific Approach

When conducting research, it is important to first determine the scientific approach, which is how the research is viewed and performed. There are many different types of scientific approaches but the suitable approach for this thesis is considered to be the system approach. The system approach sees the world as a system; where all the components are dependent on each other (Gammelgaard, 2004). The researcher's task is to identify the system's mechanisms in order to improve the overall system. The FSC can be regarded as a system since all actors are dependent on each other. For example, if the cold chain is broken by one of the actors or if a transport is delayed, it will affect all the others. The actors can therefore be regarded as components in the system and they are interlinked through the common goal of delivering a food item from the producer to the ultimate customer. As a result, the implementation of dynamic shelf life will not only have an effect on the 4PL company but on all actors that the 4PL company is linked to through the distribution chain. This means that the analysis also will include the other actors in the FSC to discover the change on the entire system. Consequently, the system approach is coherent with the purpose of this thesis since one goal is to investigate the opportunities as well as challenges for all actors in the FSC.

One of the goals in the thesis is to study how an introduction of dynamic shelf life would affect the 4PL company's business model. By using a system approach when finding a solution, relevant external aspects can be taken into account. The success of dynamic shelf life will depend on for example market factors, the collaboration with key partners, existing technology and costs and benefits which all need to be considered to discover the business potential for the 4PL company. Moreover, the system approach acknowledges that an ultimate solution does not exist and instead the goal is to find a good solution to the problem (Gammelgaard, 2004). This is true for the thesis; there are many factors to consider and many solutions to be found.

The recommendation is a result of analyzing the most important factors and it is likely that if the circumstances change, the best solution will change. Finally, the system approach supports case studies as an appropriate method, which is used in this thesis (Churchman, 1979). The data collection has been of both qualitative and quantitative nature, which is common when using the system approach (Arbnor & Bjerke, 1997).

2.2 Research Process

There are three different types of research processes; inductive, deductive and abductive. The inductive process is suitable for this study, and can be described as *"the logical process of establishing a general proposition on the basis of observations of particular facts"* (Zikmund, et al., 2009, p. 44). According to Kovács and Spens (2005), this process starts with real-life observations, where the researcher only has the knowledge that he or she has gained in previous research. The final theoretical conclusions are drawn from the observations and generalization of these (Kovács & Spens, 2005). Furthermore, they explain that the aim for this process is to make a new contribution to the research and the theory already existing. In order to follow the inductive process (see Figure 2) a literature review is first conducted, focusing on important aspects in supply chain management that will be affected by a dynamic shelf life implementation. The literature review also covers the specific knowledge concerning the sensors, RFID technology and similar research projects that exist. Secondly, the specific FSC is studied, through interviews and observations that lead to the development of a supply chain map and knowledge about the current state of the FSC. From the theory and the empirical studies, conclusions are drawn in order to answer the research questions.

Figure 2. The Inductive Research Process, (Kovács & Spens, 2005)

2.3 Research Design

There are different types of research studies, which describe the manner in which the research process is conducted. This thesis covers two types of research studies. Firstly, exploratory studies are used, which consists of unstructured interviews and conversations that are carried out to learn about the current situation and what the biggest issues might be. The definition of exploratory studies is: "*conducted to clarify ambiguous situations or discover ideas that may be potential business opportunities*" (Zikmund, et al., 2009, p. 54), which is true for these methods. Zikmund et al. (2009) say that exploratory studies often is the first step in a research and used to identify and clarify the decisions that need to be made, not to provide conclusions for actions.

Secondly, descriptive studies are conducted when the framework has been established and the purpose of the study been set. These consist of in-depth interviews and study visits. These actions will provide a detailed picture of the FSC and the current situation, the available technology and other important factors. Interviews and study visits are regarded as descriptive studies since these describe a certain situation and answer the questions *who, what, when, where* and *how*. Descriptive studies are more directed towards specific issues than exploratory studies (Zikmund, et al., 2009). According to Zikmund et al. (2009) descriptive studies can be confirmatory, even though some additional studies may be needed, and the results can function as the material for making management decisions.

There is a third step after exploratory and descriptive studies, called casual studies, which seeks to identify the cause-effect relationships. This is done since managers often want to know how a certain decision or action will change or affect the future (Zikmund, et al., 2009). When knowledge and information is gathered, normative study is used, with the purpose to create action proposals (Wallén, 1996). This type of study will not be used since dynamic shelf life is prognosticated to be ready for commercialization in approximately three years (Törnberg, 2014), which implies that an immediate action plan is not required. Moreover, this is one of the first studies conducted on dynamic shelf life concerning coordination and implementation, which makes this an earlier stage study. The causal and normative studies will therefore be left for other researchers to explore.

2.4 Methods for Data Collection

When conducting research the methods used for collecting data are either of qualitative or quantitative nature. Qualitative methods, i.e. techniques not of a numerical kind that the researcher can elaborate interpretations from, are mostly used in this research since the problem is of a strategic nature (Zikmund, et al., 2009). The collected data originates from a literature review as well as from a case study that includes observations and interviews. Quantitative methods, i.e. techniques that consist of numerical measurements and analyses, are used as supplement to the qualitative methods (Zikmund, et al., 2009). Collection of quantitative data has been made to quantify the examples, e.g. to analyze the costs of implementing a DSLP service or to get an overview on the magnitude of the supply chain.

2.4.1 Literature Review

The literature review, in accordance with the abductive theory process, is conducted first, which is usually the case of any research since previous knowledge must be acquired in order to advance with the research (Zikmund, et al., 2009). The literature search is done by scanning through trusted databases with published articles, e.g. Web of Science, Emerald and Ebscohost. Many of the articles have been used in previous courses within supply chain management at Lund University while some are recommended from experts and peers. This is in line with a definition of a literature review stated by Zikmund et al. (2009, p. 65): "*A directed search of published works, including periodicals and books, that discusses theory and presents empirical results that are relevant to the topic at hand*".

2.4.2 Case Studies

A case study refers to a documented history of a specific person, group, organization or event, e.g. a company that faces a specific situation such as reorganization or a large decision (Zikmund, et al., 2009). The case that will be studied in this thesis is the supply chain for hot smoked salmon 200g. The choice to look closer at the hot smoked salmon was taken together with the supervisor at Bring Customer Solutions who argued that the salmon could benefit from having dynamic shelf life due to its value and perishability. Bring Customer Solutions distributes different packages of the hot smoked salmon and the reason for focusing on the 200g package is because it is sold in the largest quantities. The salmon is studied in the extended supply chain, ranging from the producer to two of Bring CS's customers: the retailer in Paris, France and the retailer in Brest, France. In the thesis, the specific customer of Bring

CS has been referred to as the customer or the retailer. Both of the stores in France belong to the Southern Europe region and goes through the distribution center (DC) located in Brussels. These two retailers were chosen due to a number of aspects. Firstly they are located in France, which is the country that orders the largest quantities of salmon and therefore will be affected a lot if dynamic shelf life is to be implemented. The retailer in Paris is one of the largest stores in France and was chosen due to this reasons as well as the fact that they order large quantities of salmon. The retailer in Brest was chosen since it is the store that takes the longest time to reach from the DC in Brussels. Moreover, the supply chain for Brest looks a bit different from the one for Paris since it is cross docked one additional time after leaving the DC.

The case study used in this thesis is mainly based on interviews and observations conducted in cooperation with Bring Customer Solutions, but also on interviews with researchers and consultants in the DynahMat project. The interviews are of two kinds: semi-structured interviews and conversations. Semi-structured interviews contain questions divided into sections: open-ended questions are followed by more probing questions which can be flexible depending on the respondents answer (Zikmund, et al., 2009). The advantages of this form are that specific issues can be addressed and that result easily can be interpreted (Zikmund, et al., 2009). Conversations are, according to Zikmund et al. (2009, p. 151), "*An informal qualitative data gathering approach in which the researcher engages a respondents in a discussion of the relevant subject matter*". The advantages of this form, according to the same authors, are that it can gain unique insights, meanwhile the draw-backs are that it is easy to get off course and that the interpretations are to a large extent depending on the researcher.

A great part of the data collection that concerns the operations at Bring CS is gained from interviews with employees. The employees that participate in the interviews are partly operational staff such as demand coordinators, supply planners and transport planners but also managerial staff that has insights regarding management issues such as collaboration and contracts. The interviews were held at Bring CS's office in Helsingborg in February and March, 2014, and there was only one interview with each employee. If needed, a supplementary email was sent to the employee, asking for additional information. All interviewed employees are referred to simply as employees at Bring CS. In addition, a study visit to the central warehouse was made, where employees were observed in their workplace. The advantage of observing instead of interviewing is that the researcher can gain insight in matters

that respondents cannot or will not talk about (Zikmund, et al., 2009). The collected information from the interviews and conversations is used to get an understanding of how the FSC works today and also to make a map of the supply chain that provides a better overview of the FSC. This in turn provides a better understanding of the challenges and opportunities that exist if implementing dynamic shelf life.

There were also interviews held with researchers in the DynahMat project to provide an insight to the technology and the idea behind the DynahMat project. Specifically, these were a RFID technology consultant (referred to as RFID consultant) and a researcher that is studying the effect of using sensors in a cold chain (referred to as cold chain researcher). There was only one interview held with the RFID consultant, but several with the cold chain researcher. Also, there were three short interviews conducted via email with the producer of the chosen product to retrieve information about the current setting of best before date and how the product was packaged (referred to as the producer).

2.5 Theoretical and Analysis Framework

According to Yin (2003), the quality of the analysis depends on the researcher's ability to think rigorously and present sufficient evidence along with careful consideration of alternative interpretations. The strategy that has been chosen when analyzing the data is "theoretical propositions". Yin (2003) states that this is the most preferred analysis method for case studies. The strategy concerns focusing on the theoretical propositions that set the base for the research questions and choice of the literature review. The research questions chosen in this thesis revolve around supply chain management and have been specified to a certain setting and for a specific event, i.e. the implementation of dynamic shelf life. The literature review has therefore concerned supply chain management in general, implementation considerations and also specific theory connected to dynamic shelf life and the sensors. The theoretical orientation has been a guide to what data to include and what data to discard, which is in line with the theory behind the strategy (Yin, 2003). The strategy is good for finding focus areas, which in this thesis has lead to the development of a theoretical framework that has been used when creating an analysis framework.

The theoretical framework is designed based on Simatupang and Sridharan's (2005, p. 357) model "Antidotes for supply chain discontent", which can be found in Figure 3. With the help of the model, Simatupang and Sridharan (2005) show how to apply antidotes on two different levels in the supply chain: shared commitment and

collaborative business drivers. By antidotes, they mean how to mitigate effects of supply chain discontent and finding solutions that have a positive effect on the supply chain. According to Simatupang and Sridharan (2005), the model implies that the four business drivers, i.e. strategy, measurement, coordination and operations, all have a strong effect on total pay-offs. This is the reason to why the model has been used as a base when creating the theoretical framework; it shows the important areas to consider when making changes in the supply chain, e.g. implementing a DSLP service.

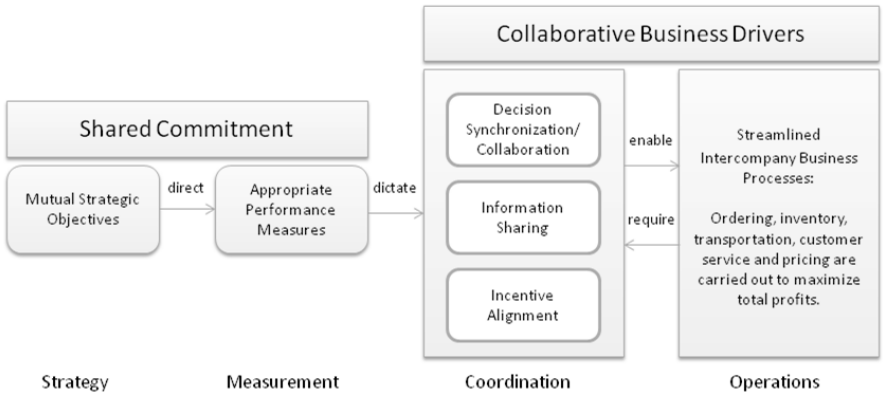

Figure 3. Antidotes for Supply Chain Discontent (Simatupang & Sridharan, 2005)

The theoretical framework, see Figure 4, needed to be adjusted from Simatupang and Sridharan's (2005) model to fit the specific case of implementing the DSLP in the supply chain. Apart from the main areas – strategy, measurement, coordination and operations – adoption of new innovations, implementation considerations and project specific factors are added to cover aspects that will have an effect on the decision to implement or not.

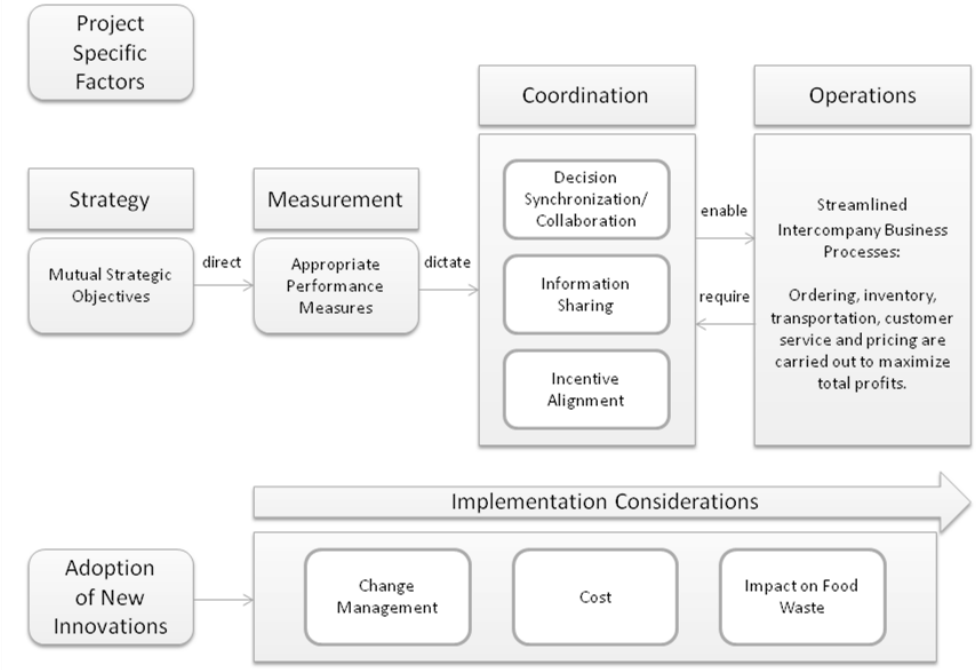

Figure 4. Theoretical Framework, inspired by Simatupang and Sridharan (2005)

Adoption of new innovations is a section that is included in order to be able to give a recommendation to the 4PL company on when they should implement dynamic shelf life if they decide to do so. This is because the characteristics of companies in the different adoption segments differ, as well as the benefits and consequences of an implementation in these. This section is therefore included to provide the 4PL company with an understanding of the process and as material for their decision on when to implement, if they decide to do so. The adoption is a prerequisite to implementation considerations since first, a company need to decide if and when to adopt a new innovation. If the innovation is considered valuable and interesting, they can continue by looking at what the implementation considerations would be and the innovation's applicability. In the case of implementing the DSLP service; change management, costs and impact on food waste are deemed to be relevant aspects to consider. Change management is always important to consider when making changes in a company or supply chain and also the cost of the investment. The impact on food waste is added since the ultimate goal of the DynahMat project is to reduce food waste. Project specific factors are needed to take technological aspects into account, since they will have a great impact on the possibility to implement the DSLP service. Also since the DynahMat project still is in an early stage of development, the DSLP service has not yet been designed. The project specific

factors are therefore used to make some assumptions about how the DSLP service could work, concerning sensors, RFID technology, readers and cloud service, in order to be able to do an analysis.

The analysis framework, see Figure 5, is an extension of the theoretical framework. Almost every segment in the theoretical framework; strategy, measurement, coordination, operations, implementation considerations and project specific factors are analyzed in regards to opportunities, challenges and the effect on the 4PL company's business model to provide answers to Goal 2, Goal 3 and Goal 4. By analyzing each segment in the theoretical framework, the information can be structured and different aspects regarding the implementation can be found. All segments are analyzed based on the data collection and the result works as a base when answering the research questions. As already mentioned, adoption of new innovations is included to provide a recommendation to the 4PL company on when it is suitable to implement the DSLP service. This is therefore a stand-alone segment and not analyzed in regards to opportunities, challenges and effect on the 4PL company's business model.

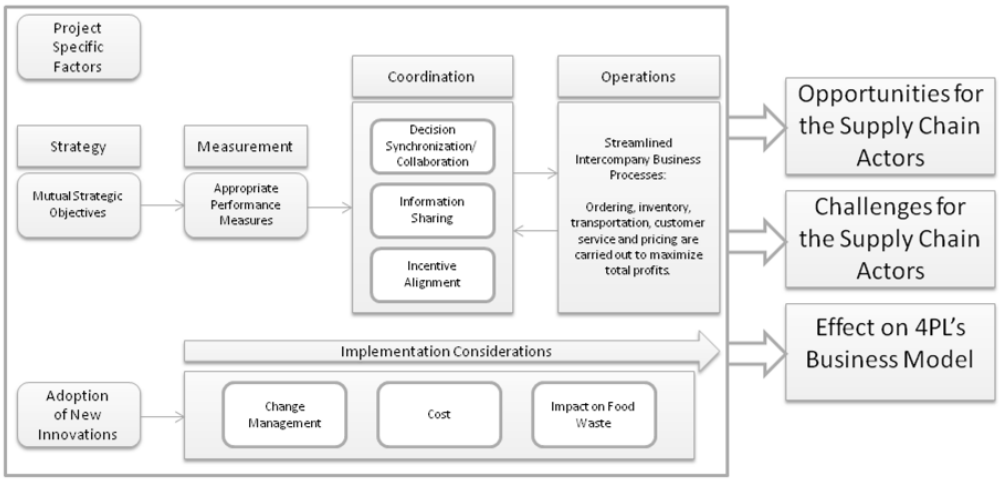

Figure 5. Analysis Framework

In addition, supply chain mapping is used as a complement to answer Goal 1: "How does the chosen supply chain currently function?". The map provides an overview of the specific supply chain and how the goods flow. Since Goal 1 is answered in Chapter 4 'Empirical Study' with the help of the supply chain map, it does not require an analysis and is therefore not included in the analysis framework.

2.6 Research Credibility

A research paper needs to meet many criteria in order to be credible and uphold a certain level of quality. From Ejvegård's (2003) point of view, these are factuality, objectivity and balance. Factuality means that the collected data needs to be true and that every piece of information is verified. Nevertheless, published research papers and doctorial theses or dissertations are considered reliable since their sources probably have been carefully verified already (Ejvegård, 2003). As mentioned in *Literature Review* (2.4.1), the sources used in this thesis have been carefully selected by searching in reliable databases. Many of the articles have been cited many times by other authors, which imply the factuality of the data. Moreover, some articles have been used in courses given at Lund University, which means that the professors also have verified these. In order to increase the factuality of the collected data, all interviews were taped, compiled in writing, and all interviewees were given the opportunity to approve the text so that the fact was correct. All interviewees apart from one approved the interviews.

Furthermore, a researcher is obligated to be objective (Ejvegård, 2003). This is done, in interviews at Bring CS, by asking the same questions to employees that have the same positions and working tasks and then comparing them to separate fact from opinion. Moreover, the articles used in the thesis have been chosen to cover many angels of the studied subjects to increase the objectivity of the information. Also, some statements and findings are presented by different authors that increase the authenticity of the data presented.

Finally, Ejvegård (2003) discusses the criterion balance. Balance includes both factuality and objectivity and needs to exist throughout the entire paper. For example, unimportant details should not be covered but instead leave room for the essential reasoning and findings. If debating on a specific subject, both sides should receive equal attention.

2.6.1 Credibility of an Empirical Research

When it comes to assessing the quality and credibility of an empirical research, there are two main parameters that should be considered: reliability and validity (Höst, et al., 2006), (Ejvegård, 2003). In addition to these, representativeness should also be considered (Höst, et al., 2006).

Reliability is a measure of the accuracy and applicability of a measuring instrument and the measure itself (Ejvegård, 2003) but also the accuracy in the data collected

(Höst, et al., 2006). The researcher often creates the measuring instrument him or herself by for example creating an interview or questionnaire, and therefore there is a risk that the reliability is low (Ejvegård, 2003). The researcher can have an impact on accuracy by designing the questions so that they are easy to understand and motivates the respondents to answer (Zikmund, et al., 2009). The questions should be simple, short and unbiased and these criteria have been considered when making the interviews. Also, Höst et al. (2006) mean that in order to create reliability in a research it is important to be thorough when collecting data and making the analysis. They say that it is important to clearly state the methods used and let colleagues or peers review the data collection and analysis in order to find weaknesses (Höst, et al., 2006). The thesis has been reviewed by both the supervisor and the assisting supervisor who have provided feedback and pointed out flaws in the thesis that have been corrected.

Validity is a measure that determines if the researcher in reality tests what was intended from the beginning (Ejvegård, 2003), (Höst, et al., 2006). It is the connection between the object that the researcher wishes to examine and the actual measure that is used. It is therefore important to know what the measurement is and use it consequently throughout the research (Ejvegård, 2003). A researcher should also use triangulation, which is when applying different methods on the same object, in order to increase the validity of the research (Höst, et al., 2006). Triangulation has been used in the thesis by interviewing employees from different levels and positions within Bring CS and also with other members of the supply chain. Observations have also been made to study processes and working habits within the operations.

Representativeness is that the conclusions made need to be generic (Höst, et al., 2006). Höst et al. (2006) mean that the representativeness of the results increases if the context that the researcher wants to make generalizations about is similar to the context where the study has taken place. This can be done by making a good and detailed description of the context that is investigated. The result of the thesis is considered generic since the context that has been studied is not unique. There are many supply chains that have the same structure and that could use the recommendations from this thesis when implementing dynamic shelf life.

2.6.2 Sources of Error

There are risks connected with the methods used in the thesis such as the authenticity and reliability of the interviewees as well as misunderstandings

between the interviewers and the interviewee. Measures have been taken to minimize these; the same questions have been addressed to all interviewees at the same level in the organization and then been compared to discover errors or difference in opinion. All interviews have been written down and approved (all but one) by the interviewees. Also, the supervisor at Bring CS has reviewed Chapter 4 'Empirical Study'. However, there is still a risk that there are faults in the information or that the interpretations made, both by the interviewees and the researchers, are incorrect.

Moreover, since the DynahMat project still is a work-in-progress, there are many facts that are merely speculative of how the system is supposed to work when released on the market. This may have an effect on the result, which needs to be considered before implementing dynamic shelf life.

A source of error when it comes to the impact on food waste is the claim system where all reports of unsellable goods are received. The claim system is, according to employees at Bring CS, not used as often as it should and there might therefore be more food waste than reported through the claim system. However, the salmon is a quite expensive item, which means that the stores probably make the claim if it is unsellable. Also, if there were a lot of food waste at the customer, Bring CS would most likely have received that piece of information.

3 FRAME OF REFERENCE

The following chapter provides a framework for the research and sets the scope for the empiric study. Firstly, the concepts of supply chain and supply chain management are defined to set the baseline for the study. Next section covers why and how the supply chain actors should cooperate to create the best possible supply chain. In the section after that, performance measurements are described. Next, project specific factors are described and thereafter, how to implement changes. Thereafter, theory on business models is presented and adoption of new innovation in companies is discussed. Finally, the collected literature is summarized in a theoretical framework.

3.1 Defining Supply Chain and Supply Chain Management

A supply chain is, according to Mentzer et al. (2001, p. 4), defined as *"a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer"*. Even though there are many different definitions of supply chain in the literature, they are all rather similar and the essence is the same (Mentzer, et al., 2001).

Mentzer et al. (2001) also discuss different levels of supply chain complexity, which they call "*direct supply chain*", "*extended supply chain*" and "*ultimate supply chain*". A direct supply chain, see Figure 6, includes three entities: a company with a supplier and a customer that are involved in upstream and downstream flows. The extended supply chain (see Figure 7), also consists of the suppliers to the immediate supplier and customers to the immediate customer. The ultimate supply chain involves all organizations or individuals from the ultimate supplier to the ultimate customer (see Figure 8).

Figure 6. Direct Supply Chain, (Mentzer, et al., 2001)

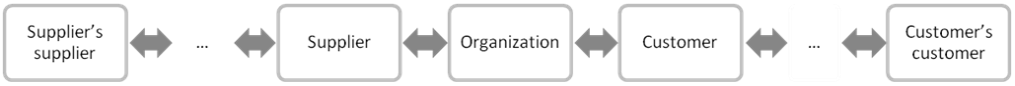

Figure 7. Extended Supply Chain, (Mentzer, et al., 2001)

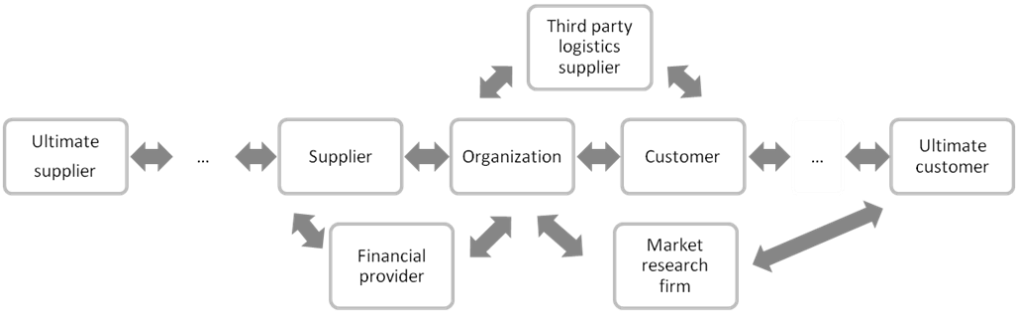

Figure 8. Ultimate Supply Chain, (Mentzer, et al., 2001)

Supply chain management (SCM) is a concept that has been developed over time. The term SCM was introduced in the early 1980' and one of the most used definitions was made by the Global Supply Chain Forum in 1994 and modified in 1998 to the following (Lambert, et al., 1998, p. 1):

"Supply chain management is the integration of key business processes from end user through original suppliers that provides products, services and information that add value for customers and other stakeholders."

Bagchi and Skjoett-Larsen (2002, p. 90) offers another view of supply chain management. They say that:

"Supply chain management consists of the entire set of processes, procedures, supporting institutions, and business practices that link buyers and sellers in a market place".

There are several different viewpoints of supply chain management to be found. Mentzer et al. (2001) presents one viewpoint; that there are three main characteristics of supply chain management from a management philosophy point of view. The first characteristic is that SCM has a systems approach and views the whole supply chain as one entity rather than several different parts. The goal is to optimally manage the flow from the supplier to the ultimate customer. The second

characteristic is to strategically use and synchronize resources and capabilities in collaboration. The third characteristic is to increase customer value by having all actors throughout the chain focusing on the end customer. The flows that exist in a supply chain are not only the goods itself but also information, transfer of ownership and payment flows, which also need to be managed strategically in order for the chain to be effective (Bagchi & Skjoett-Larsen, 2002).

If the actors in a supply chain want to implement a supply chain management philosophy, they need to act accordingly (Mentzer, et al., 2001). The activities that exist in SCM are an essential element in creating an effective supply chain (Lambert, et al., 1998). According to Mentzer et al. (2001), there are a number of different activities that are very important in supply chain management, such as information sharing, sharing of risks and rewards, cooperating, integrating behaviors and processes and maintaining long-term relationships which are covered in the following sections.

3.2 Supply Chain Coordination and Collaboration

Supply coordination and collaboration are utterly important for a well-functioning supply chain. Coordination involves logistics coordination, information sharing, incentive alignments and collective learning. Collaboration could briefly be described as the aim to move from the approach “us vs. them” to “we’re in this together” (Min, et al., 2005).

3.2.1 Supply Chain Coordination

Simatupang et al. (2002, p. 291) defines supply chain coordination as “*An act of properly combining (relating, harmonizing, adjusting, aligning) a number of objects (actions, objectives, decisions, information, knowledge, funds) for the achievement of a chain goal*”. The authors present four modes of coordination, namely logistics coordination, information sharing, incentive alignment and collective learning. These four modes are placed in Table 1, categorized by focus and mutuality of coordination, which refers to the underlying values of responsibility among the supply chain partners.

Table 1. Categorization of Coordination Modes in a Supply Chain, (Simatupang, et al., 2002)

FOCUS OF COORDINATION:	**MUTUALITY OF COORDINATION:** Complementary	Coherency
Operational Linkages	Logistics	Information Sharing
Organizational Linkages	Incentive Alignment	Collective Learning

A linkage exists when measures taken by one supply chain member affects one of the other. These interfaces need to be coordinated in order to succeed with joint decision making (Simatupang, et al., 2002). The linkages are divided between operational and organizational. The operational linkages include integration of interdependent processes and information flows that enables the actors to plan logistics and operational daily transactions. When these linkages are recognized, it is easier for the supply chain members to contribute to the operational decision making. Organizational linkages, on the other hand, are when connected members discuss their own interest in performing collective actions, which allows the partners to understand each other. Both linkages provide the foundation for successful coordination (Simatupang, et al., 2002).

According to Chopra and Meindl (2013), lack of coordination can occur when the actors have different objectives, when the information shared between different stages is delayed or distorted or when the supply chain is sub-optimized. They argue that when lack of coordination occurs, the total supply chain profit is less than what it would have been if the supply chain was coordinated. In addition to the monetary effect; the relationships are affected, the costs increased and the responsiveness falls.

3.2.2 Aligning Incentives in the Supply Chain

The definition of alignment in the supply chain is to *"establish incentives for supply chain partners to improve performance for the entire chain"* (Lee, 2004, p. 1). Lee (2004) presents different methods to achieve alignment in the supply chain:

- Information, like forecasts, sales data and plans, should be exchanged between vendors and customer.
- The terms of the partnerships should be redesigned to share risks, cost and rewards.

- The incentives should be aligned so that the players maximize the overall supply chain performance, while maximizing their own benefits from the partnership.

The risk of not aligning the incentives is that the actors will strive for different goals, which can be in conflict with each other. The consequence of this is that the total supply chain profit is not maximized (Naraynan & Raman, 2004). Furthermore, Naraynan and Raman (2004) argue that the incentive schemes must be designed the right way, so that only behavior that strives to achieve the common goal is encouraged. To tackle this, the problems should be acknowledged, the causes identified and the incentives created or redesigned so that the entire supply chain's profit is maximized. Altering the existing contracts is one way to redesign the incentives so they become aligned. In addition to this, intermediaries or personal relationships should be used to develop trust with the partners. Another way to align incentives is to use more performance measurement to make actions more visible in the chain (Naraynan & Raman, 2004).

Naraynan and Raman (2004) also argue that incentive problems can be avoided from the start if managers are educated about the processes and incentives at the other companies. Finally, they argue that a supply chain should be studied and improved periodically, since a network always can be better designed.

3.2.3 Information Sharing in the Supply Chain

Information sharing is, according to Mentzer et al. (2001, p. 8) "*the willingness to share strategic and tactical data with other members of the supply chain".* Wadhwa and Saxena (2007) argue that to be effective not only information needs to be shared but also knowledge and data.

3.2.3.1 *The Importance of Information Sharing*

In order to succeed with supply chain management, information sharing is an essential part and many researchers emphasize its importance. Lee and Whang (2000) argue that information sharing, due to the advances in information technology, has enabled supply chain management to develop. They also state that information sharing makes coordination possible, which would not be possible without the technological advances. This will lead to many benefits, for example a decrease in uncertainty, reduction of inventory buffers and better customer service by being more flexible and reducing cycle times (Bagchi & Skjoett-Larsen, 2002). Other benefits are increased visibility of transactions, better tracing and tracking and reduced transaction costs. Moberg et al. (2002) agree by saying that information

sharing and coordination can reduce logistics costs and is value adding to customer which is the main principle in supply chain management. Lee (2004) puts information sharing as a method for creating agility and alignment in supply chains in his triple-A framework. In order for a supply chain to be both agile and aligned, there needs to be an instant flow of information and knowledge between the actors in the supply chains and it is important that there are no delays.

3.2.3.2 *Which Information to Share*

It is important that the right information is shared. There are many types of information that can be shared between the supply chain partners and the extent of information sharing is expanding (Lee & Whang, 2000). These can, as well as in collaboration (see section 3.2.4), be divided into three different levels: strategic, tactical and operational (Moberg, et al., 2002). At the strategic level, information sharing is a long-term commitment and deals with different business strategies, such as marketing and logistic strategies (Moberg, et al., 2002). Moberg et al. (2002) state that, at this level, the information shared is qualitative and sensitive and used in collaboration between the partners when setting future business strategy changes. At the tactical level, the information is medium-term, and includes medium-term forecasts, trends, plans and performance indicators (Yigitbasioglu, 2010) (Bowersox, et al., 2000). At the operational level, Moberg et al. (2002) explain that the shared information is short-term and concerns daily information such as logistics and sales activities as well as the status on orders and inventory. This information is mainly used for operational excellence i.e. reducing cycle times and inventory levels and improving service to customers.

In general, it is argued that for a suitable level of shared information must be applied to the specific supply chain context (Yigitbasioglu, 2010). In some situations, supply chain integration may not even be desirable (Bagchi & Skjoett-Larsen, 2002). It is also important to consider how the shared information should be utilized and that the needed capabilities exist in the company (Lee & Whang, 2000).

3.2.3.3 *Models for Information Sharing*

Lee and Whang (2000) present three different system models that can be used when sharing information: the information transfer model, the third-party model and the information hub model. In the information transfer model, one partner sends information to another partner who puts it in the database for decision making. Vendor managed inventory (VMI) is an example of the information transfer model. The issues that may arise include dealing with different system standards in different collaborations as well as high investment cost for the system. Another issue is the

fact that electronic data interchange (EDI) is made to fit all industries and may not have the specific functions for the supply chain. In the third-party model, the partners in the supply chain use a third party to collect and handle the information and data. The third party can also offer information services (e.g. accounting, sales analysis and order tracking), services for transactional processes and analyses of the data. The information hub model resembles the third-party model with the difference that the third-party consists of a system instead of a company.

3.2.3.4 *Challenges of Information Sharing*

In order to succeed with information sharing in the supply chain there are several prerequisites that must exist and challenges to overcome. For example, a prerequisite to a beneficial information sharing is that the information is both accurate and timely (Lee & Whang, 2000). Also, it is of uttermost importance that every actor clearly sees the advantages of it (Yigitbasioglu, 2010). Yigitbasioglu (2010) suggest that there needs to be an initiator to information sharing and collaboration that effectively can communicate with all the involved members. Furthermore, trust among the actors is an important element. In order to gain trust, actors must show each other loyalty and when trust has been established, the actors will be more willing to share information among each other (Min, et al., 2005)

According to a survey among European companies, the main barrier to supply chain integration is IT, which is a large part of information sharing (Bagchi & Skjoett-Larsen, 2002). The reason for this is a lack of proper information systems, multiple platforms and also lack of information visibility. Lee and Whang (2000) also argue that technology is a barrier to effective information sharing. It is costly, time-consuming and risky to implement cross organizational systems and partners may have difficulties to agree on specifications and on how to split the investment costs.

Another challenge is to align the incentives for all partners in the chain so that everyone benefits from information sharing, since the sharing also implies a risk (Lee & Whang, 2000). Yigitbasioglu (2010) means that companies often need to be compensated for sharing since information is viewed as an asset. However, even if every partner is guaranteed a profit from the shared information, there is a risk that some still will not cooperate but instead fight over how much (Lee & Whang, 2000). A solution can be to pay the concerned partners in advance (Yigitbasioglu, 2010). Moreover, there is a fear of opportunism among supply chain members and that someone will use the shared information for their own benefit, which is why sensitive data, like cost data, seldom is shared (Lee & Whang, 2000). Also, if a supply

chain partner believes that opportunistic behavior exists or that the information is a threat to their bargaining power, there is risk that the partner withholds important information or exchanges incorrect information which means that the information is worthless (Yigitbasioglu, 2010). Yigitbasioglu (2010) suggest that companies should be selective and only choose to share information with the most trusted partners to minimize the risk of opportunism. He also suggests that supply chain partners can start small and only share a piece of information. If proven successful, they can continue by sharing more and more, which also will build the trust between supply chain partners. Another solution can be to narrow the focus to specify what data actually need to be shared, which can facilitate the sharing between partners since not all data needs to be uncovered.

A final drawback to information sharing is the risk that the partners will be more interdependent on each other or rely too much on one supplier (Yigitbasioglu, 2010). The mitigation strategy in this case can for example be to gradually increase the collaboration, weighing the benefits and costs in every step, and also try to avoid being caught up in trends and to be careful when making decisions. A conclusion is that trust and cooperation is essential in order to succeed with information sharing (Lee & Whang, 2000), (Yigitbasioglu, 2010) and also that trust and a shared vision increase the quality of the information (Yigitbasioglu, 2010).

3.2.4 Supply Chain Collaboration

Collaboration in supply chains is defined as *"two or more companies sharing the responsibility of exchanging common planning, management, execution and performance measurement information"* (Min, et al., 2005, p. 1). Collaboration is often referred to as the driving force behind effective supply chains (Ellram & Cooper, 1990) (Horvath, 2001). Essentially, it is about shifting the approach from "*us vs. them*" to "*we're in this together*" (Min, et al., 2005). According to Lambert et al. (1999), the objective of interorganizational collaboration is to secure a higher performance than would have been achieved for the firms individually and to share risks and rewards.

Giguere and Householder (2012) argue that visibility is utterly important to achieve collaboration throughout a supply chain. An effective level of visibility is created by maximizing the knowledge creation of available data, in the aspects of balancing the visibility demand and the data supply as well as identifying the critical decisions in the supply chain. Also, the actors need to develop relationships and create an understanding of each other's businesses in order to comprehend what is important

from the other's point of views and how win-win situations can be created (Min, et al., 2005). Stank et al. (2001) argue that successful collaboration requires a change from standard business practice, especially when it comes to information exchange.

Giguere and Householder (2012) have divided the types of collaborators into three different groups: strategic, tactical or transactional. The strategic collaborators have aligned long-term business strategy and joint decisions making. They are directly dependent on each other, e.g. by shared investments in technology. For this type of relationship, maximum information sharing is appropriate. The other group includes the tactical partners who are needed in order to run everyday business operations. Often, it is not of importance with whom to have tactical collaboration with, since a tactical partner easily can be replaced with a company offering the same type of service. An issue in this relationship is that it is often a zero-sum game, where one actor is gaining more than the other. An important question is if the collaboration and information sharing leads to collective gain, or if one of the partners feels that the more he shares the more value is captured by the partner. If this is the case, the future visibility in the chain will suffer. The final group is the transactional partners who offer commodity goods and this is where the majority of the partners belong.

3.3 Supply Chain Performance Measurement

In the literature, it is generally well known that supply chain measurements, also called supply chain metrics, can increase the possibility to reach success when collaborating in the supply chain (Lambert & Pohlen, 2001). Lambert and Pohlen (2001) explain that this is due to several reasons. Firstly, metrics can help align processes in the supply chain and encourage cooperative behavior across firms. This should be done by setting proper measurements that encourage companies to behave and perform in a direction that is beneficial for the entire supply chain. The metrics can also shift managers' focus from individual performance to total supply chain performance and better show areas that require improvement, which leads to a higher supply chain performance. By sharing joint performance measurements, the supply chain members can implement a common strategy that achieves the set objectives. Lambert and Pohlen (2001) mean that this increases the chances to reach the overall corporate goals.

Furthermore, by using metrics, the supply chain can obtain an advantage in comparison to other supply chains by creating synergies, lowering costs and bringing value to the customer by differentiated services through increased performance. Supply chain performance measurements are needed to create an understanding of

how the own business correlates to the supply chain performance and also the complexity of the supply chain. The performance measurements can help guide management to realize which internal efforts that results in the highest impact on overall performance. The risks of not using supply chain metrics can therefore result in failure to meet customer needs, sub optimization or conflict within the supply chain, and missed opportunities to outperform competition (Lambert & Pohlen, 2001).

Implementing and using supply chain performance measurements are connected to many challenges (Beamon, 1999). Beamon (1999) says that the level of difficulty increases with supply chain complexity and it becomes more challenging to measure effectively. First and foremost, effective communication is vital (Ramanathan, et al., 2011). Moreover, creating common performance measures can be challenging due to that different companies uses different measures, or that the companies have little in common which can lead to conflict (Lambert & Pohlen, 2001). The reasons to why many supply chains are not using integrated metrics can be a lack of supply chain orientation or the complexity of capturing measurements across multiple companies (Lambert & Pohlen, 2001). Lambert and Pohlen (2001) also mention the unwillingness to share information or incapability to capture performance by customer, product or supply chain. A risk that the companies take is that they will become accountable for their performance of key businesses since the supply chain will become more transparent (Lambert & Pohlen, 2001). There is also a challenge for managers to shift their focus from the individual performance to the supply chain's overall performance, and work in a more collaborative manner with the other supply chain members to create mutual gains.

3.4 Project Specific Factors

In order to implement the DSLP service in a FSC, new technology needs to be utilized. In this chapter, the sensors and the RFID technology are described. In addition to this, the legal aspects regarding BBD are described, since this is of high importance to an implementation.

3.4.1 The DSLP Service

The DSLP service will be an automated data sensor processor in a cloud service (Göransson & Jevinger, 2014) (Göransson & Nilsson, 2013). The sensors are placed in the RFID tags. Sensor data, like time and temperature, are detected by the RFID readers (see 3.4.3) and sent to the cloud service that calculates the remaining shelf

life by using prediction algorithms (Göransson & Jevinger, 2014). When e.g. the consumer scans the RFID tag, the information is sent from the cloud service to the scanning device. The BBD can also be communicated to the actors in the supply chain, via their information systems, which can be integrated with the cloud service (Göransson & Jevinger, 2014). The idea is that the consumers will use their smart phones for scanning the food and that the tags will be able to communicate with smart refrigerators. Nilsson (Törnberg, 2014) believes that in the future, the tags will communicate directly with the retailers pricing system, so that the price of the products can automatically be reduced when the BBD is approaching. A process scheme over the vision for the DSLP service can be found in Figure 9.

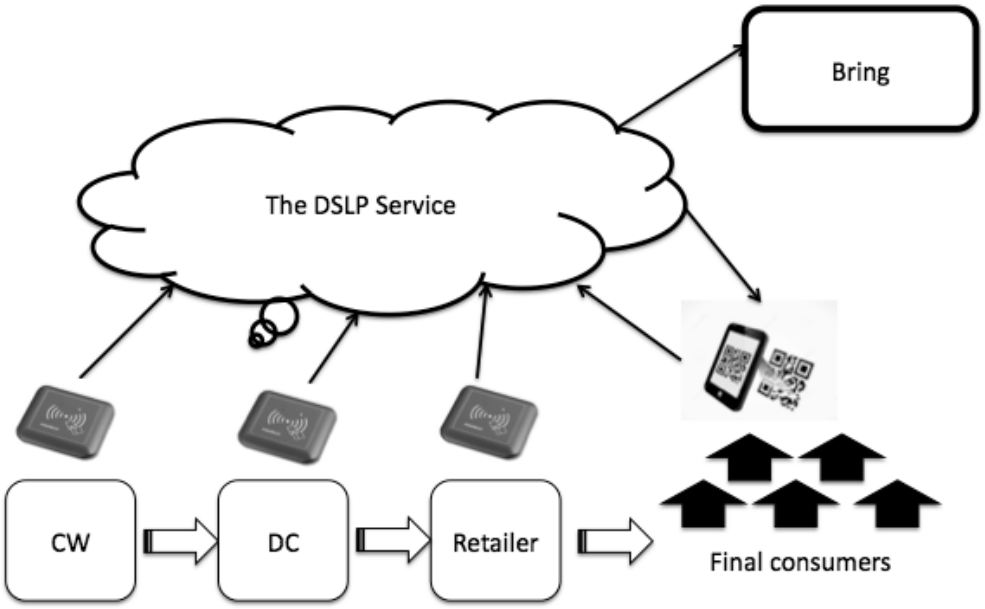

Figure 9. The DSLP Service, inspired by Göransson and Jevinger (2014)

3.4.2 Sensors

Sensors are used in FSC to ensure food quality. In this context, quality refers to the state of the food; that the food has been handled correctly within the acceptable temperature and that it is eatable. Depending on the level of intelligence in the sensor, it can measure changes in temperature, microbiological growth, quality of raw materials, product information and the quality of food handling (Göransson & Nilsson, 2013). Additional benefits of the sensors are that they contribute to an increased traceability and information flow throughout the FSC.

3.4.2.1 *The DynahMat Project*

The DynahMat project is currently working on developing biosensors, which are physiochemical detectors that measure and categorize biological material. Göransson and Nilsson (2013) argue that there are several advantages to using biosensors compared to regular date labels, especially for products that are sensitive from a microbiological point of view. Furthermore, since they help to communicate the true state of the food products, a deeper trust can be developed between the producers and consumers, and the waste can be reduced. Nilsson (Törnberg, 2014) estimates that the biosensors developed within the DynahMat project have the potential to reduce the current amount of food waste with one third. In the future, the biosensors will probably be able to detect specific microorganisms, such as specific enzymes, DNA-sequences, antibodies or proteins (Göransson & Nilsson, 2013). However, there are some biosensors, with biochemical mechanisms that have been developed further and are used in ongoing projects. The object of these biosensors is to control food quality by detecting and categorizing general changes in food, like conductance, pH value or gas composition.

Other sensors that can be attached to the food packaging are the *Time and Temperature Indicators* (TTI). These are already on the market, and are mostly used by producers and distributors to control the quality of their chilled chains. It is mainly used between the producer and the retailer, but it is not common that the information is shared between all actors in the FSC (Göransson & Nilsson, 2013).

The DynahMat project aims to combine the biosensor with the TTI in order to create an information platform that can be utilized by all actors in the FSC. Apart from time and temperature, the sensors measure the conductance in the food, which is connected to the microbiological growth (Göransson & Nilsson, 2013). The information from the sensors is sent to a cloud service that calculates the BBD from these three parameters (Törnberg, 2014). Additionally, the information that usually exists in QR- and barcodes is also included (Göransson & Nilsson, 2013). Nilsson (Törnberg, 2014) estimates that the sensors will be ready to enter the market within three years.

3.4.3 RFID Technology

The information in the DSLP service will be communicated by RFID technology (Packaging Logistics, 2013). RFID is short for Radio Frequency Identification technique, and is already used in many supply chains today (Pålsson, 2007). The RFID technology is generally believed to be the replacement or a complement to the traditional barcodes (Göransson & Jevinger, 2014). The technique captures data

from an object without visual contact; the normal procedure is that a reader transmits and registers radio waves that are modified by an antenna or tag that is attached on an object (Pålsson, 2007). According to Göransson and Jevinger (2014), the paramount advantages of the RFID technology are that hundreds of tags can be scanned at the same time and that the tags can handle more information than just the product ID. The major drawback is the cost of the tags, which implies that this technology will not be used for low cost products (Göransson & Jevinger, 2014).

3.4.3.1 *RFID in Logistics Systems*

According to Pålsson (2007) there are two types of logistics systems that the tags can be implemented on. The first is in a closed loop, which means that the same tags are used over and over again in the chain. In this solution, the cost of the tags is not that relevant since they can be used for a long period of time. The other system is the open system. In this case the tags are disposable and must therefore be rather cheap, but still reliable. Another challenge is that the tags must function for all actors involved, which means that interorganizational barriers, such as cost and benefit sharing, information sharing and technology transfer issues, can arise. Even so, there are RFID initiatives taken by large retailers, like Wal-Mart. In the Wal-Mart case, there are over 600 suppliers that have been mandated to adapt to the RFID technology but the majority is operating it at the minimum level required (Fries, et al., 2010). However, there are also some suppliers that have made investments in the systems and derived benefits from it (Fries, et al., 2010). According to Fries et al. (2010) the implementation of RFID in a network is highly complex and interdependent, and in order to fully optimize the benefits, all actors should make investments. The actor who starts implementing it, called the initiator, must convince the others to do the same. This is often done by coercive methods, as in the case of Wal-Mart. The firms that also implement the technique are called the followers. Fries et al. (2010) argue that what motivates the followers is often their valuable relationship to the initiator. Furthermore, the authors present three necessary conditions for a successful implementation: top management support, existence of cross functional teams to ease the communication and the degree of technical knowledge in the organization. The last condition implies that if related technology knowledge already exists in the company, this technology will be easier to adapt to.

3.4.3.2 *Types of RFID Tags*

The two types of tags that are relevant for the Dynahmat project are passive and semi-passive RFID tags (Göransson & Jevinger, 2014). The first type has a lower cost than the second, but needs to be activated by the readers each time the

temperature should be read. Consequently if the reader cannot connect with the tag, due to signal attenuation it is not possible get the data. This can occur e.g. if there is water in the products between the tag and the reader. The semi-passive tags, on the other hand, can log the information but they also needs to be connected to a reader to share the contained information (Göransson & Jevinger, 2014).

3.4.3.3 *Implementation of RFID Technology*

The implementation of RFID includes investment in the technology, acquisition of the technology, reorganization of business processes and utilization of the data created by the system (Fries, et al., 2010). The reason that some followers only adapt at the lowest possible level is that the cost of integrate with the platform is greater than the possible benefits. However, for an organization that proceeds with the total implementation, it is required that they alter their business process, activities and procedures, so that data can be collected and distributed effectively among the actors in the supply chain. The final part of a successful implementation is that the followers have the ability to make use of the data and extract valuable information for their business.

3.4.4 Previous Research

In the DynahMat project there has already been some research about implementing dynamic shelf life in supply chains. There are also other projects in regards to dynamic shelf life, e.g. the CHILL-ON project, the pasteur project and research from SFB.

3.4.4.1 *Previous Studies on Implementation in the DynahMat Project*

Göransson and Jevinger (2014) interviewed different actors in a supply chain to get an overview of their approach to the implementation of a DSLP service. Firstly, the main sources of error in the cold supply chains today were discussed. These include that the food may be placed outside the cold room at the warehouse; because the personnel are on lunch break, the cold room is already full etc. Furthermore, in some trucks, the cooling aggregate is turned off when the engine is turned off, which causes a broken cold chain. During the transport, the temperature is often measured close to the aggregate, which may not give an accurate overall temperature of the perishables. Normally, if the cold chain is broken, no measures are taken, since this is very costly.

When the interviewees were asked about the advantages, one answer was that the first actor to implement the service would get a strategic advantage over its

competitors. Furthermore, it was mentioned that the DSLP service would work as a quality control and reveal the weak points of the cold chain. Also, the retailer could combine the dynamic shelf life with a dynamic pricing strategy, which could be used for creating campaigns. It was also mentioned that the service has a possibility to reduce food waste. On the other hand, risks mentioned were e.g. that the service could lead to that less products get sold. Also, there is a risk that food gets a faulty date if the service does not work – which can lead to increased food waste or that people are consuming food that should not be eaten.

Furthermore, in order for the service to be useful, the dynamic shelf life must reach the final consumer. If not, their behavior will still be based on the static BBD. Another issue mentioned was that the potential difficulty to convince the customers that they should trust the dynamic BBD. The main obstacle for an implementation mentioned was the costs: the solution cannot be too expensive and the actors must share the costs. It is important that the retailer is one of the actors carrying the costs. When it comes to information sharing related to the DSLP service, the actors sees no problem with sharing it with the other actors in the supply chain, but it is important that it does not reach the competitors. Another comment on the DSLP service was that the random temperature samplings throughout the supply chain could be removed.

3.4.4.2 *The CHILL-ON Project*

The CHILL-ON project was funded by the European Commission and was carried out from 2006 to 2010. The aim of the project was to improve quality, safety and transparency in chilled food supply chains (CHILL-ON, 2012). The project is similar to the DynahMat project since the CHILL-ON project uses a software module for estimation of remaining shelf life in real time throughout the supply chain, which they call the Shelf Life Predictor (CHILL-ON, 2012). The estimation is based on bacterial growth, but TTI sensors are also used in the project. Furthermore, for the improved transparency, the project has developed a system called the CHILL-ON TRACEHILL. This is "*a complete and integrated Chain Information Management System for the entire supply chain from 'farm to fork'*" (CHILL-ON, 2012, p. 18). The objective is to tackle the crucial points in the supply chain, by continuous monitoring the temperature, identifying temperature abuse and food contamination as well as quick tracking and tracing of the products. In addition, the TRACEHILL will support supply chain coordination, e.g. by registering and providing an insight into product flows and processes (CHILL-ON, 2012). One part of the project have been to examine different types of methods and criteria to establish alerts in support systems, by using WSN technologies for real time temperature monitoring, in perishable food

supply (Haflidason, et al., 2012). To do this, the researchers followed cod in a supply chain from the fishermen in Iceland to the fishmonger in France. The findings were that mapping and exploring the supply chain is an important prerequisite for defining the suitable temperature criteria for alert setting. A too low temperature criterion will give unnecessary alerts and a too high will alert first when damage is done. The temperature abuse that occurred in the supply chain was at handover points, and it turned out that most operators only measured the ambient temperature – not the products actual temperature. The findings were that measuring both temperature and period gave a better result than just temperature. However, the best method was the one that took also temperature abuse and the severity of temperature abuse into account (Haflidason, et al., 2012).

3.4.4.3 *The Pasteur Project*

The Catrene[1] Pasteur project has developed a multi-capability wireless sensor platform, which was done in 2012 and then ready to be handed over to the industry (Guillory & Standhardt, 2012). The project focused on two main application areas, namely fruit and meat. For the fruit case, an integrated smart sensor tag would measure temperature, humidity and also have the possibility to measure carbon oxide. For the meat, an integrated smart sensor stick would be used, that measures temperature and pH. The project answered the question of who would benefit from the service, and the result was that the producer and the freight forwarder would benefit today, and the retailer and consumer in the future. The producer will be assured that the quality of the food is guaranteed and the freight forwarder will be notified if any events in the supply chain occur so these can immediately be adjusted, e.g. monitoring the temperature of the aggregate in the trucks. The retailer will in the future be able to implement a quality control system at their sales venue, and the consumer can ultimately check the quality of the food also at home, using their mobile phone (Guillory & Standhardt, 2012).

3.4.4.4 *Research from SFB*

In this research, the main challenges of using WSN technology in fruit transport and food distribution has been identified. These have been found through experimental validation with industrial partners (Becker, et al., 2009). The four main challenges identified are radio propagation, autonomy, user interface for data illustration and

[1] Cluster for Application and Technology Research in Europe on Nano Electronics

housing. Firstly, the radio propagation concerns that the radio waves are attenuated, more or less depending on the media, when transmitted from the sender to the receiver, and water, which is often found in food, is a problem. Secondly, with autonomy, the researchers mean that the operation of WSN should not interact with the usual processes of the actors in the supply chain, since it should not be an added burden to them. This also includes that the attachment to Internet should be autonomous configured. Thirdly, the user interface for data illustration is about how the data should be presented and analyzed. Finally, the housing of the individual nodes has to meet several requirements, such as being water tight and safe to store next to the food (Becker, et al., 2009). The overall conclusion of their research is that there are several challenges in applying WSN in logistics, but most of these can be solved with the technology that exists today (Becker, et al., 2009).

3.4.5 Legislation

The current law in Sweden requires the producer of food to mark the product with a best before date[2], BBD, or date of expiry[3], DOE (Packaging Logistics, 2013). The DOE is only required on the label for food that is vulnerable from a microbiological point of view. Moreover, there are voluntary labels that could be added, such as date of packaging[4], date of producing[5] and date of baking[6]. Furthermore, once the food has been labeled with a BBD it is not allowed to remark it with a new date, according to the regulations in Sweden (Livsmedelsföretagen, 2013). If the food is handled correctly, the food should still remain its specific characteristics until the BBD. According to Livsmedelsföretagen (2013), how specific the date must be, i.e. if both date and month should be stated, or only month or year, depends on the preservation of the food.

It is the food producer that determines the preservation and the BBD, by making preservation tests and following industry recommendations. The food preservation is dependent on the ingredients, the production process (e.g. pasteurization), the

[2] Swedish: Bäst före datum
[3] Swedish: Sista förbrukningsdag
[4] Swedish: Förpackningsdag
[5] Swedish: Tillverkningsdag
[6] Swedish: Bakdag

preservative canner, the packaging, the temperature and how the food is handled (Livsmedelsföretagen, 2013).

More in specific, the laws regulating this in Sweden are three EU and EG regulations that are presented in Appendix – EU and EG Regulations Regarding Food Safety.

3.5 Implementation Considerations

In the implementation process of a supply chain strategy, there are several aspects to be considered. One of these is the costs of an implementation. Since the DynahMat project aims to reduce food waste, this should also be investigated. Another aspect is how to deal with change management should be considered through the implementation.

3.5.1 Change Management

Change Management is according to Moran and Brightman (2001, p. 111) the *"process of continually renewing an organization's direction, structure, and capabilities to serve the ever-changing needs of external and internal customers"*. Todnem (2005) argues that an organization needs to be able to manage change if to survive in today's very competitive business environment. He states that more emphasis should be put on the company's skills to predict future needs and how to serve these as well as the company's ability to change in order to be competitive in a future market. Thus, there is a strong link between organizational strategy and organizational change. Furthermore, the consensus among researchers is that the pace of change within the business industry never has been higher and that change affects all organizations since it is a result of both internal and external factors (Todnem, 2005). As a consequence, it is of great importance that people within the organizations are prepared and willing to change.

3.5.1.1 *Planned and Emergent Change*

According to Bamford and Forrester (2003), there are in general two major types of change to be found in the literature: planned and emergent. The characteristics of planned change are that an organization starts as a fixed state and, through a number of planned process steps, finally reaches a new fixed state. Lewin's (1958) three step model explains the different phases in a planned change process. The steps consist of *freezing*, *unfreezing* and *refreezing*. *Freezing* is when an organization hold on to what they know, *unfreezing* is to identify and approach new ideas and issues and *refreezing* is the integration between earlier believes with the new values and skills obtained from the unfreezing step. The model identifies that in order to

adapt fully to a change, the old working ways must be discarded (Bamford & Forrester, 2003).

The emergent approach is a newer concept in comparison to the planned approach to change. The core in the emergent approach is that the business environment is too unstable and unpredictable to let organizations go from a stable state to another stable state (Bamford & Forrester, 2003). Bamford and Forrester (2003) mean that the emergent approach has been developed as a bottom-up process rather than a top-down. This is a consequence of the high pace of change that implies that senior management does not have the possibility to identify and plan for change and implement the actions.

3.5.1.2 *Dealing with Resistance*

A presumption in the planned change models is that employees work towards the change with no disagreement, which is not always true (Bamford & Forrester, 2003). Waddell and Sohal (1998) recognize resistance as an important factor that can play a large part in the success of a project. Maurer (1996) state that 50-66 percent of all projects connected to change fail and that resistance is a critical contributor that is not recognized as much as it ought to. Todnem (2005) on the other hand claims that as much as 70 percent of all change programs fail, which is a result of reactive, discontinuous and ad hoc change. However, Waddell and Sohal (1998) argue that resistance can be beneficial for a project and enlighten aspects that are inappropriate or could be made better. Also, they mean that often the employees are not resistant to change in general but rather the uncertainties and possible negative outcomes that change causes. In order to succeed with a project and reduce the amount of resistance, it is essential to include the employees in the change process and consult them on a regular basis. Waddell and Sohal (1998) claim that this is one of the most crucial success factors in facilitating change. It is important that employees have the power to influence the change and provide opinions and feel that they are given this opportunity. Therefore, it is suggested that organizations should encourage teamwork between managers and employees since there is a greater chance to avoid wrongs made in the past connected to resistance (Waddell & Sohal, 1998).

3.6 Business Models

In this section, the elements included in a business model are presented, as well as a framework for designing business models in actor networks. According to Johnson et

al. (2008, p. 596) a business model is defined as what *"describes the structure of product, service and information flows and the roles of the participating parties"*.

3.6.1 Steps of the Business Model

Chesbrough (2007) explains that a business model has two important functions: to create and capture value. He defines the steps of a business model as follows:

1. Define the value proposition, i.e. the value created by the offering.
2. Identify the different market segments.
3. Map the structure of the value chain required by the company to create and distribute the offering. This should be done from the procuring of raw materials until the final customer.
4. Specify the mechanisms that are generating revenue in the processes and estimate the cost structure and profit potential.
5. Describe the company's role and position in the supply and value chain.
6. Formulate the competitive strategy.

3.6.2 Business Models in Actor Networks

Storbacka et al. (2012) presents a framework for designing business models for value co-creation, which can be found in Figure 10. This framework is divided into four design dimensions: market, offering, operations and organization, and three design layers: design principles, resources and capabilities. The design principles are the ideas and choices that the actors have to take in order to build the foundation for their business model. Moreover, the resources are the foundation for co-creation among the actors. These are critical designing components for the business model. The last design layer, capabilities, is the practices that the actors use in their value creation processes. It refers to the actors' abilities to utilize their resources in an effective manner.

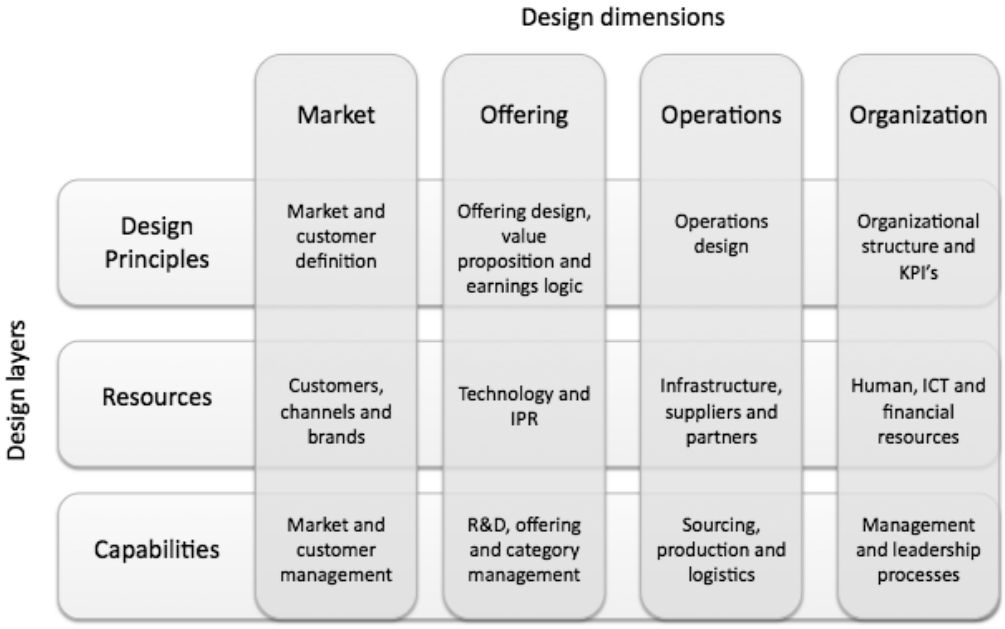

Figure 10. Framework for Business Model Design, (Storbacka, et al., 2012)

All the areas included in the framework are presented more in specific in Table 2, starting with the market column.

Table 2. Description of the Framework for Business Model Design

MARKET	
Market and Customer Definition	The actor's: - definition of its market - position within the market - go-to-market or channel strategy - target customers, based on its customer definition - segmentation of its existing and potential customer base
Customer Channels and Brand	Customer asset management: - Customers - Brands
Market and Customer Management	- Customer and market insight practices - Market making and shaping - Sales and account management - Customer experience management - Customer relationship management - Customer service management

OFFERING	
Offering Design, Value Proposition and Earnings Logic	- The offering design outline the available offering components and possible offering configurations - Value proposition refers to the resource integration promises made by the actors - Earnings logic defines how the actor makes a profit from its operations, which is affected by the pricing logic (bundling etc), cost and asset structure
Technology and IPR	- What technology is the offering based on? - Does the company hold the intellectual property rights?
R&D, Offering and Category Management	The main offering-related capabilities are offering management and R&D. Offering management includes: - Product/service development - Product/category management
OPERATIONS	
Operations Design	The principle defines how the actor conducts its operations: - Decision to make or outsource for all functions in the process, from purchasing to after-sales support - Choices related to modular processes
Infrastructure, Suppliers and Partners	Infrastructure: - Factories and machines - Information and communication technology Infrastructure - The actor's geographical cover area Suppliers and partners: - Stakeholder groups - Raw material suppliers - Channel partners - Production partners
Sourcing, Production and Logistics	- The outline on how the actor conducts its sourcing, production and delivery process - Supply chain management - Management of the delivery channel - Invoicing of delivered offerings
ORGANIZATION	
Organizational structure and KPI's	- Organizational structure - Roles and responsibilities - Metrics
Human, ICT and Financial Resources	- Human resources - Future competence supply - ICT - Financial resources
Management and Leadership Processes	- The actor's planning and control practices - Human resource development practices and strategy practices

3.7 Adoption of New Innovations

In this section, companies' adoption processes to new innovations and the drivers for these are presented. Also, the challenges of adopting radical innovations and how to overcome them are described.

3.7.1 The Adoption Process and Stages of Adoption

The adoption process can be divided into five stages: awareness of the product, interest in the product, evaluation if it is worth investing in, trial of the product and adoption (Armstrong, et al., 2009). At what time consumers or companies adopt new products can be classified into five categories, which correspond to the maturity of the market at different times. The five categories and market stages are presented in Table 3 (Armstrong, et al., 2009) (Gailly, 2011). It is also presented how many of the total amount of customers that belongs to this category (Armstrong, et al., 2009).

Table 3. Categories of Innovation Stages

CATEGORIES	DESCRIPTION OF CATEGORIES	MARKET STAGES
The innovators – the adventurous *(2.5 percent)*	- Try new ideas at some risk - Do not regard change as something negative	Introduction
The early adopter – the visionary trendsetters *(13.5 percent)*	- Adopt to new ideas early but carefully - Find and define where the market is going	Growth
The early majority – the deliberate *(34 percent)*	- More thoughtful and pragmatic - Adopt to new ideas before the average	Early Majority
The late majority – the skeptical *(34 percent)*	- Skeptical to new ideas - Only adopt after the majority of the market has	Late Majority
The laggards – the traditional *(16 percent)*	- Traditional or conservative - Convert only when the market is declining	Decline

The first two of these categories represents a minor share of the potential customers on the market for a product. In the next coming stage, the adoption rate increases and after that it decreases.

3.7.2 Drivers of the Process to Adopt a New Innovation

In the literature there is no consensus on what initiates or drives the decision process to adopt an innovation. However, there are two common streams: there is either a business need or an awareness of the innovation that leads to adoption (Ciganek, et al., 2014). The first of these requires a performance gap, which the innovation provides a solution for. In other words, if the innovation does not provide a solution for an existing gap it will not become a success. The second alternative is the belief that implementing the innovation will improve the company's performance or processes. The time it takes from either an occurrence of a need or awareness to the actual decision to adopt or reject the innovation is influenced by different variables. These can be divided into innovation-, organizational-, environmental- and control variables (Ciganek, et al., 2014). The control variables include industry type and firm size, but these are not further discussed in the thesis. The other categories are presented below (Ciganek, et al., 2014) (Hall, 2005) (Rogers, 1995):

Innovation variables:

- *Complexity*: The degree to which an innovation is perceived as being difficult to understand and use. This variable has a negative relationship to adoption of an innovation.
- *Compatibility*: The degree to which an innovation is perceived as consistent with the existing values and norms, as well as previous experiences, skills, practices and needs. This could be the firm's ecosystem, the cost of adopting or the cost of switching system. This variable has a positive relationship to the innovation adoption.
- *Relative advantage*: The degree to which a solution is perceived as better than the one it supersedes, i.e. it creates added value for the products or has other benefits. This relates to both the efficiency and the effectiveness goals of the adopting unit. This variable also has a positive relation to the adoption process.
- *Triability*: The degree to which an innovation can be experimented with, which also has a positive relation to adoption.
- *Observability*: The degree to which the results of the adoption of an innovation are visible to others, i.e. if others will notice that the firm has switched to the new innovation. This is also positive for the adoption process.

Organizational variables:

- *Organizational culture*: The risk-orientation of the firm, i.e. if the firm takes risks or if it is risk averse.
- *Top management*: The degree to which the top management are supporting the change. Ciganek et al. (2014) state that this is especially important when it comes to IT projects.

Environmental variables:

- *Coercive isomorphism*: This is the external pressure that a firm is exposed to from organizations that it is dependent on. This could take the form of persuasions, invitations or direct force.
- *Mimetic isomorphism*: When the firm imitates other firms, e.g. competitor's actions or behaviors. Mimetic behavior can confirm the legitimacy for actions or decisions taken at the firm. If all other actors on a market change, the probability for the company to change increases.
- *Normative isomorphism*: This pressure comes from peers, e.g. people having the same profession or the same education, which have adopted or are stressing the advantages of the innovation. New ideas and technologies diffuse rapidly in these types of professional networks.

Moreover, Vowels et al. (2011) state that the process of adopting becomes increasingly more complex when the innovation incorporates technology that radically differs from the predecessor. They presents three different factors that the decision to adopt or not is depending on. Firstly, what the firm's intent is to adopt should be considered. Secondly, the firm's characteristics should be considered. Often, the firms in the category *early adopters* (see Table 3) seek information actively, which leads to product knowledge and can lead to adoption of radical innovations. The firm's ability to absorb new innovations is also depending on the previous related experiences to the information and the innovation. Furthermore, there is a positive correlation between the adoption and if it exists a *champion*, i.e. a charismatic individual who openly and actively supports the innovation within the firm. The role of this individual is particularly important when it comes to radical innovations. Finally, the characteristics of the innovation itself are influencing the adoption decision, e.g. if the product can meet the customers' need without a range of accompanying products.

3.8 Theoretical Framework

In order to summarize and interlink all parts of this chapter, a theoretical framework has been created (see Figure 11) that concerns relevant aspects to consider when investigating the effects of implementing a DSLP service. For more information and explanation to the framework, see section 2.5.

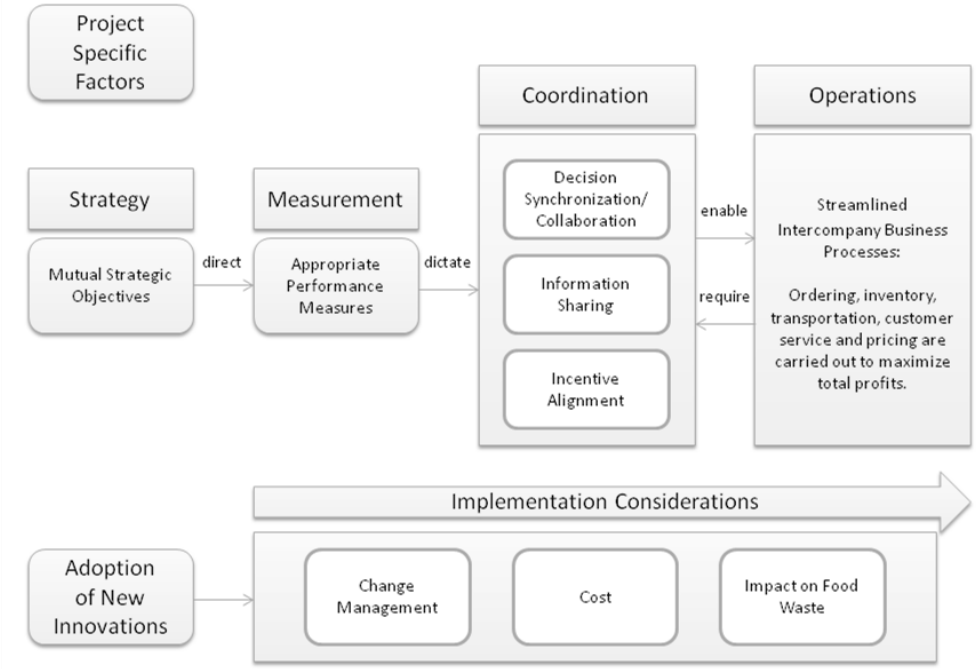

Figure 11. Theoretical Framework, inspired by Simatupang and Sridharan (2005)

To maximize supply chain performance, the mutual strategic objectives and goals need to be set and supply chain members need to have an answer to the question "what is in it for me?". This will then direct the chain to what performance measurements should be used. The measures will ensure that the actors are guided to act in a way that is beneficial for the entire supply chain. In turn, the measures will dictate the coordination of the supply chain including how to collaborate, what information to be shared and the incentive alignments for the supply chain members. When this is decided, the business operations can be coordinated to receive the highest profit for the chain.

When adopting new innovations, it is important to consider if, how and when to implement them. To provide an answer to this, aspects regarding the implementation need to be considered. The success of the implementation will

partly depend on the capability to manage change and partly on how big the investment will be. The impact on food waste is also important to consider, given that this is the ultimate aim with the DynahMat project. Finally, the supply chain must take project specific factors into account; in this case concerning dynamic shelf life in the FSC, such as the technology of the biosensors and RFID technology.

4 EMPIRICAL STUDY

The structure of the empirical study is based on the theoretical framework, presented in section 3.8 (see Figure 12). Firstly, the operations part is covered, to give an overview of the supply chain; who the different actors are and how the work is performed today. This will be done by studying a specific case; the supply chain for hot smoked salmon. To help visualize the supply chain, a map is created. Secondly, the strategic objectives for the different actors in the chain are presented followed by performance measurement in the chain. The coordination in the supply chain is then introduced, showing how the collaboration and information sharing works in the chain today and if there are aligned incentives. Next, the project specific factors such as the RFID technology are further studied. Finally, implementation considerations are studied, such as willingness to change and food waste in the hot smoked supply chain. Costs are introduced throughout the empiric study and summarized in section 4.6.2 Summary of Implementation Costs.

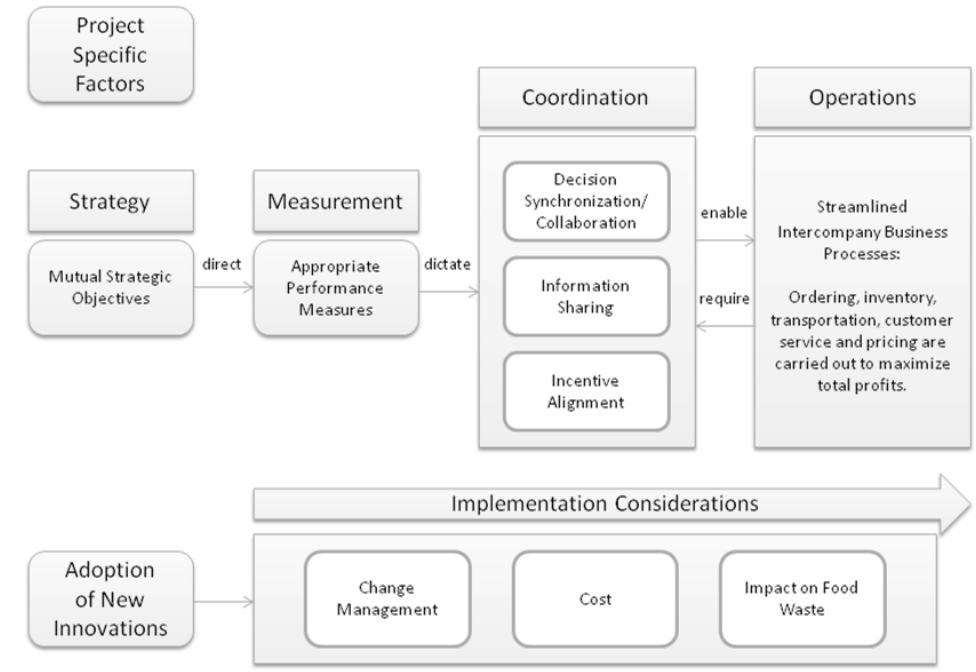

Figure 12. Theoretical Framework

4.1 Operations – the Supply Chain for Hot Smoked Salmon

Bring CS is a part of numerous supply chains since they are coordinating the flows of many different food items to a large number of stores. In order to get an understanding of the operations and an example of a supply chain that Bring CS is coordinating, a specific supply chain is studied (see section 2.4.2). This section covers the supply chain for hot smoked salmon 200g, distributed from the producer to two of Bring CS's final customers; two retailers in France, one in Paris and one in Brest. The stores belong to Bring CS's Southern Europe region and the distribution of goods goes through the distribution center (DC) in Brussels. The following section describes the chosen supply chain and its operations.

4.1.1 Bring Customer Solution's Organization

Bring CS is a 4PL company, meaning that they handle the distribution of various goods and that they work as the single contact point for their customers. The personnel at Bring CS are divided into working groups depending on the region they are handling. The current five groups are; Nordics, Northern Europe, Southern Europe, Near Shore and Overseas market. Each group includes a regional manager and a team consisting of demand coordinators that act as the main contact between the supply chain actors, supply planners that are responsible for forecasts and inventory levels and transport planners that control the transports to the distribution centers.

4.1.2 Hot Smoked Salmon

The hot smoked salmon, along with other fresh salmon products, is both valuable and has short shelf life, and is therefore handled differently than other food products that Bring CS manages. The salmon products, as well as pick-and-mix candy, are order initiated products. This means that an order is sent to the producer every week, which only contains the amount that has been ordered by the retailer. The other food items are push initiated, which means that there is always stock at the DCs so that the retailers quickly can get the products that they want.

The main challenge of the supply chain for the hot smoked salmon is that the salmon has a long lead time but short shelf life. The lead time for the salmon is two to three weeks from the day the customer places the order until the food is delivered. If an order is placed week [1], the delivery is in the end of week [3], or in some cases even beginning of week [4]. This makes it difficult for the purchaser, since the quantities cannot be adjusted with short notice and the need must be foreseen beforehand.

4.1.3 The Producer of Hot Smoked Salmon

The fresh salmon in this study is sourced from Norway. This salmon is part of the global flow, which means that this producer supplies all countries that have chosen to include the product in their range. The producer provides several different products, and also packages of different sizes, e.g. 100, 200, 300 and 400g packages. Apart from the fresh salmon, frozen salmon is also purchased from the Norwegian producer.

The producer has, from its production date, set a BBD of 28 days of the hot smoked salmon. This has been done through both microbiological and sensorial tests. In the microbiological tests, the producer checks the microbial growth of six different bacteria and in the sensorial tests they examine the flavor, texture, scent and appearance of the salmon close to its BBD. The tests are performed in the temperature that the supply chain has, in this case 4°C. When Bring CS collects the products from the producer's refinery in Smögen, it must have 75 percent of its BBD left, i.e. 21 days. Moreover, when Bring CS delivers the products to the final retailer, they are obliged to give the retailer at least 14 days until the products' BBD, which corresponds to 50 percent. These requirements are the same regardless of the distance to the retailer.

The hot smoked salmon is packed in vacuum packages and this is done by automatic special equipment. The packages are then manually put in a carton that contains 50 packages. The producer manually marks the packages and the carton with labels that need to match the country it is being shipped to regarding language and country specific regulations. In Europe, the same label can be used in many countries, i.e. in one language cluster, whilst there are other requirements for a certain type of information on the labels for e.g. Australia and Japan.

4.1.4 The Central Warehouse – Staffanstorp

All the food that is not directly shipped from a producer to a store goes through the central warehouse (CW) in Staffanstorp, Sweden. Bring Frigo owns the warehouse and the flow connected to the retailer stands for approximately 50 percent of its operations. The warehouse works both as a distribution center for the Nordics region and as a central warehouse for the other regions. The warehouse stores all of Bring CS's food items except for the fresh salmon and the pick-and-mix candy. These products are only cross docked in the warehouse. The turnover rate for Bring CS's part of the warehouse is 11.5 per year, i.e. approximately one turnover per month. There are 40-45 people working at the warehouse, divided into two shifts. They

accept about 20-25 trucks of goods per day. There are more trucks arriving with food than departs. This is because the arriving trucks often deliver from one producer; meanwhile the departing leaves with consolidated goods for a specific DC or store and therefore has a higher filling rate. Regarding the goods for Bring CS, the warehouse uses eight gateways for inbound deliveries and twelve gateways for outbound. The entire warehouse holds in general a temperature of 2°C but it also contains a number of large freezers that have a temperature of -28°C. The warehouse applies a First-Expiry-First-Out principle (FEFO) since Bring CS requires this for their products.

The warehouse checks the status of the goods when it arrives. For the cold food, they use a temperature stick to see that the goods do not have a higher temperature than 4°C. The personnel place the stick in between the cartons to get the temperature on the inner cartons. They also count all the pallets or, in the case of a broken pallet, the cartons and controls this, as well as the BBD, against the purchase order that Bring CS has sent. When this quality control is done, they manually enter the BBD and quantities in their warehouse management system, called FAS, and send a purchase order confirmation to Bring CS's ERP system via EDI. The FAS system also controls that the BBD from the producer is correct and that it, e.g. for salmon, has at least 75 percent left. If not, a report is sent to Bring CS. If everything has been accepted at arrival, the receiver signs the transporter's delivery note to clear him from responsibility of the goods. Most of the goods are then stored in the warehouse until an order has been placed. However, the candy and the salmon are treated differently. When the pallets with the salmon arrive, each has a label stating which DC it is going to be shipped to. The warehouse accepts the pallets and puts them on the warehouse floor awaiting the trucks that arrive the same day for transportation to the DCs in Europe.

The warehouse manually handles all Bring CS's goods, even though they use scanners for their other customer's goods. The reason for this is that many of Bring CS's labels cannot be scanned due to the structure of the article numbers. For some goods, there is not a one-to-one relationship between the article number on the pallet and the article number in the system. The article numbers are being replaced continually but there are only 35-40 percent of the pallets that can be scanned. In November 2014, new EU regulations will come into effect and force a change in the article number structure. This means that labels need to be updated and the pallets will be able to be scanned in the future. RFID technology is not implemented at the CW.

4.1.5 Distribution Centers

In the Southern Europe region there are three DCs: one in Barcelona (Spain), one in Brussels (Belgium), and one in Parma (Italy). There is one company that handles both the DCs in Spain and Belgium, meanwhile the DC in Italy is handled by another player. The DCs handles the distribution to the stores across the Southern Europe region. The DC in Brussels distributes to Belgium, the Netherlands and France. Bring CS has frequent, daily contact with the DCs, who stand for a large part of the operations in the supply chain. There is one demand coordinator from Bring CS who works as the main contact with the DC. The DCs store all food items for Bring CS and many of them operate their own trucks for deliveries to the retailers.

When goods arrive to a DC, the activities in the chain are set and if there are no interruptions in the flow, there is little verbal communication between Bring CS and the DC. The goods are received and stored at the DC and picked to order according to the FEFO principle. The retailers have order deadlines that need to be met in order for the DCs to be able to send the goods in time. The trucks arrive on different, but set weekdays to pick up the goods for a specific route of stores. On some routes the truck passes a consolidation point to cross dock the goods. This is done to increase the fill rate of the trucks leaving the DCs and to have a high fill rate on the trucks for as long as possible. For example, in France, which is supplied by the DC in Brussels, there are three cross docking points: Bondoufle, Lyon and Salon-de-Provence. The DC in Brussels owns these, and Bring CS is not involved in the planning or operations in this part of the supply chain. The goods are often left at the consolidation point overnight, in order to create a time margin until the next transportation.

The activities are almost the same for the salmon as for the other food products. When the salmon arrives, it is put on the next truck leaving for the destined stores. However, since the routes are set on specific days, it can vary from one day up to a week for the salmon to be distributed to the store.

The products are handled both manually and with scanners at the DCs, which can be time consuming. As already mentioned, 35-40 percent of the global flow products have labels that can be scanned. An employee at Bring CS means that this is almost a too low percentage to introduce a scanning process at the DCs, due to increased amount of sorting work to separate scanned items from manual items. The DCs scan products for other customers, which mean that the technology and working habits are in place. The DCs do not use RFID technology today.

4.1.6 Transportation Companies

Bring CS has contracts with several different transportation companies all around the world. For the transportation in the salmon supply chain, Bring International ships from the producer to the DC. Then, there are different set-ups concerning the transportation from the DCs to the retailers. The DC in Brussels has its own trucks and handles all of the transportation from the DC to the retailers.

The chilled goods are transported in 4°C. For the larger DCs, the chilled goods often fill an entire truck. For the smaller DCs on the other hand, it is possible to divide the truck into two parts, separated by a removable wall. If there is one aggregate in the truck, it is possible to transport both chilled/frozen goods with the dry goods. However, if there are two aggregates in the truck, it is possible to have both chilled and frozen goods. For the truck with one aggregate, it is often placed in the front of the compartment, which means that the back of the truck may not hold 4°C at all times. Also, if the truck is unpacking its goods at different locations, the temperature outside will affect the goods in the back when the truck is unloaded. For the transports, from the CW in Staffanstorp to the DCs in Europe, there are no extra stops for unloading on the way. The furthest DC in the Southern Europe region is the one in Barcelona, which takes two days to reach. However, for the transportation from the DCs to the stores, the truck does a milk round and stops at several different stores on the way, which is likely to increase the temperature in the truck.

4.1.7 The Supply Chain Map

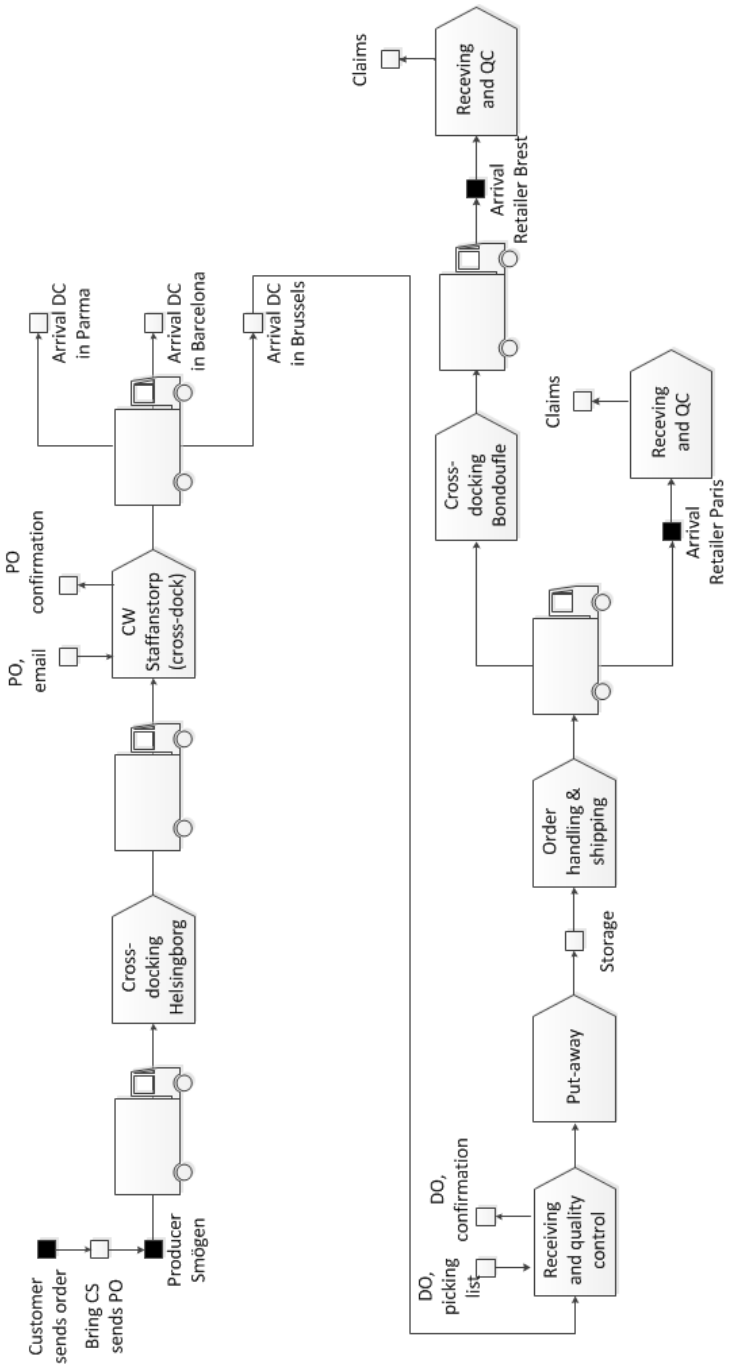

Figure 13. Supply Chain Map of the Salmon Flow

Figure 13, shows the map of the chosen hot smoked salmon supply chain. The specific supply chain is described in this section and provides the answer to Goal 1: "How does the supply chain currently function?".

The supply chain starts with Bring CS receiving orders once a week from the retailers at the different locations in Southern Europe. On Wednesday week [1], when the deadline has passed, Bring CS accumulates the orders depending on the destination and sends several purchase orders (PO) to the producer by email. One PO includes all the customer orders that go through the same distribution center, which means there is one PO for the DC in Brussels for example.

The fresh salmon is fished in Norway and then transported to Smögen in Sweden, where it is refined. On Tuesday, week [2], Bring International collects the order at Smögen, on behalf of Bring CS who books a designated truck every week. Bring International's truck goes to a consolidation point in Helsingborg where the salmon is kept overnight. On Wednesday morning, week [2], Bring International transports the goods to Bring Frigo's central warehouse (CW) in Staffanstorp. The CW receives the goods and PO and makes the necessary quality controls. Then, the salmon is cross docked to the trucks leaving at the same day for the DCs in Europe also containing the other food items that have been ordered.

It takes one day for the truck to reach the DC located in Brussels, which means it arrives on Thursday week [2].The DC receives a distribution order (DO) for the goods, both physically with the transport and electronically via EDI. After the quality control is done, the DC confirms the DO to Bring CS electronically via EDI.

The salmon is then stored in the warehouse until a truck leaves for the right destination. This is due to the number of set routes that leaves for different stores on a specific day of the week (see section 4.1.6). The truck leaving for the retailer in Paris departs on Wednesdays and the truck for Brest departs on Thursdays. Because of this, the salmon is stored in the warehouse for approximately a week before being shipped to Paris and Brest.

When the order containing salmon and other food items leave the DC, the DC confirms that they have sent the order. After that point in time, there is no communication concerning the salmon between Bring CS and any other actor and it is assumed that the salmon reaches its final destination. Bring CS only gets contacted if there is problem somewhere on the route.

The truck for Paris takes one day and arrives at the store on Thursday in week [3]. The truck for Brest goes to the consolidation point in Bondoufle, south of Paris. It stays there overnight and then leaves for Brest on the next day. In total, it takes five days for the truck to arrive at the store in Brest, which corresponds to Tuesday week [4]. When the salmon reaches its final destination, the store also checks the salmon and makes sure that the BBD has at least 14 days left and that the quantity and quality is correct. If there would be any issues with the products, the store makes a claim via Bring CS's claim system. A summary of the activities each week can be found in Table 4.

Table 4. Weekly Overview of the Supply Chain

WEEK [1]	WEEK [2]	WEEK [3]	WEEK [4]
Wednesday: Deadline for order from retailer to Bring CS	Tuesday: Goods are picked up from producer in Smögen and delivered to cross docking Wednesday: Delivered to CW in Staffanstorp Thursday: Arrives at DC in Brussels	Thursday: Arrives at retailer's store in Paris	Tuesday: Arrives at retailer's store in Brest

4.2 Strategic Objectives in the Supply Chain

Bring CS's goal is to simplify and improve logistic services as well as handle operations for companies with supply flows that are big, complex and who operates on the international arena (Bring Sverige, 2014). Bring CS, as well as Bring International and Bring Frigo, is a part of Norway Post Group who has the overall vision of being "The world's most future-oriented mail and logistics group" (Norway Post, 2014). By future-oriented, they mean being more creative and at the forefront of development than their competitors. Moreover, Norway Post aims at being an environmentally aware company e.g. by "Making use of new technology and constantly seeking to improve our use of renewable energy both for heating and for resource-efficient logistics solutions" (Norway Post, 2014).

Bring CS has involvements with numerous producers of food. The Norwegian producer of smoked salmon is one of the world's largest within its field. They strive

to find the most environmentally friendly and sustainable systems for their products and their company culture drives innovation[7]. The producer believes in long-term partnerships and finding new solutions together with their customers.

Regarding storage, Bring CS works together with twelve different companies that operate the DCs in different ways and have different strategies. The DC in Brussels operates within three fields: transportation, logistics services and information systems. This company is a major player in cold logistics and on the European market. The goal of the DC in Brussels is to manage physical and informational flow[8]. The DC in Brussels also has a sustainability agenda, where one of the goals is to use new technologies to reduce their impact on the environment and to save energy.

The retailer is a huge player in its field and has a goal that focuses on offering both good quality and good price to its customers[9]. They claim to be a company that takes responsibility and wants to have a positive impact both on people and on the planet. An employee at Bring CS says that CSR is important for the retailer and also that the retailer is concerned about the problem with food waste. The retailer has many progressive ideas but the way they handle them is not always as progressive as the idea itself since they have a high focus on price. Nevertheless, an employee at Bring CS says that that the retailer, as well as Bring CS's other customers, is at the forefront of development since they are willing to outsource their distribution of goods.

4.2.1 Incentives Concerning the DSLP service

An employee at Bring CS claims that there are no monetary incentives to implement dynamic shelf life since Bring CS does not earn money on reducing food waste. However, the employee at Bring CS sees possibilities in investing in the DSLP service to be able to offer a value adding service to the customer as well as offer a superior and more sustainable supply chain. Another incentive from Bring CS's perspective is to have more control and visibility of the supply chain.

[7] Producer's website
[8] DC's website
[9] Retailer's website

Moreover, the employee at Bring CS thinks that the DCs should see advantages in implementing the DSLP service by looking at the investment in a future oriented manner and being able to offer the service to their other customers.

4.3 Performance Measurement

Bring CS's customer started a KPI initiative a year ago, to measure the performance of the supply chain. The measurements are based on the claim system that the customer uses if there is an issue with the delivery of the products, both regarding quality and service. However, it is important that the customer uses the claim system properly, which is lacking today. Employees at Bring CS agree that this is a problem since the defects in the supply chain are not detected. Sometimes Bring CS sends inquiries to their supply chain partners to establish the true value of the KPIs and can then receive different and more accurate answers than the claim tool provides. The three main measurements are if the retailer receives the right quantities of the product at the right time and with the right temperature. The temperature is only determined when the goods arrive at the retailer and not earlier. One of the KPIs is BBD, which measures if the stores receive the contracted shelf life expectancy, i.e. 14 days. This is, according to an employee at Bring CS, a KPI that measures the entire chain since every actor plays a part in securing that the BBD is within its limit when it arrives to the retailer. The other KPIs measure the individual performances of Bring CS or the other actors. An employee at Bring CS means that there is a lot of improvement to be done when it comes to measurement.

4.4 Coordination of the Supply Chain

The coordination of the supply chain includes, according to Simatupang and Sridharan (2005), collaboration and information sharing between the actors, as well as aligning the incentives in the chain. This section covers how Bring CS collaborates and shares information with their partners today and if and how they ensure that there are common incentives in the supply chain. There is a certain focus on the salmon supply chain since it has been studied the most but also general information is covered.

4.4.1 Incentive Alignment

According to Naraynan and Raman (2004) and Lee (2004) there are several ways to ensure aligned incentives, e.g. contracts, aligned performance measurements and information sharing.

4.4.1.1 *Contracts and Aligned Performance Measurements*

The retailer owns and negotiates all contracts with the producers of the food. The product specifications in the contracts are however available for Bring CS, which means that they are aware of requirements of minimum shelf life, the agreed lead times etc.. Bring CS owns and negotiates the contracts with their logistics suppliers, i.e. the other actors in the chain. There are no bonuses or penalties in these contracts. However, if a logistics supplier performs very badly or makes large errors, i.e. gross negligence, they risk losing their contract with Bring. The contracts contain the overall agreement while the routines for the activities are specified in the appendices so they more easily can be changed. The retailer's contract with Bring CS is short-term, which means that Bring CS in turn has short contracts with their suppliers. An employee at Bring CS believes that the contracts with their suppliers in the future will be longer to make the collaborations smoother.

Bring CS does not have any common performance measurements with their suppliers but measures according to the customer's setup (see section 4.3).

4.4.2 Collaboration and Information Sharing

Bring CS is the coordinator of the global flow, and has the overall responsibility that the goods reach the destination on time. Bring CS has through the contracts with their partners set up the activities in the supply chain and the routines to follow. Bring CS never specifies how the activities should be done, only the requirements on the result. Bring CS has contact and collaboration with all actors in the supply chain, as well as with the retailer. The forms of contact, at all levels, are phone calls, emails and EDI. At the tactical and strategic level, there are also some face-to-face and telephone meetings. According to employees at Bring CS, the relations with the DCs in South Europe are well functioning and it is easy to contact and collaborate with them.

4.4.2.1 *Operational Collaboration and Information Sharing*

On the operational level, there is day-to-day sharing of information, especially if there is an interruption in the flow. Every piece of information regarding the global flow should go through Bring CS but there is occasional contact between the other actors. For example, the transporters contact the CW and DCs to book the time slots

to load and unload the trucks, so that these are coordinated with ferry schedules and other deliveries.

None of the actors in the supply chain share an ERP system with Bring CS. However, all twelve DCs and one producer are integrated with Bring CS's ERP system and much of the daily information, such as order information, is sent via EDI.

As previously mentioned, the retailer can claim faulty products, e.g. products that do not fulfill the BBD requirements, and receive a refund. The claims offer a possibility for Bring CS to improve their service and quality of the products, since they become aware of problems and areas of improvement within the supply chain.

4.4.2.2 *Tactical Collaboration and Information Sharing*

The regional managers, the head of sourcing and the DCs have two face-to-face meetings per year; one at the DC and one at Bring CS's office in Sweden. The purpose of these meetings is to optimize the operations in the different countries. These meetings offer possibilities to discuss problems in the supply chain, which for example can have been discovered through the claim tool. Each region has these meetings separately. The meetings are both on a tactical and strategic level. In general, information that gains both parties is shared in conversations. However, it is still business and it is important not to reveal too much, according to one employee at Bring CS.

In addition to the face-to-face meetings, there are also telephone meetings every sixth to eight week between Bring CS and the DC. The telephone meetings are on a tactical level and the discussions mainly concern medium-term improvements, but also issues that cannot be solved at an operational level. The majority of the improvement proposals are from Bring CS and their customer, but sometimes the other actors contributes with ideas as well. Moreover, there are meetings between the retailer's service office in each country, the regional manager and the demand coordinators once a month. At this occasion, it is mostly the KPIs that are discussed.

There are no tactical collaboration and information sharing with transporters and they can be replaced quite easily since there are many companies that offer the same kind of transportation services.

4.4.2.3 *Strategic Collaboration and Information Sharing*

Bring CS and their logistics providers have traditional supplier-customer relationships. The contracts with the suppliers are short-term, which puts an upper limit on the level of collaboration. The consequence is that the partners are not

willing to invest in the collaboration with the short-time horizon. The partners in the chain make some smaller investments to maintain service but they are not prepared to make any bigger investments, which sometimes is a problem. However, Bring CS is working on making the contracts with their suppliers longer.

When an investment is made, the actors usually stand for their own costs and the investment is shared equally among the actors. There can be an issue when a system change is required, but the actors often accept the costs since they consider it in a long-term perspective, where they might keep the customer longer.

4.4.3 ERP Systems and Electronic Information Sharing in the Supply Chain

The systems at Bring CS are today partly integrated with the other actors' systems in the supply chain. Previously, purchase orders and picking lists were sent by fax and later by email, but today a lot of the information exchange is sent via EDI files. EDI is the transfer of structured information in accordance with an agreed format. It enables information to be directly inserted in the partner's systems without manual handling. This is more time efficient and it eliminates the manual input process where errors can occur. Practically, information is sent from Bring CS's internal ERP system and transferred into xml format, thereafter into EDIFACT (standardized language for EDI) and after that translated to the language of the partner's systems. Moreover, Bring CS has systems that their customer can access, like the previous mentioned system for claims. The customer accesses the claim system by a webpage with a user account, and sends information about faulty products to Bring CS via that tool. Bring CS's long-term aim is to develop a conceptual solution – a standardized system – that many suppliers can be integrated with.

4.4.3.1 *Electronic Information Sharing and Integration throughout the Supply Chain*

Bring CS has currently only electronic integration with one producer, which is not the salmon producer. In general, the purchasing orders are sent by automatic emails from Bring CS to the supplier. How the different suppliers handle the purchase orders vary, but the impression is that many of the suppliers still handle this process manually.

Bring CS is today partly integrated with the CW and DCs, e.g. regarding the receiving and ordering systems, and EDI files are sent frequently between Bring CS and the warehouses. In general, picking lists are sent to the CW through EDI. However for the salmon, an email is sent instead, since that product is not kept in stock. The email contains the expected delivery information i.e. what have been ordered from

the producer. When the goods are received, the CW reports back the actual quantity and shelf life to Bring CS who registers it in their system. In most cases, this quantity corresponds to the purchase order, but it may differ e.g. if the producer has a shortage of the products. The picking lists sent to the DCs goes only via EDI since all products by then have been registered in the system. Currently, Bring CS receives the last update of the delivery status of the goods when the loaded truck leaves the DC, which roughly means that the products are considered as delivered at this point.

4.4.3.2 *Costs of System Implementations*

Several changes would be needed in the system in order to use a DSLP service, which depends on what information to share. Bring CS is not using its current ERP system fully today and there are more information from the labels that could be inserted in the system. If Bring CS would like to add a new piece of information that is included in the ERP system standard, it would not require a large investment. However, if new information were to be included, which currently is not in the standard, e.g. microbial growth in the products, a new variable would be needed in the system, and this would require more efforts.

Using the DSLP service will require integration to the DynahMat cloud service from where the information gained from the sensors will be sent. It is uncertain what the costs would be, but the IT consultants will probably stand for the largest part which is difficult to estimate. Moreover, the ERP system needs to be altered to be able to handle updated BBDs and also direct the FEFO rotation so that the batch with earliest BBD is shipped first. Changing the ERP system today as to handle updated BBD is estimated to cost 50,000-100,000 SEK. Apart from this, there are also costs for the educating internal personnel at Bring CS and also for implementing the new processes physically in the organization.

4.5 Project Specific Factors

In this section, more data about the RFID technology and its costs has been collected for the analysis, as a complement to the information gained from the empirical study.

4.5.1 RFID Technology

According to the RFID consultant, there are six different types of RFID technologies, whereof two are suitable for the DynahMat project: the ultra-high-frequency (UHF) and high-frequency (HF) technology. The RFID readers can connect with a UHF tag on a distance of two to five meters. The RFID consultant suggests that the suitable

solution for the DynahMat project would be to attach an UHF tag to the outer package, e.g. the pallet, and HF tags to all the individual consumer packages. Both types should be semi-passive tags, which mean that they log information but only send it to the cloud service when detected by a reader.

One of the challenges that the researchers from SFB are examining, radio propagation, is also found to be an issue here. None of these tags can send information if there is water between the reader and the tag. This is a challenge when the technology is used for food products, since most contains water. The UHF tag can detect through water on a radius of 30 centimeter via the magnetic field, but on longer distances this goes via the electromagnetic field where the water attenuates the signal.

The advantage of the consultant's proposed solution is that the UHF tag can be detected on longer distances than the HF tag, wherefore it is suitable to put on the outer package. There is no need to place UHF tags on the individual packages, since these are piled in cartons and the water in the products will attenuate the signals. Instead it is better to have the HF tags on the consumer packages, since these will be read on a shorter distance when unpacked. The HF tags on the individual packages should be connected to the UHF tag which can, until the pallet is unpacked, show the general status of all packages. There is often a difference in temperature between the outer consumer packages and the ones in the middle, but this difference is considered to have a negligible impact on the BBD.

4.5.1.1 *Costs of RFID Technology*

Currently, the unit price for both UHF and HF tags are approximately 5 SEK if buying around 1 million units. Although, the RFID consultant believes that the cost will be lower than 1 SEK in three or four years. The researchers in the DynahMat project believe that the price will be approximately 0.10 SEK in the future. Regarding the RFID readers, the RFID consultant suggests that installing one reader in a gate at a warehouse costs about 15,000 SEK; whereof ten thousands is the reader, one thousand the antenna and the rest is wires and installation.

4.6 Implementation Considerations

An aspect to consider when implementing dynamic shelf life is change management, which in this section focuses on the supply chain's general approach towards change. Also, the costs that have been presented earlier in the chapter are

summarized followed by the results from the study on food waste, which only concerns the hot smoked salmon supply chain.

4.6.1 Change Management

According to one employee, the approach towards change in the Southern Europe region is positive and the DCs realize that changes are important to maintain their level of service. By fulfilling the proposals for change and making joint investment, the DC show Bring CS loyalty and it increases their chance of keeping Bring CS as a customer. Furthermore, if the proposed change from Bring CS corresponds to the other customer's requests, the DC is often optimistic about the change.

The internal attitude to change has in the past not been very optimistic. However, this is changing and the personnel start to realize that changes lead to improvements. The level of cooperation also varies internally, in the same way as it generally does; some people have a positive attitude towards change while others do not.

4.6.2 Summary of Implementation Costs

In Table 5, the costs relevant for an implementation are summarized. The cost concerning system integration can also be found in section 4.4.3.2, and the costs for RFID technology in section 4.5.1.1.

Table 5. Summary of Implementation Costs

COSTS FOR SYSTEM IMPLEMENTATION	
System integration	50,000 – 100,000 SEK
COSTS FOR RFID TECHNOLOGY	
RFID readers	15,000 SEK
UHF &HF tags (current price)	5 SEK
UHF &HF tags (price in 3-4 yrs)	1 SEK
UHF &HF tags (future price, according to DynahMat)	0.10 SEK

4.6.3 Food Waste in the Hot Smoked Salmon Supply Chain

The flow of salmon is order initiated: only the amount ordered by the retailers is sent which means there is no safety stock in the warehouses. Therefore there are few or no food losses in the supply chain since the warehouse does not carry any stocks. However, food losses can occur if packages are misplaced at the distribution

centers or sent to the wrong retailer, but according to an employee, there were no such incidents during the last year, i.e. in 2013.

However, the retailers made a few claims to Bring CS in 2013 concerning the salmon. The stores in France made in total eight claims since they received products with a shorter shelf life than agreed, i.e. 14 days, and one claim due to the temperature being too high at arrival. The value of the destroyed goods was approximately 15,000 SEK. There were no claims from the stores in Belgium or Netherlands connected to short shelf life or high temperature.

5 ANALYSIS

The following chapter covers the analysis for the implementation of dynamic shelf life in the FSC. Firstly, some assumptions based on project specific factors are made in order to do an analysis. The proposed solution also covers some opportunities and challenges. Then, 'Strategy', 'Measurement', 'Coordination', 'Operations' and 'Implementation Considerations' are analyzed with a focus on opportunities and challenges. After that the effect on the 4PL company's business model is analyzed and finally, there is an analysis regarding adoption stages and drivers of innovations.

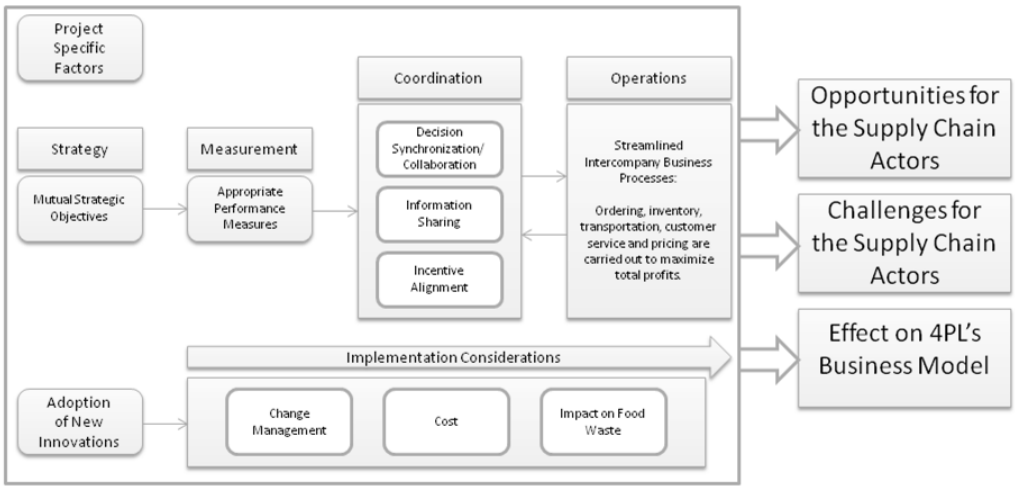

Figure 14. Analysis Framework

5.1 Assumptions Based on Project Specific Factors

The DSLP service is still a work in progress and has not yet reached the market. When it does, the 4PL company has a chance of being one of the first logistic companies to offer this service since they have been involved in the project from the beginning. However, the opportunities and challenges in the implementation of the service depend on the project specific factors; e.g. what sensors and RFID technology to use, where to install the readers in the supply chain and how to connect the information from the DynahMat cloud service to which actors. Since the circumstances will change due to project specific factors, some assumptions need to be made in order to analyze the DSLP service implementation in the food supply chain that has been studied. It can be stated that there will be a challenge to make the service and the technology work effortlessly in all stages of the supply chain. The

success of the project depends on the design of the DSLP service and therefore, different scenarios should be studied more closely to evaluate pros and cons.

5.1.1 Choice of Sensor

First, the service will look differently depending of what information the 4PL company decides to store in the sensors, for example global positioning system (GPS), TTI sensor and biosensor. Different types of sensors will also have different types of requirements and costs for the service set-up.

Bring CS has expressed that the TTI sensor is probably the sensor that they want to use which means that they are not interested in measuring the microbial growth, at least not initially. In addition, this is supported by the findings from the CHILL-ON project that states that a temperature and period sensor is better than one that only measures temperature. The TTI sensor will be attached to the RFID tag in a label that will be put on the package. Also, increased visibility and control is an incentive for Bring CS to implement the DSLP service and therefore it is assumed that a GPS should be included in the readers.

The choice of sensor has an impact on the design of the DSLP service implementation. Using a biosensor will more accurately decide the shelf life of the product since it will measure the true microbial growth and not the expected one (Göransson & Nilsson, 2013). However, biosensor needs to have contact with the food at all times which require more effort in handling the goods as well as higher costs. This is not necessary for the TTI sensor that can be put on the outside of the package. On the other hand, the TTI sensor will still depend on the shelf life expectancy given by the producer. Therefore, in general, only using a temperature indicator will not increase the shelf life of the product; only decrease it if the product has been treated badly.

The only way a TTI sensor could increase shelf life is if the producer has used a safety margin when setting the BBD. In the smoked salmon case, the producer claimed that the shelf life was 28 days, given that the supply chain always kept the salmon at 4°C. This means that using a temperature sensor on the salmon will not have the possibility to increase shelf life – only decrease it if the temperature exceeds 4°C. This implies that the selling period of salmon cannot be longer than it is today. However, according to the cold chain researcher, there are some producers, which claim that they do include a safety margin on their products to ensure food quality even if the cold chain is broken. In this case, the producer can set the BBD as calculated, without a safety margin, and then the DSLP service will automatically

adjust it depending on how the food actually is handled. Ultimately, with the help of the DSLP service, a safety margin will not be required. Nevertheless, both the TTI sensor and the biosensor will be able to guarantee the safety of the food if handled properly and give warnings if there is a disruption in the cold chain.

5.1.2 RFID in Logistics System

There are according to the RFID consultant six different types of RFID tags available whereof two are suitable for the DynahMat project. The assumption for the implementation regarding RFID tags is that Bring CS applies the RFID technology according to the RFID consultant's recommendation (see 4.5.1), but also includes a UHF tag on every secondary package, i.e. the carton. As a result, the assumption is to have one semi-passive UHF tag on the pallet as well as on all cartons, and semi-passive HF tags on all individual consumer packages. The reason for placing UHF tags also on the cartons is because the salmon seldom is delivered in full pallets, which means that the cartons need to have UHF tags to be detected on the way. Also, all individual HF tags in the carton will be connected to the UHF tag on the carton. The overall reason that the salmon is not sent in full pallets is that none of the retailer's store can sell that much salmon within the short shelf life.

Furthermore, the assumption is that Bring CS would use an open system, which mean that the tags are disposable, i.e. only used once (Pålsson, 2007). This assumption is based on the fact that a closed loop would require the pallets to be returned to the producer, which is considered a too big effort and change in the operations, at least initially. The decision for how many tags that should be used and where to place them is a trade-off between costs and opportunities to make use of the technology in the best way possible.

5.1.3 Positioning the RFID Readers

In this analysis, the assumption is that the RFID readers should be placed where responsibility shifts from one actor to another, and when the products leave the DC for the stores (even if the DC company also handles these in the current supply chain). This is due to the fact that the transparency in the chain increases and it gets easy to find room for improvement.

In the specific supply chain that has been studied, there should be a reader at the producer's facilities before the goods is loaded onto Bring International's truck. Then readers are needed when Bring International unloads the goods at the CW in Staffanstorp and also when Bring International picks up the goods for transportation

to the DCs. The DCs would therefore also need readers both when receiving trucks and possibly when the goods leave the DC for the stores in order to separate the warehouse operations from the transport operations. Finally, the retailers need to have readers when receiving the goods. The cross docking points do not necessarily need to have readers, especially not in the studied since one company has the responsibility from the DC to the store. The suggested positioning of the readers can be seen in Figure 15.

5.1.4 The DynahMat Cloud Service

Every time the RFID tags pass a reader, the information including temperature and time logs is sent to the cloud service that calculates the remaining shelf life by using prediction algorithms (Göransson & Jevinger, 2014). There can be different solutions on how to use the service, e.g. which actor that will have access to the service and what information they should have access to. Depending on what is decided and agreed in the supply chain, there will be different opportunities and challenges. It is therefore assumed that Bring CS, the CW in Staffanstorp, the DCs and the retailer are connected to the cloud so that they all can be updated on BBD of the products, in order to prioritize the shipments according to the FEFO principle. All the information from the temperature and time logs is suggested only to be visible for Bring CS (see 5.4.2).

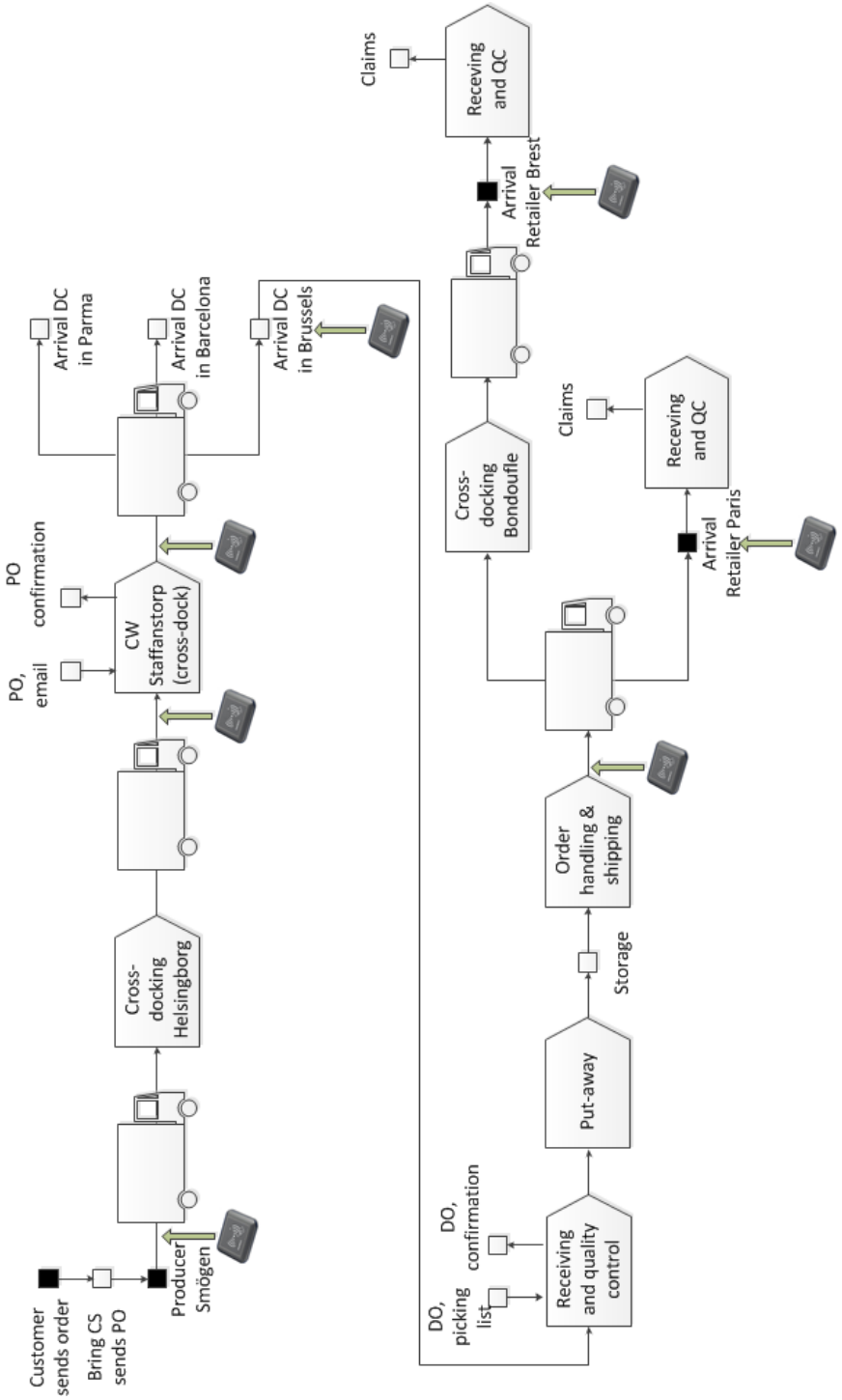

Figure 15. Where to Position the Readers in the Supply Chain

5.2 Strategic Objectives

The supply chains that Bring CS coordinates can be characterized as supply chains with a level of complexity that is found somewhere between an extended supply chain and an ultimate supply chain, see Figure 16. The aim is to look at all the actors that are affected by the DSLP service. This includes more than three entities, which is the case in a direct supply chain, but not all organizations such as in an ultimate supply chain. Even though the ultimate customer, i.e. the consumer, is not included in the analysis, it is important to consider its needs and wants which is partly done in the analysis on the effect on the 4PL's business model.

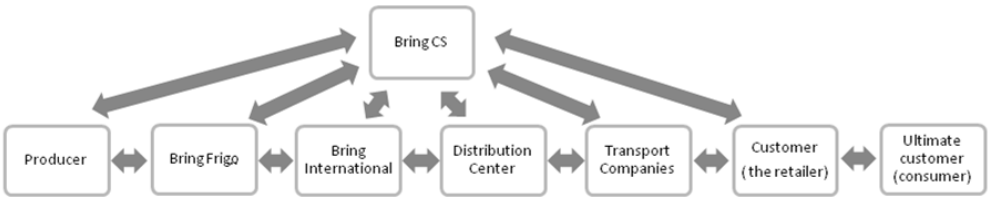

Figure 16. The Analyzed Supply Chain, based on the models by Mentzer et al. (2001)

5.2.1 Bring Customer Solutions

In order for the implementation of the DSLP service to succeed, it needs to have support from top management and be in line with the company's strategic objective (Fries, et al., 2010). Looking at Norway Post's (that includes Bring CS, Bring Frigo and Bring International) strategic objective, they state that they have an objective of being creative and in forefront of development. Being a part of the DynahMat project goes therefore hand-in-hand with how Norway Post wants to position itself. Also, their goal of using new technology to be more environmentally friendly can be reached by being one of the first companies to use the DSLP service since the overall project objective is to reduce food waste. Hence, there should be several incentives from Bring CS's point of view to be at forefront in the DynahMat project.

5.2.2 The Producers of Food

Only looking at the producer of salmon, they should have strategic incentives to want to be a part of the DynahMat project since they value reducing their environmental impact and collaborating with their customers to find new and better solutions. Furthermore, as findings from the Pasteur Project shows, the producer benefits from the continuous monitoring since the quality of their food is guaranteed throughout the supply chain. Since they are a leader in their business area, they should also find incentives in being at forefront of development.

However, in a larger perspective for Bring CS, it will be difficult to analyze all the producers' attitudes towards the DynahMat project, since Bring CS is involved with a great number of producers.

5.2.3 Distribution Centers

The DC in Brussels also has an aim of being environmentally friendly which should be an incentive to cooperate in the DynahMat project. Moreover, they are a large player on the European market and therefore it is likely that they would like to respond quickly to market changes and be able to offer the best service. Also for the DCs, it is hard to make a general statement, since there are twelve different DCs with different agendas.

5.2.4 Transport Companies

The transporter's strategic view is not considered important since their operations will not be affected by the DSLP service. In addition to this, they are easily replaced (see section 5.4.2.2).

5.2.5 The Customer – The Retailer

The retailer should also have several incentives to be a part of the DynahMat project since they highly value CSR work and has, as an employee at Bring CS said, been alarmed by the food waste. A challenge for the project is to involve the retailer in the investments, since they are very focused on costs. On the other hand, the retailer is the actor that has most to gain on the dynamic shelf life and should of that reason be interested in the project. For example, they can guarantee the food quality to the ultimate customer and might be able to sell more or to a higher price. In addition to this, they will probably receive the most attention for the project since they are the supply chain actor closest to the consumers who will be affected the most by the introduction of dynamic shelf life. It is very important that the retailer supports the project and is willing to invest. Otherwise there will be few incentives for the other actors to do so, according to an employee at Bring CS.

5.2.6 The Supply Chain

There are common opportunities for all actors to implement the DSLP service. First and foremost, they have the possibility to be a part of a quality supply chain that can guarantee the quality of the food to the retailer and the ultimate customer. Also the supply chain offers a value added service to its customer, something that the actors can offer to their other customers. By implementing the DSLP service the actors have the possibility of keeping current customer and also gaining new customer due

to the extended offering in their services. One of the biggest challenges is making sure that all actors are onboard and willing to invest in the project, especially since it would concern many actors with different mindsets and objectives.

5.3 Performance Measurement

Lambert and Pohlen (2001) recognized numerous reasons to use supply chain metrics in order to improve the supply chain's performance, such as aligned processes and cooperative behavior across firms. However, the 4PL company only has one KPI that measures the performance of the entire supply chain, which is BBD (i.e. if the food is delivered within the contracted time span). If implementing dynamic shelf life, the collaboration between the actors will increase and more information will be shared. According to Lambert and Pohlen (2001), the chance of reaching success in such collaboration is higher if using common supply chain metrics. The supply chains that Bring CS handles have little experience of using common metrics and measuring throughout the supply chain, which means that this will be a challenge for them. Today, most KPIs are measured only when the goods arrive at the retailers and they are solely based on the information from the claim tool which is not used properly. There are no measures done at other points in the supply chain, which makes it difficult to see the true performance of the supply chain and improve it. If Bring CS wants to implement common performance measurements, they need to be able to capture the performance of the different actors, something that will require time and effort (Beamon, 1999).

Since many of the actors, as well as Bring CS, will be connected to DynahMat's cloud service, there will automatically be more performance measurement in the supply chain. Temperature, time and BBD will be measured and updated continually in the cloud service, which will make the supply chain more transparent. It will be visible how the temperature has changed and also BBD, which both are connected to the handling of the food. The DSLP service is therefore an opportunity to make common performance measurement easier to use. Since the cloud service will receive the information from all the actors, there will not be an issue with capturing measurement across the supply chain, which often is a challenge (Lambert & Pohlen, 2001). By using performance measurement and having more visibility in the supply chain, it is easier to show areas that require improvement, which leads to a higher supply chain performance (Lambert & Pohlen, 2001). The temperature logs will for example be a good measurement on how the chilled food is handled throughout the chain and actions can be taken if the goods are not handled properly.

However, more transparency is also connected to more risks. For example, there is a risk that the supply chain actors are not willing to cooperate since they will, as stated by Lambert and Pohlen (2001), become accountable for their performance of key businesses and risk showing their weaknesses. A higher degree of transparency increases the risk of opportunism, which will be further discussed in section 5.4.2 about information sharing (Lee & Whang, 2000).

5.4 Coordination of the Supply Chain

The supply chain that Bring CS is a part of is different from the classic supply chain since Bring CS is not involved in the flow of the goods. Instead they handle all coordination, collaboration and information sharing with the other actors in the chain, see the example of the hot smoked salmon supply chain in Figure 17.

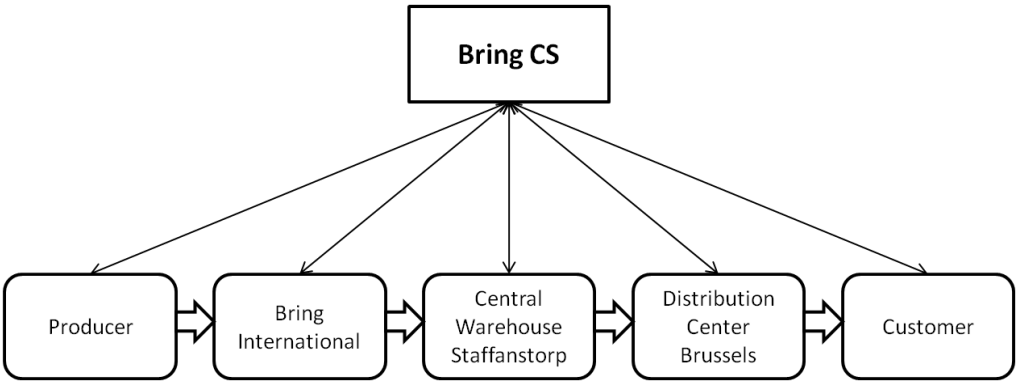

Figure 17. Flow and Information Sharing in the Hot Smoked Salmon Supply Chain

Therefore, the operational and organizational linkages that exist are generally between Bring CS and the actors and not between the actors themselves. Bring CS coordinates all interfaces and plans the logistic activities. However, there are some operational linkages between the actors, for example when booking time slots for loading and unloading. This means, that when implementing dynamic shelf life, the linkages that will be affected and where the focus needs to be, is between Bring CS and its logistics suppliers. These linkages provides, according to Simatupang et al. (2002), the foundation for successful coordination and are key to making the implementation succeed.

In the CHILL-ON project the TRACEHILL, which is similar to the DSLP service, had the purpose of supporting supply chain coordination. The aim is that the DSLP service will be a useful tool for this purpose as well.

5.4.1 Incentive Alignment

According to Lee (2004), incentive alignment is a way to improve performance in the supply chain. Lee (2004) has several suggestions on how to better align the incentives such as more information sharing, redesigning the terms of the partnership and aligning the incentives as to maximize the overall supply chain performance. One way to do this is to design the contracts to make all actors strive for the same goals; another is to use performance measurement to make the supply chain more visible (Naraynan & Raman, 2004). Bring CS contracts does not create any incentives for the logistics providers to perform in a certain way and there is improvement to be made when it comes to using performance measurement and aligning them in the chain. There are thus no direct incentives for the actors to invest in the DSLP service since the contracts are not performance-based. Moreover, the contracts are short-term which does not encourage partners to invest in Bring CS, according to employees. There can therefore be a challenge to convince the actors to make the necessary investments and changes in the operations, especially since dynamic shelf life is new on the market. In the future, the contracts might be longer which would be a better incentive for the actors to invest and collaborate.

Naraynan and Raman (2004) also believe that trust and personal relationships are important to align the incentives. There are therefore some incentives for the actors to invest in order to develop their relationship with Bring CS to keep their contracts in the future. This is however a balancing act. For example, many of the DCs are large companies and are not dependent on Bring CS as a customer. Changing DCs is, according to employees, difficult and requires a large investment. It can therefore be crucial that the DCs are willing to change and invest in the DSLP service since the costs of changing DCs are very high. Changing transporters is considered easier since there are many companies that offer such services according to an employee at Bring CS.

5.4.2 Collaboration and Information Sharing

Bring CS has different collaborations and types of information sharing with the different supply chain actors. Bring Frigo and Bring International will not be analyzed since they are a part of Norway Post Group.

Bring CS currently uses the information transfer model with their strategic collaborators; sharing information directly via EDI. However, the DynahMat cloud service will act as an information hub model, where the information can be retained from the cloud. The proposition is to connect Bring CS, the CW, the DCs and the

retailer to the cloud so that they all can be updated on BBD of the products but having the temperature and time logs only available for Bring CS. This is to avoid too much sensitive information sharing that can increase the risk of opportunistic behavior.

5.4.2.1 *The Producer*

The producer of the food is considered to be a transactional collaborator. The information shared only concerns the volumes of the next order, which is short-term and can be classified as operational information according to Moberg et al. (2002). The producer is not electronically integrated with Bring CS, which is an indication of low collaboration level (Giguere & Householder, 2012). The information is instead shared through email, which only is a onetime transaction when the goods are shipped from the producer to the CW. Since the DSLP service would require the producer to make investments in the RFID readers for their facilities, the level of collaboration might need to increase. There are rather small investments for the producer in the proposition of installing the readers (see 5.1). However, if a biosensor were to be used, the requirements on the producer would be higher since this kind of sensor needs to be in contact with the food, i.e. not only on the outside of the package. This would force a change in the producer's operations and hence a bigger investment. The shared investment in technology between the producer and Bring CS would require a higher level of collaboration.

5.4.2.2 *Transport Companies*

The transport companies are considered to be tactical collaborators since they, according to Giguere and Householder (2012), are needed to run everyday business operations. They can however, in line with what employees at Bring CS stated, be replaced rather easily since there are many companies offering the same services which also points towards a tactical relationship. If implementing a DSLP service, the relationship with the transporters will not change considerably, apart from that there will be more information sharing between them and Bring CS. Including a GPS in the readers will result in increased track- and traceability of the transports. Currently, Bring CS does not have track and trace on their products, which they believe is an issue. If there is disturbance on the route or quality issues, it is necessary to locate the products fast and this could be improved by having a GPS in the readers. This increased level of information sharing can be a challenge since it is connected to more risks (Lee & Whang, 2000). More visibility means that the transport companies are more exposed in terms of how they run their business and can become liable for product damage. Today, the temperature of the goods is only checked when they arrive to the CW, DC and the customer, which means that there

is no knowledge of what has happened in transit and if the products have had the same temperature all the way. By implementing a DSLP service, the temperature and BBD would at least be checked at the transition points and data would be compared before and after the transportation. For example, if the shelf life has decreased, it is a consequence of the increased temperature of the goods. The transport companies will therefore become more exposed to how they handle the goods than before.

5.4.2.3 *Distribution Centers*

The DCs are considered to be strategic collaborators due to their electronic integration with Bring CS and high level of collaboration (Giguere & Householder, 2012). According to employees, the DCs are not easily replaced and the information sharing covers all levels, from operational to strategic. Also, they work together on solving problems and optimizing the supply chain. The relations with the DCs in the Southern Europe region are good and there is trust between Bring CS and DCs, e.g. Bring CS only gets involved when there are issues in the supply flow. Implementing a DSLP service would have most effect on the DCs since they need to be integrated to the DynahMat cloud service and make changes in their operations. The DCs also need to install readers in their gates, both for incoming and outgoing trucks. The level of information sharing and collaboration would need to increase in order to make the DSLP service work, which could be a challenge since the requirements on the DCs would increase. As Yigitbasioglu (2010) says, there must be clear advantages for the DCs to increase the level of information sharing since the DCs will take more risks and invest in their collaboration with Bring CS.

5.4.2.4 *The Retailer*

The retailer is also considered to be a strategic collaborator since they are very involved in Bring CS decision making and also share information with Bring CS on all levels. The retailer would also need to make some investments in readers, the cloud service and preferably also in technologies on how to communicate the true shelf life to the ultimate customer. The collaboration and information sharing between Bring CS and the retailer should not need to change considerably since they already have a high level of collaboration. Nevertheless, the performance of the supply chain will be more visible due to the DSLP service. This can give both parts more bargaining power, depending on the outcome; if the supply chain performs well, Bring CS can use it in negotiations but if the supply chain performs badly, it increases the retailer's bargaining power.

5.4.2.5 *The Supply Chain*

It is essential that the IT solution and system integration work very well since it is a barrier to effective information sharing (Lee & Whang, 2000). In order to really succeed with the DSLP service, the shared information needs to be both accurate and timely which is very much dependent on the integration between the cloud service, Bring CS's ERP system and the warehouses' WMS systems (Lee & Whang, 2000).

Implementing the DSLP service will in most cases lead to a higher degree of collaboration between Bring CS and the other actors and more information sharing. There are many opportunities connected to this. As Lee and Whang (2000) states; information sharing is essential to make coordination in the supply chain possible and according to Moberg et al. (2002), it can lead to reducing logistics cost and be value adding to the customer.

For example, by sharing information about the true shelf life of a product, the supply chain has a better chance of avoiding food waste by reallocating the goods. This is also dependent on the system integration and how to share the information. An advantage of the proposed solution is that the CW and DCs quickly can act on changed BBDs and redistribute the goods so that the batch with the earliest BBD is sent first. If they cannot reach the information directly via the cloud, it may take too long until they are informed about changes in BBD.

As already mentioned, the visibility that comes from implementing the DSLP service can help reduce logistics cost by finding the weak spots in the supply chain. Visibility can also increase the collaboration between the actors (Giguere & Householder, 2012). Moreover, a higher degree of information sharing can help align the incentives in the chain (Lee, 2004). For example, if the CW and DCs receive information about the current BBD of the goods and have knowledge that this might change by bad handling; they have more incentives to be concerned by it. This might result in that they are more attentive to goods and make sure that it is always kept in a chilled storage, thus increasing the performance of the chain.

A challenge with information sharing is if the actors suspect risks of opportunism and that the increased visibility in the chain affects their bargaining power (Lee & Whang, 2000) (Yigitbasioglu, 2010). It is therefore, according to Yigitbasioglu (2010), important that Bring CS only shares the necessary information with the concerned actors, which is why only changes in BBD should be shared with the other actors. The temperature and time logs should be used as performance measurement

instead. Min et al. also argue that trust need to be established to make the actors share more information with each other. The contracts play a part in establishing trust and since they are short, this might be a challenge for Bring CS. One solution can be to compensate the actors for the increased information sharing (Yigitbasioglu, 2010).

Another challenge that Bring CS faces is the risk of becoming too interdependent on their suppliers and investing too much in logistics providers that they in the future may not want to cooperate with (Yigitbasioglu, 2010). The cost will be higher if more actors are connected to the cloud service (see section 5.6.2). It is important that Bring CS carefully chooses with whom to collaborate with and that they are willing to invest in the relationships with their current suppliers.

The proposition also has requirements on the operational information sharing and a challenge is to coordinate the goods and communicate the changes in the supply chain. For example, if the goods need to be sent to a closer retailer, the constraints on the coordination are much higher. However, since Bring CS already communicates with all involved members, the chance of succeeding with an increased level of communication is better (Yigitbasioglu, 2010).

5.5 Operations

Implementing DSLP service in the supply chains that Bring CS coordinates will demand changes in the operations for some actors in the studied supply chain.

5.5.1 Bring Customer Solution's Organization

The operations at Bring CS will be affected if implementing the DSLP service. There will be more information to keep track of and the conditions can change suddenly if there has been a mistake with the food handling. However, this is also a benefit, as stated in the Pasteur Project, since they will be notified every time a considerable error occur, which gives Bring CS an opportunity to correct this or take necessary measurements.

The idea from the DynahMat project is that goods can be reallocated if the status on the goods has changed during the handling and the shelf life has decreased (Göransson & Nilsson, 2013). However, this is not fully applicable on the FSC that Bring CS handles since there are different labels and requirements for different geographical areas. In many cases, the goods need to be relabeled if the destination changes which takes both time and effort. The possibility to ship the goods

elsewhere if there is a reduction in shelf life is therefore very limited and is a challenge to make work. However, it is still possible to ship the batches with shortest BBD first and relocate goods within the same language cluster.

An opportunity with introducing the DSLP service is that tracking and tracing of the goods will be easier, thanks to the GPS. This can improve the operations at Bring CS since they easier will see where the goods are and communicate this to the retailer or other logistics providers concerned.

In order to make the implementation of DSLP service easy for the employees that constantly work with the supply flow, there needs to be a good system for handling changes in BBD. Making necessary changes in the ERP system will probably do this. There should also be some kind of warning system in order to prevent goods with a short BBD from being shipped off to countries overseas.

Today, the salmon requires special handling by all actors in its supply chain. It is unlikely that this can change since the salmon, even after a DSLP implementation, is a product with short shelf life that requires the supply chain to run effortlessly. Having a dynamic shelf life on the product will only help discover products that have turned bad; the salmon must still have special handling to ensure that it is delivered within the agreed range.

5.5.2 The Producer

With the TTI sensor, it is not necessary to make changes in the producer's operations since the RFID tag will be put into the label.

5.5.3 Transport Companies

The transport companies will not need to change their operations at all. The readers will be installed before and after transports, which will not change the way transports are done today.

5.5.4 The Central Warehouse and the Distribution Centers

The CW and the DCs will need to make some changes in their operations to handle updated BBD on food items and the new technology. Hopefully, the most work will be done by their WMS systems so that the batch with the earliest BBD will be sent first and also give warnings about changes in BBD so that they can redistribute the goods if needed. Since the labels of the goods need to be updated, the new labels should be able to be scanned which could decrease the amount of manual handling at the warehouses.

5.6 Implementation Considerations

There are several aspects to consider connected to the implementation phase of the DSLP service. First, it is important that the Bring CS raises the possible issue of change management and deals with it. A cost analysis is also essential to make before deciding if to implement or not. Finally, it is relevant to analyze the DSLP service's impact on food waste since it is the primary argument for using and is important for several reasons, e.g. marketing and the companies' corporate social responsibility profiles.

5.6.1 Change Management

In the theoretical framework, two types of changes are described: planned and emergent changes. The change to a dynamic shelf life can be described as a planned change. This is because the implementation would happen according to the following process: freezing, which is the current state; unfreezing, when the new ideas are identified and approached, and refreezing, which is when the new values and skills from the unfreezing step are in place. Emergent change is often a bottom-up approach. This is not the case for the DSLP service, since the initiative to implement cannot be taken at an operational level, but at management level.

The attitude towards change within the organization and among concerned parties can be crucial for the success of an implementation. Especially crucial is the level of existing resistance. As mentioned by Bamford & Forrester (2003), one presumption in the planned change is that employees work towards the change without disagreement, and this is not always true. Waddell and Sohal (1998) explain that employees are not resistant to change in general but rather the uncertainties and possible negative outcomes that change causes. Because of this, it is important to include the personnel in the process and consult with them (Waddell & Sohal, 1998). This needs to be considered internally within Bring CS's organization since there probably will be some resistance towards the new working ways. As employees at Bring CS say, some in the personnel will have a positive attitude towards the project, and some will not and it is important to discuss the changes with them. For example, Fries et al. (2010) propose cross functional teams in order to ease the communication within the organization. If a team with personnel from different departments is established, the group can function as informers and ambassadors for the project; explaining for their colleagues what is happening and why it is done in a specific way. Secondly, they can come up with important inputs on how to design the change so it moves as smoothly as possible with their departments

working processes. Furthermore, they can inform the rest of the group if problems concerning the implementation are occurring at their level. Finally, if employees are given responsibility for the change, they are more likely to work hard for it.

Different organizations can have different approaches towards change. For example, in the supply chain from the salmon producer to the retailer, there are at least five different organizations. This is just one of the supply chains that Bring CS manages in one region, there are three regions in Europe, and Europe is one of five regions globally. In other words, there are many organizations that are involved if this change should be implemented globally. Not all of the organizations have to change their working ways, e.g. the transporters can carry on in the same way as they do today. The DCs for example, are important players to get onboard, but there are several different DCs in Bring CS's network and they have individual attitudes towards change. For the DCs in the Southern Europe region, the attitude towards change is positive which will make collaboration easier. But this may not be the case for all DCs and Bring CS needs to provide them with an incentive to change. Also, as mentioned before, they are probably more willing to change if Bring CS's request coincides with the requests of other customers to the DCs. Luckily, RFID technology are used for other purposes than the dynamic shelf life, so the DCs are probably more willing to invest in this technique, since they can offer it to other customers as well. Moreover, it is probably wise to start the implementation for the FSC going through one DC; preferably with one DC which Bring CS has a well-functioning relationship. In this way, the service can be tested and small errors can be fixed before it is implemented globally, which reduces the overall risk of the implementation. If this works well, it is also easier to convince the other DCs that this will work.

5.6.2 Costs of an Implementation

The implementation of the DSLP service will require investments. It is mainly an initial investment, but the RFID tags that should be attached to the pallets, cartons and consumer package will be a variable cost. The initial costs include:

- The RFID readers and the installation of these.
- The costs of the tags including the TTI sensor
- Setting up connections between the 4PL company's and the other actors' ERP/WMS systems with the DynahMat cloud service.

The focus of this analysis will be on the RFID readers, the installation and the RFID tags. Since the GPS is included in the readers, it is also included in the cost. The same

goes for the TTI sensor, which is included in the RFID tag and its cost. The connection with the DSLP cloud service will be partly analyzed, but this is harder to estimate since it is depending on many factors: the current ERP systems, how the DynahMat cloud service will function, how information about the BBD should be sent in the supply chain etc.

All figures and calculations concern the studied supply chain, i.e. the distribution of the 200 g hot smoked salmon from the producer in Smögen through the CW and DC in Brussels, to the retailer's stores in France,

5.6.2.1 *Fixed Costs*

Firstly, the RFID readers should ultimately be placed at all locations where responsibility shifts from one actor to another. For the situation in the case, this would be at the producer, the CW in Staffanstorp, the DC in Brussels and at the retailer's stores. At the CW and the DC, the sensors should be read both when the goods are unloaded and when they get reloaded to a truck. In Table 6, there is a summary of the costs for the total flow from Smögen to the retailer's stores. The numbers in the brackets are the gates used for unloading plus the ones used for reloading. For the producer, one reader is sufficient, since they send one truck per week for Bring CS. The figure for the CW is what they currently use, and the figure for DC is an estimation: it is not likely that it arrives more than two trucks at the same time from the CW, but since there are many stores to be supplied, more gates with readers are needed. Considering the retailer's stores, one gate is calculated per store. As mentioned in section 4.5.1.1, the approximate cost for the reader and its installation is 15,000 SEK.

Table 6. Fixed Costs

FIXED COSTS		TOTAL COSTS (SEK)
Readers:		
Producer [1]	15,000 SEK	15,000
CW in Staffanstorp [8 + 12]	20 · 15,000 SEK	300,000
DC in Brussels [2 + 6]	8 · 15,000 SEK	120,000
Retailer's store [47[10]]	47 · 15,000 SEK	705,000
		1,140,000
System connections:		
Bring CS's ERP	100,000 SEK	100,000
Other systems [3]	3 · 100,000 SEK	300,000
		400,000
TOTAL		**1,540,000**

In the system connections list, the other systems to be connected with the DSLP cloud service are the CW, the DC and the retailer's ERP/WMS systems. The costs for the connections are estimated together with personnel who are used to purchase these services. It is not certain that this is exactly how it will work, but the calculations are made with the assumptions in section 5.1.

5.6.2.2 *Variable Costs*

In addition to the fixed costs, there will be variable costs for the RFID tags. As for now, it is required to place one on each pallet, carton and individual package, which is disposed at arrival to the retailer according to the assumptions in section 5.1.

The calculations can be seen in Table 7-9, and concern the salmon in three different possible future stages of technology development. However, it should be mentioned that the sensors should preferably be used on all chilled food and not just the salmon. An exception could be low margin products where it might be too expensive to implement dynamic shelf life. The first table contains the current prices (Table 7), meanwhile the second (Table 8) is the forecast in 3-4 years made by the RFID consultant. The third (Table 9) is the forecast of future prices made by the DynahMat project (not specified in how many years).

[10] Retailer's website.

Each pallet can carry 32 cartons, and each carton contains 50 consumer packages. This equals 1600 consumer packages per pallet. The variable X represents the total flow per annum of consumer packages of hot smoked salmon 200g. In the calculations, five significant digits are used.

Table 7. Variable Costs, Current Prices

VARIABLE COSTS (CURRENT)		
RFID tags:		
UHF (pallet)	5/1600 · X	0.00313 · X SEK
UHF (cartons)	5/32 · X	0.15625 · X SEK
HF	5 · X	5 · X SEK
TOTAL		**5.15938 · X SEK**

Table 8. Variable Costs, Prices in 3-4 Years

VARIABLE COSTS (IN 3-4 YEARS)		
RFID tags:		
UHF (pallet)	1/1600 · X	0.00063 · X SEK
UHF (cartons)	1/32 · X	0.03125 · X SEK
HF	1 · X	1 · X SEK
TOTAL		**1.03188 · X SEK**

Table 9. Variable Costs, Future Prices

VARIABLE COSTS (FUTURE)		
RFID tags:		
UHF (pallet)	0.10/1600 · X	0.00006 · X SEK
UHF (cartons)	0.10/32 · X	0.00313 · X SEK
HF	0.10 · X	0.10 · X SEK
TOTAL		**0.10319 · X SEK**

Intuitively, one sees that it is a large difference between the current and the forecasted costs. Actually, the difference between the first and second is a cost reduction of 80 percent, and between the first and third, 98 percent. However, these are forecasts and cannot be taken as facts on how the actual situation will be. For example, EU regulations can change the market for RFID: either to enable a development or to disrupt it. Depending on this, the price reduction can move faster or the price reduction might not occur at all.

5.6.2.3 *Sharing the Costs*

As previously mentioned, it is often that all actors in the supply chain carry their own costs when making investments. According to the interviews made by Göransson and Jevinger (2014), it is important that all actors contribute to the investments for a dynamic shelf life, especially the retailer. This is also supported by Fries et al. (2010), who say that all actors should make investments in order to fully optimize the benefits in an implementation of RFID technology. However, the transporters do not need to make any investments, since the tags will be read at the producer, the warehouses and retailer's stores only.

In the following table, the costs have been shared among the actors. The costs are the same as in Table 10, where they are described more in depth. However, the cost of the RFID tags is not included, since this can be shared differently among the actors depending on the set-up and the actual cost.

Table 10. Costs per Actor

ACTOR	COSTS (SEK)
Producer:	
RFID reader	15,000
	15,000
CW, Staffanstorp:	
RFID readers	300,000
System integration	100,000
	400,000
DC, Brussels:	
RFID readers	120,000
System Integration	100,000
Rearrangements in facilities/operations	*not known*
	220,000
Retailer:	
RFID readers in stores	705,000
System integration	100,000
	805,000
4PL company, Bring CS:	
System integration	100,000
Changes in operations	*not known*
	100,000

How the other costs should be divided is connected to how the pricing of the DSLP service is designed and how Bring CS designs the contracts with their suppliers.

Regarding the incentives, it is Bring CS's customer who has most to gain on dynamic shelf life, thereafter Bring CS and finally the other actors. In that aspect, it might be reasonable to suggest that Bring CS's customer would take a larger share of the investment. In section 5.8.3, *Earnings Logic and Pricing Strategies*, this will be further discussed.

5.6.3 The Impact on Food Waste

In the salmon supply chain, there are few food losses due to the controlled supply chain and the fact that the salmon is order initiated. Thus, there is little to gain in less food waste or in monetary terms. Last year, the value of the reported food waste in all of the French stores was in total 15,000 SEK. Initially for the DSLP service, there might even be more food waste due to better knowledge about the true state of the product and before the issues in the supply chain has been taken care of.

Moreover, since the producer of the smoked salmon claims that the product has a BBD of 28 days in 4°C, the selling period of the salmon cannot be longer than it is today; only shorter if the goods are badly handled. Hence, there are few opportunities for reducing food waste of salmon at the consumers either. However, if a biosensor would be attached, the BBD might be prolonged since this would measure the actual state of the food. Even if the food waste in this supply chain cannot be reduced, the dynamic shelf life is still useful since it guarantees the safety of the food.

5.7 Summary of Opportunities and Challenges

A summary of opportunities and challenges according to previous analysis of the implementation of the DSLP service can be seen in Table 11.

Table 11. Summary of Opportunities and Challenges of Implementing Dynamic Shelf Life in the FSC

SUPPLY CHAIN	OPPORTUNITIES	CHALLENGES
Project Specific Factors	- To only implement the TTI sensor, not the biosensor, makes the process easier and cheaper - The sensors can guarantee the safety of the food	- The success depends on the design of the sensor and service - To make the service and technology work without disruptions - TTI sensors cannot at the moment increase shelf life or the selling period for salmon - Which actors should be trusted with what information
Strategic Objectives	- Bring (Norway Post) has an objective of being in forefront of development - Many actors have an aim of using environmentally friendly alternatives - Offer a value added service to the retailer - Being a quality supply chain - Possibility of keeping existing customers and gaining new customers	- Different actors with different strategies and goals - Cost focus in the SC - Convincing the retailer that it is worth to invest in
Performance Measurement	- Using common performance measurements - Easier to find areas for improvement - Correct errors in the SC - Optimize the performance of the SC	- Risk of unwillingness to cooperate - Each actor will be more accountable for their performance - Risk of opportunism

Coordination	- Actors can develop their relationship with Bring CS - Actors want to keep the contract with Bring CS - Increased track- and traceability of transports - Increased collaboration and information sharing - Reduced logistics costs	- Short-term and non-performance based contracts - Some actors are difficult to replace if needed - Higher level of information sharing between Bring CS and the other actors – the actors more exposed - Can affect the actors' bargaining power - Shared investment in technology increases the risk of being too interdependent on logistics suppliers - More coordination and communication needed
Operations	- A successful ERP implementation is an opportunity for smooth operations - Easier track and trace of goods - Decrease the amount of manual handling at the warehouses	- More information to keep track of - Risk of sudden change of conditions - Goods need to be relabeled with a change in destination - The salmon still needs the same attention and work-effort
Implementation Considerations	- Cross functional teams can ease communication and have important inputs - Sharing the cost involves the actors - Small possibility to reduce the salmon food waste - Costs for RFID tags will decrease over time	- Dealing with resistance - Many actors involved in the process of changing - Costs of equipment and setting up IT connections - Cost calculations in a long-term perspective are not certain

5.8 Effect on the 4PL Company's Business Model

In Storbacka et al.'s (2012) framework for business model design (see Table 2, chapter 3.6.2), certain areas will be affected by the implementation of a DSLP service and this is analyzed in this section. In Figure 18 the areas that will be affected are marked, whereas the ones not marked will remain the same also after an implementation and will therefore not be discussed. This is true for customer channels which will not change – it is rather the characteristics of the channel that

will change. Also the brands will remain the same, even if the DSLP service might attract new brands in the long run. The R&D, offering and product management will not change either. The DSLP service is a new innovation, but is not part of the 4PL company's own R&D. The product management will remain the same, since the organization at 4PL company is the same. This means that the operational staff still will be in charge of the same areas, e.g. transportation and purchasing. The human, ICT and financial resources will not change either, since no new competences are required to manage the DSLP service. The ICT will change slightly, since the 4PL company's system will be connected to the DynahMat's cloud service, but that is the only change. The financial resources will not change since the 4PL company will continue to make money in the same way. Finally, the management and leadership processes do not have to change, since this is mainly an operational change.

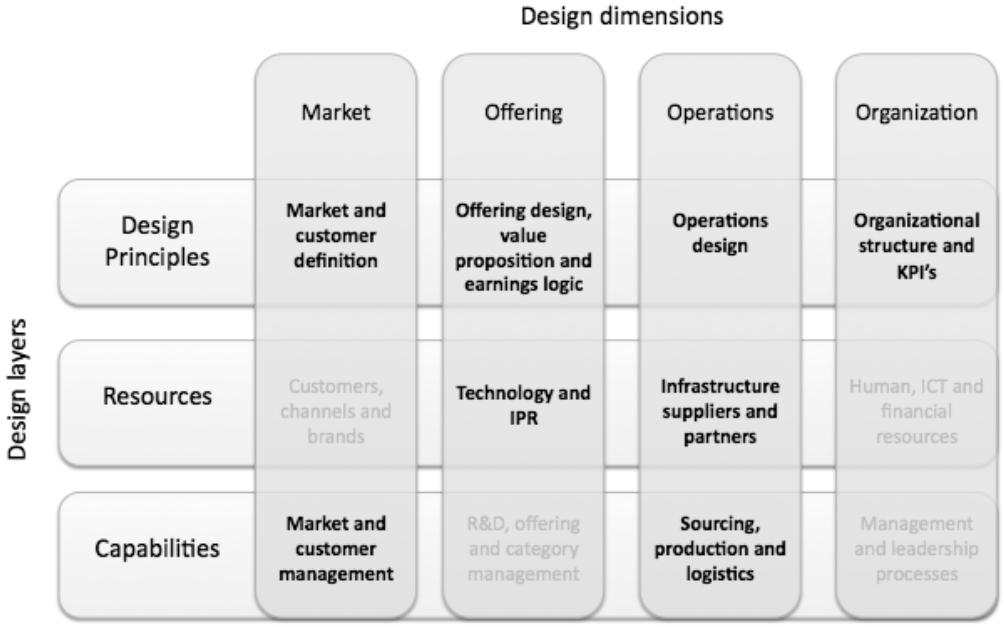

Figure 18. Relevant Areas in the Framework for Business Model Design

5.8.1 Market and Customer Definition

This section addresses the company's position on the market, how the market is defined and what customers the company serves or potentially could serve.

5.8.1.1 *Position and Definition of the Market*

If Bring CS implements the DSLP service, at least if they are among the first 4PL companies to do so, the company's position on the market would change. They would be providing the latest technology, which, among other services, could offer

an improved transparency of the supply chain. In today's society, there is demand for more transparency and traceability. One of the reasons is that it is a way for companies to avoid or mitigate scandals. Therefore, there will probably be an interest in the service among the 4PL company's customers. In what segment of the market Bring CS will be positioned depends on when they decide to implement the service (compare with Table 3 in section 3.7.1). However, if they implement it within the next coming years, they will end up within the first segments and gain strategic advantages over other 4PL companies, referring to the interviews in section 3.4.4.1.

5.8.1.2 *Current and Potential Target Customers*

Bring CS's current target customers, defined as companies that are willing to outsource their logistics services, will remain also after an implementation of the DSLP service. However, the implementation may enable a new type of customer segment, namely retailers that value guaranteed quality of their products. This could be luxury brands or conscious companies. Examples of conscious companies are businesses that want to make it easy for their customers to reduce food waste by choosing the right products or whose target customers are families that want healthy and high quality food. The DSLP service should be used on food products that are fairly expensive in order to carry the added cost of the sensors. Apart from the salmon, the service is suitable for meat products, other fish and seafood, as well as for high-end chocolate.

Another new large potential customer segment could be drug companies. These are suitable for the DSLP service since drugs are expensive and it is utterly important to know the correct BBD to ensure that they still work. This is especially important for drugs in warmer areas, e.g. for vaccines in Africa.

5.8.2 Market and Customer Management

This section contains how the company manages its market and customers.

5.8.2.1 *Market Making and Shaping*

The aim for the DynahMat project is to make dynamic shelf life the industry standard. Introducing dynamic shelf life will slightly reshape the market in the introduction phase, but if it becomes the industry standard it will definitely change the market.

5.8.2.2 *Customer Management*

Customer management includes three areas: experience-, relationship- and service management. Since the DSLP service brings more value to the 4PL company's

offering, the customer's experience of using their products will change. The increased transparency enables the customer to be more involved in the service they order from the 4PL company. What information they will have access to depends on the agreement between the 4PL company and the customer. However, the DSLP service could, in an extension, allow the customer to follow the goods, see the estimated arrival, temperature, current BBD etc. The relationship between the 4PL company and the customer will likely be developed and more trust will be established, since the customer immediately can see the supply chain's performance. Trust favors information sharing among the actors, and improved information sharing leads to an improved supply chain (Lee & Whang, 2000) (Yigitbasioglu, 2010). Furthermore, the DSLP service can provide more data on the supply chain for both the 4PL company and its customers. Currently, it is a trend to use "big data" in order to create new services and collecting more data in the supply chain can enable new services both for the 4PL company to its customers, and for the customers to the final consumer.

5.8.3 Offering Design, Value Proposition and Earnings Logic

This part outlines the available offering components and possible offering configurations. Moreover, the company's earnings logic, i.e. the pricing strategy is discussed in this section.

5.8.3.1 *Offering Components*

The DSLP service leads to an improvement of the supply chain and the different components can be measured and improved separately. For example, sometimes errors occur when unloading and loading goods onto trucks, which can cause a disruption in the chilled supply chain (Göransson & Jevinger, 2014). These occasions will be visible through the temperature graph that is included in the DSLP service, and thereby also possible to improve. Also, if a customer is satisfied with everything in the supply chain apart from one of the transporters for example, it is easy to replace this "component" in order to satisfy the customer.

5.8.3.2 *Offering Configurations*

One possible configuration is that the customer could choose to use the DSLP service for one part of the supply chain, e.g. let the BBD change dynamically until the goods reaches the DC or the retailer's stores and then set a fixed BBD for the rest of the supply chain. If doing so, the dynamic date could be used at the warehouses for prioritizing shipments of goods, but the consumer would not have to get involved with the dynamic BBD. However, this is probably not a good idea since the sensors are quite expensive and to implement it half the way would ruin the purpose of the

DSLP service. In addition to this, it was mentioned in the interviews made by Göransson and Jevinger (2014) that the dynamic BBD must reach the final customer in order to make a difference, i.e. be able to reduce food waste, since households are responsible for the largest part (Jensen, et al., 2011).

5.8.3.3 *Earnings Logic and Pricing Strategies*

The earnings logic and pricing strategies does not have to change when introducing the DSLP service. However, the service enables new ways of pricing the services offered by the 4PL company. Due to the high level of complexity in the supply chain, complex contracts e.g. with dynamic pricing, will be hard to manage and therefore a fairly easy set-up is preferable. One suggestion that is similar to the current contracts with the logistics supplier is given below.

The price towards the retailer should be raised, which is motivated by the added value that the DSLP service offers. If the BBD is shorter than expected (i.e. shorter than the static BBD) when delivered, but still within the contract period, a discount should be given. This is because the retailer's selling period will be shorter, which implies that their revenue will be reduced. The logistics suppliers should have an allowance in their contracts, which means that they are allowed to have some errors in their handling that affects the BBD without any consequences. This allowance should be designed differently for the different types of logistics suppliers. If the allowances are exceeded, the logistics suppliers will pay for the damages that they have caused. This payment should preferably be a variable sum, depending on how many errors that have occurred, but not corresponding to the actual damage, since this will be too complex to keep track of. The suggestion is summarized in Table 12. This type of pricing is likely to function as an incentive for the logistics suppliers to perform the best possible.

Table 12. Suggestion of Pricing Strategy

ACTOR	PAYMENT/ALLOWANCE	COMMENTS
Producer	Always the same payment.	This payment will not be altered, since they have to fulfill the requirements on the BBD, otherwise the products should not be accepted.
Transporter	Given allowance.	Smaller allowance than for the warehouses, since they handle the goods during a shorter period of time.
Warehouses	Given allowance.	Higher allowance than for the transport suppliers. Different allowances could be offered to different actors; depending on relationship and set-up.
Retailer	Offered a discount if the BBD is shorter than expected.	

5.8.4 Technology and Intellectual Property Rights (IPR)

This is the second area of the offering design dimension and covers the technology used and the intellectual property rights.

5.8.4.1 *Technology*

The implementation of the DSLP service requires RFID technology. This will naturally require investments, but the technology can be used for more than just the DSLP service e.g. real-time GPS tracking, which improves the traceability of the products. Moreover, the general belief is that the RFID tags will be the standard labels in the future, so the 4PL company might have to adapt to the technology regardless if the DSLP is implemented or not.

Furthermore, the 4PL company's ERP systems must be updated or altered to handle the RFID technology. Depending on the functions the 4PL will use from the DSLP service, there will be different costs. For example, the costs vary depending on for example the information the 4PL company wants to include in the ERP system or how often the ERP system should be updated. Nonetheless, for the DSLP to work; the 4PL company and its suppliers must be connected to the DSLP cloud service and RFID technology needs to be implemented throughout the chain.

5.8.4.2 *Intellectual Property Rights (IPR)*

When it comes to the IPR, DynahMat does not hold a patent on the sensors or the cloud service. At the moment, IPR is not something that is discussed within the project since many companies are involved.

5.8.5 Operations Design

In this section the modular processes are analyzed.

5.8.5.1 *Modular Processes*

In the studied supply chain, the modular processes are interpreted as the transport from the producer to the CW, the handling at the CW, the transport to the DC etc. In between all sequences, i.e. when responsibility shifts from one actor to another, the UHF tags should be connected to readers, so that the current BBD can be detected. When this is fully implemented, there will be no need to physically measure the temperature of the food, since the readers will do this. This implies that the quality control will be eliminated (see section 4.1.4) which will save time for the warehouse workers and result in that the food can reach the cold rooms faster.

5.8.6 Infrastructure, Suppliers and Partners

This is the second area of the operation design dimension and includes how the infrastructure will change as well and the relationships to and base of suppliers and partners.

5.8.6.1 *Infrastructure*

Regarding the supply chain's infrastructure, the facilities can remain the same when implementing the DSLP service, but new machines need to be added. These are the RFID readers, which should be placed in the gateways at the producer, the warehouses and the retailer, so that the pallet of food can be connected to the cloud service when entering and leaving the facilities. At an initial stage, readers can be installed at a few gates, and these should always be used for the 4PL company's deliveries. However, in a couple of years, the RFID technology might be the standard, and then the facilities will probably need to install readers in all gateways to satisfy all their customers. Furthermore, as mentioned previously, the 4PL company and the suppliers need to connect their ERP systems with the DynahMat cloud service.

5.8.6.2 *Suppliers and Partners*

If the DSLP service is implemented, it is assumed that a company will take over the handling of the service from the DynahMat project and that company will become a

new supplier to the 4PL company. Depending on how their organization and offers are designed, different type of relations or partnerships can be considered. Also, a supplier for the RFID tags needs to be found – either centrally sourced by the 4PL company or by each food producer alone.

5.8.7 Sourcing, Production and Logistics

This is the final operations design dimension part, and in the capability layer. In this section the sourcing, supply chain management and the management of delivering channels are discussed.

5.8.7.1 *Sourcing*

In the case studied in this thesis, the 4PL company is not handling the sourcing of the products. They purchase the food from the producers and have contact with them – but their customer is choosing the producers and negotiating the contracts. However, Bring CS handles the sourcing of logistics suppliers. The choice is most likely based on their track record of their previous performance. For the warehouses, the relationship with Bring CS also plays a part in the decision since they have close collaborations. Furthermore, the choice regarding warehouse providers is more important than transporters providers. This is because the relationship with a warehouse is often for a longer period of time and shared investments may need to be done (strategic relation), meanwhile the transporter are only moving the goods from one location to another (tactical relation). As mentioned earlier, investments in the DSLP service can be a way for the DCs to keep Bring CS as a customer for a longer period of time. This will on one hand make them less flexible when it comes to sourcing, but on the other hand this can function as a fundament for a better relation.

5.8.7.2 *Supply Chain Management*

The supply chain management needs to be altered to suit the DSLP service. The paramount alteration is the planning of supply and demand. Today, the supply chain is planned with the static BBD in mind, which means that the supply chain is set on a certain time interval, which all actors are aware of and can plan towards. However, with the dynamic shelf life, unforeseen changes can occur, which require the planners to replan, e.g. if a delivery is mishandled and the BBD has suddenly decreased. Then a new purchase order needs to be initiated to replace the cartons that cannot be sold and maybe an additional truck needs to be booked to transport the food at an earlier stage than what was planned. Also, the food may need to be relocated, as long as it goes to a country within the same language cluster.

5.8.7.3 *Management of the Delivering Channel*

Another change in the supply chain is the improved transparency. Today, companies are more aware of avoiding and mitigating scandals since these can have devastating effects on the reputation of a company. If there would be a scandal, the measurements throughout the supply chain can work as evidence to clear suspicions from the 4PL company, its logistics suppliers and its customer. This should be an additional reason for the 4PL company's customers to be interested in the DSLP service.

5.8.8 Organizational Structure and KPI

The only section in the organization design dimension that will be affected by the implementation is the KPIs.

5.8.8.1 *Key Performance Indicators*

One or more performance measurements should be created that reflects the dynamic shelf life since this is a new way of measuring performance and quality throughout the FSC. Examples of KPIs could be:

- The percentage of the packages that are delivered to the retailer with a BBD that corresponds to or is longer than the static BBD.
- How many of the supplier's handlings that have been perfect,
    - E.g. 88 % perfect handling in January.

These performance measurements will enable both the 4PL company and the logistics supplier to detect errors and correct them. Furthermore, it will work as an incentive for the suppliers to perform at their best since the measurements will show their performance and work as a foundation for upcoming negotiations. Furthermore, new KPIs can be a way to align incentives among the actors, which most likely will improve the overall performance and thereby the service to the 4PL company's customer.

5.9 Adoption of New Innovations

There are several aspects to consider before deciding when it is suitable to implement the DSLP service. Firstly, the service is not yet ready for the market and the researchers at the DynahMat project predicts that it will be within three years (Törnberg, 2014). Furthermore, current processes in the supply chain need to be altered in order for dynamic shelf life to be implemented. The preparations also include getting every actor onboard and negotiations of which actor that will make

what investment. This in addition to the operational changes will take some time, which mostly depends on the actors and the current set-ups. Conclusively, even if it takes at least three years before the service actually is on the market and can be implemented, the preparations and change management can begin earlier if the 4PL company would like to be part of the innovator segment (described in section 3.7.1).

5.9.1 The Adoption Process and Stages of Adoption

Currently, Bring CS is in the phase of the adoption process where the innovation is evaluated if it is worth investing in or not. This is the third phase of five, where the phases of awareness and interest of the innovation has passed. This study evaluates the opportunities and challenges of the innovation. But since the DSLP service is not yet available on the market, more thorough studies need to be conducted at a later stage to serve as a basis for decision making.

Depending on in what stage Bring CS would implement the DSLP service; they can be categorized into different segments with regards to their willingness to adopt new innovations (see Table 3). This section describes the effect the different stages of implementation would have on Bring CS and also where it is likely that they will be categorized. The segments are not connected to time intervals, since it is hard to predict how long time an adoption phase will take. It depends on many factors; when the DSLP service is finalized, which company that will handle the DSLP service, regulations in EU and other parts of the world, which companies that will adopt and when, what the demand from the final consumers will be, etc.

5.9.1.1 *Innovator and Early Adopter*

One of the primary arguments to implement dynamic shelf life at an early stage is that a strategic competitive advantage can be gained. By being one of the first to use the DSLP service, Bring CS can provide their customers with a value that none or few others can offer. It can contribute to a reputation of the company being innovative and a forerunner for reducing food waste and taking measures for reducing impact on the environment. However, an early entrance also equals a larger risk. It will be more expensive to implement at an early stage and it is not certain that the market will adopt or be positive to a change from static to dynamic shelf life. Also, Bring CS might suffer bad publicity if the DSLP service does not work as expected. Today, all food must be labeled with a static BBD and as long as that law remains, the food will have both a dynamic and a static shelf life. Two BBDs can be confusing for the consumer and if the dynamic BBD is longer than the static - the consumer might not trust the new dynamic shelf life.

Furthermore, the future of RFID technology is depending on what the EU regulations will look like (see section 5.6.2.2). If these regulations would prevent the development, it will be difficult for the DSLP service to reach a breakthrough. The DynahMat research group's aim is that the dynamic shelf life will become the industry standard. If Bring CS and their customers are the only supply chain adopting the technology, it will probably be hard to gain the end consumers acceptance for it and make it profitable. Due to this, it might be better to wait until other companies have implemented the service. On the other hand, the implementation requires preparations, which take time. If Bring CS is ready to implement the service long after others have, the competitive advantage may be lost. To avoid losing the competitive advantage, the early adopter segment is more suitable, where Bring CS still would have competitive advantages over some competitors. On the upside, the risk as well as the costs will be lower if they are not the first company to invest.

Adopting dynamic shelf life early is aligned with Bring CS's strategic objectives (see section 4.2) in regards with finding a creative solution to reduce food waste and to be quick to adapt to the development of dynamic shelf life. Furthermore, Vowels et al. (2011) suggests that firms who actively search information about innovations often are placed in the category of *early adopters*. Since Bring CS is one of the companies that are active in the DynahMat project, they are evidently searching information actively. In addition to this, Vowels et al. (2011) also state that the existence of a *champion*, which is working to realize an implementation of the new innovation, is important for an implementation to be successful. They state that this is especially important when the new innovation incorporates technology that radically differs from its predecessor, as is true in this case. During the interviews with employees at Bring CS, many with higher positions in the organization were positive and enthusiastic about the dynamic shelf life, which will have a positive impact on the adopting decision. In this case there are even more than one individual supporting the idea.

One of the characteristics of the *innovator* segment is that companies do not regard change as something negative. As previously mentioned, the approach towards change is today more positive at the company than what it has been before. In this aspect, they might not fit in to the *innovator* segment, since this attitude might remain in some parts of the organization. The *early adopter* segment on the other hand "adopt to new ideas early but carefully", which seems to better fit with Bring CS's attitude.

5.9.1.2 *Early and Late Majority*

When some companies already have implemented dynamic shelf life, it will be easier to predict if the service will become widely used or not. Possible reasons against the service could be that consumers are not interested or that the reduction of food waste is too low etc. If this would be the case, it is obviously not worth to invest in the DSLP service. On the other hand, if it turns out to be a success, it might become the industry standard and then companies need to adapt to stay competitive. As the *early majority*, there might still be some competitive advantages and innovative reputation to gain.

A reason to be a part of the *late majority* segment can be that the infrastructure will be in place, including the supply of RFID tags. Consumers will also have adapted to the technology and the DSLP service will be well functioning and initial errors in the service been corrected. This means that it is both easier and cheaper to adopt in the *late majority* segment.

The *early majority* is considered to be more thoughtful and pragmatic than the *innovators* and *early adopters*, but they still adopt before the average. Bring CS seems to fit well also into this segment. The *early majority* might be a more realistic segment than the *early adopters*, since they need to get the other actors onboard, which can take time if they are not willing to take on too much risk. The *late majority*, on the other hand, is skeptical to new ideas and only adopt when the majority of the market has. Bring CS might end up in this segment if there is a lot of resistance among customers and suppliers. Regarding the internal attitude at Bring CS, the majority of the employees interviewed are not skeptical to dynamic shelf life – rather the opposite.

5.9.1.3 *Laggards*

Companies in this stage are conservative and only convert when the market is declining, which not corresponds to Bring CS's attitude. At this stage, there will be newer and better technologies available on the market that would be better to implement. The only reason for adopting in this segment is if they are forced to due to legal requirements. However, if the dynamic shelf life becomes a legal requirement, Bring CS has most likely already implemented it.

5.9.2 The Decision to Implement

Looking at the adoption segments, one sees that Bring CS fits very well into the *early adopter* segment, because of their strategic objectives and the internal attitude. However, it is not realistic that the 4PL company decides to implement this service

on their own; they need support from their customer since they handle their outsourced operations. As always, it is not profitable to sell a product or service that lacks demand. Furthermore, it is probably too expensive for a 4PL company to make all the initial investments on its own. If the retailer would require dynamic shelf life, they have the bargaining power to make Bring CS implement it. Bring CS could then in turn demand their suppliers to implement it. As mentioned in the interviews made by Göransson and Jevinger (2014), it is stated that the retailer must take part of the investments, since they have the most to gain. Furthermore, it is common that each actor takes their own investments and for this to happen, all actors need to be onboard. The conclusion is that Bring CS cannot take the initiative to implement the DSLP service alone; they need support from their customers.

5.9.3 The Driver's of Adopting to Innovations

Ciganek et al. (2014) state that there are two common streams of beliefs of what initiates the decision process: either a performance gap or a belief that implementing the innovation will improve the performance. For Bring CS, the DSLP service would be the second alternative. The time it takes from awareness to decision depends on a number of variables, described by Ciganek et al. (2014), Hall (2005) and Rogers (1995) in section 3.7.2. These will be discussed below, starting with the innovation variables, thereafter the organizational and finally the environmental variables.

The *complexity* of this product is both low and high. It is easy to understand the dynamic BBD, since the consumers are used to static BBDs. It is hard because they cannot read it directly on the package, but need a device, i.e. a smart phone or a smart refrigerator. The *compatibility* with Bring CS's current system is not ultimate, since the RFID readers need to be installed and the working procedures have to change, especially the planning of supply and demand. Externally, it might take time for the consumer to adjust to a dynamic BBD since this is something new and will require a bit more effort from them. If it turns out that the dynamic shelf life indeed would reduce food waste, it will be a *relative advantage* of the DSLP service, since this can save both money and reduce the impact on the environment. This would be positive for all actors, from producer to end customer. Furthermore, the DSLP service can be used as a tool to improve the performance of the supply chain, which the static BBDs cannot. The *triability* of the service is a bit tricky; the technology has already been tested in lesser scale but to test it fully, it would need to be implemented. The technology can be tested, but the soft values like consumer psychology (e.g. if the dynamic date will be trusted) and collaboration in the supply

chain is more difficult to test. It is also difficult to test the amount of reduced food waste, especially at the consumers. The *observability* of the DSLP service is high, since all actors will know if the new technology is used, especially the consumers.

Regarding how the *organizational culture*, i.e. the risk-orientation of the firm, affects the adopting process is not straightforward. This is because even if the 4PL company is risk prone, it is very much dependent on its customer and therefore the customer's risk orientation also matters. Neither the risk-orientation of Bring CS nor its customer has been a part of this study. Therefore no conclusion can be drawn from this factor. Next is the *top management support*, which is regarded to have a great impact on the adopting process. The impression from the interviews at Bring CS and the strategic objectives of Norway Post is that they want to update its operations in order to stay competitive. Also, the fact that Bring CS is a part of the DynahMat research project shows that top management is positive towards, or at least interested in learning more, about the implementation of dynamic shelf life.

The *coercive isomorphism* is the external pressure that the firm is exposed to. In the case of Bring CS, this comes mainly from their customer in the studied FSC. As mentioned previously, if they were to implement the DSLP service, this needs to be supported by their customer. If the customer resist, it will be hard, not to mention pointless, for Bring CS to do so. The *mimetic isomorphism* is if the company imitates other companies' behaviors or base decisions on the outcome for other companies. For example, if sales have increased after an implementation for a company, it can motivate other companies to follow. Since no other 4PL company has implemented dynamic shelf life, this is not yet applicable. If that would happen, the choice to implement or not should certainly be influenced by their operations and performance. The *normative isomorphism*, i.e. the pressure from peers etc, is not either yet applicable in this situation, since dynamic shelf life is not implemented anywhere and is not yet well known.

As to summarize, an overview of the positive and negative impacts these factors has on the drive of adoption is provided. The complexity of the product is both low and high. The compatibility with Bring CS current system is low. Nothing can be said on the relative advantage, since it is not evident if the food waste will be reduced or not. The triability is both positive and negative, since the service partly can be tested, but not fully. The observability is positive. Regarding the organizational culture, it cannot be said if this is positive or negative. The support from top management is positive. The three last factors, coercive, mimetic and normative isomorphism, are not affecting the current situation. However in the future, if the

dynamic shelf life is used more in supply chains, all of these can drive an adoption. The overall conclusion is that there are currently more positive factors that could drive an adoption than negative ones. However, there will probably be more positive drivers in a couple of years, since the service will have been more tested and more organizations will know about it.

5.10 Generalization of the Results

Since Goal 1 is only a study on a specific supply chain, the result cannot be generalized for other supply chains even though other FSCs might look similar. However, Goal 2 and 3 can be generalized for similar supply chains. It is likely that supply chains that want to implement dynamic shelf life will come across the same opportunities and challenges and that they need to consider these in beforehand to evaluate the value of the investment. The results are valuable mostly to other food supply chains or supply chains that deal with chilled and sensitive goods, e.g. medical supply chains. The results are not considered relevant for supply chains outside the chilled goods business area since they will not gain the same advantages of implementing dynamic shelf life. Goal 4 can also be generalized in concerns to other 4PL companies that may expect the same changes in their business models if they implemented dynamic shelf life.

Furthermore, Bring CS may use the results for the other supply chain that they coordinate. However, the results may differ in some aspects since most of their products are push initiated rather than order initiated, like the smoked salmon. For example, the reduction of food waste might be different if studying the push initiated products. In general Bring CS should encounter the same opportunities, challenges and effect on their business model.

5.11 Reflection on Research Method

The overall purpose of the DynahMat project is to reduce food waste, which initially was supposed to be a large part of this study. However, after a while it was evident that the chosen supply chain had a negligible amount of food waste. With this knowledge, it would have been more suitable to study another food product, since also possible monetary savings could be estimated in such situation. The preferred product would also be perishable and chilled, but sold in larger quantities, with a longer BBD and stored in the warehouses – not only cross docked as the salmon. Moreover, half way through the project there was a discussion regarding to send sensors with the smoked salmon in distribution from Norway to France. This would

have provided the thesis with interesting data, since it would show the changes in temperature and BBD as well as a rough estimation of the improvement potential in the supply chain. Due to time limits, this was however not possible to carry through. Finally, it would have been interesting for the study to find out the attitude towards the DynahMat project from Bring CS's customer. The DSLP service cannot be implemented without their support, but since they asked not to be contacted for the thesis, this was not possible.

6 RECOMMENDATION

In the following chapter, a recommendation for Bring CS is presented. The DSLP service is still at an early stage in its development and it is not possible to give a final recommendation – evaluations are needed at a later stage as well. The advice that is given is based on the vision of the DSLP service provided by the DynahMat research group and the assumptions made in this thesis. It is suitable to implement the DSLP service if Bring CS's customer supports it, if the service works as assumed and if other companies start implementing it.

When the DSLP service is available on the market, Bring CS should pay close attention to its development and reevaluate if it is suitable to implement the service. However, it should be pointed out that the customer's support is utterly important. If Bring CS makes investments in a service that the customers are not interested in, i.e. not willing to pay for, it will not be profitable. Since the customer is the one that have most to gain on having dynamic shelf life, they should take part of the investment. If they are not willing to do this, the DSLP service should not be implemented.

Given that Bring CS has the customer's support, they should aim for the *early adopter* or the *early majority* segments. In these segments, they will still have competitive advantage but it will be less risky than if they would be the first company implementing it. These segments also comply with Norway Post's strategic objective to be in forefront of development. Furthermore, the cost for the RFID tags is likely to be much lower in a couple of years (see section 5.6.2.2).

There are several drivers that support an implementation. For example, the complexity of the product is fairly low since consumers are used to BBDs and it is only how to read them that is new. It is also possible to try the sensors before fully implementing the service, which is a positive driver. Furthermore, the consumers and other stakeholders will observe when the change is done, which can help Bring CS to get a reputation as a company in the forefront of technological development. Finally, the management at Bring CS supports the idea, which is an important requirement for a successful implementation. Regarding other incentives for Bring CS to implement the DSLP service, the possibilities to detect errors in the supply chain and correct these should be mentioned, as well as the guaranteed quality of the handled products and the possibility to attract new customers.

To get the logistics suppliers onboard, incentives for them need to be created. Making investments in the service could be positive for the logistics suppliers since this is a way to keep Bring CS as their customer for a longer period of time. Moreover, the service can be offered to their other customers as well. It will also require less manual handling, e.g. the temperature will be measured automatically. Another incentive is the transparency that the DSLP service provides will help the logistics suppliers to show Bring CS that they have handled the food correctly. The transparency can be both positive and negative depending on how the food has been handled by the specific actor. However, if a mistake would occur, not all actors will be blamed and this can also function as an incentive to always perform at the best possible. Furthermore, if the implementation would require the producer or warehouses to reorganize their facilities and change their working ways, Bring CS probably have to provide a monetary incentive as well. Another advantage with the DSLP service is that it enables new performance measurements. The dynamic shelf life can be used to measure both performance and quality. Furthermore, it helps to detect errors in the supply chain so that these can be corrected. This provides an opportunity to improve the overall performance of the supply chain.

Regarding the pricing model, it does not have to change when implementing the service. However, it is possible to utilize a pricing system that depends on the actor's performances. This could be done by offering the customer a discount if the BBD is shortened, and give the logistics suppliers allowance to make some errors that affect the BBD. If that allowance is exceeded, they should pay the 4PL company a sum for the damages (see section 5.8.3.3).

If the DSLP service is to be implemented, it is important to involve the employees at Bring CS in the change in order to perform this as smooth as possible. A cross functional team should be created where employees can give inputs on how the change should be performed and inform other functions how the change is going to affect their departments. They will also function as informers at their own departments.

In summary, Bring CS should wait until the DSLP service is on the market and then make additional evaluation if an implementation is reasonable. If it is and the customer is supportive and willing to take part of the investments, it is suitable to implement the DSLP service. Furthermore, employees from different parts of the organization should be involved in the implementation process and incentives need to be created for the logistics providers to change to dynamic shelf life, in order to perform the change as efficiently as possible.

7 FUTURE STUDIES

In the following chapter, suggestions for future studies are presented. The suggestions are mainly concerned with supply chain management, but also with other fields.

Firstly, this study can hopefully function as inspiration for the future development of WSN technology in the food industry, e.g. for how the interface towards different actors in the supply chain should be designed and how contracts could be set up in the supply chain. The findings from the thesis should be combined with the findings from previous research, e.g. the CHILL-ON project and the Pasteur project to further develop WSN technology in food supply chains.

Since the studied supply chain did not show possibilities to reduce food waste, it should be further investigated if the DynahMat project can reduce food waste in other supply chains and if so, what measures need to be taken. For example, it would be interesting to make a study on goods in stock instead of order initiated goods to explore possibilities for less food waste. Also, it would be beneficial to make a larger study with several different products to investigate the products most suitable for applying dynamic shelf life; both from a supply chain and a consumer's point of view. By doing this, it would be easier to estimate the possible savings for the business and the community if the dynamic shelf life was the industry standard instead of the static. Furthermore, it would be interesting to actually send temperature sensors with a supply chain to see how the BBD change, but also to investigate if it is possible to make improvements of the overall supply chain performance from this data.

This study has focused on the supply chain and not on the end customer. More studies need to be done on the opportunities and challenges that concern the consumers and how to make the DSLP service value adding and user-friendly, e.g. connecting the DSLP service to smart refrigerators. Also, it would be interesting to explore the possibilities to connect the DSLP service to more business opportunities and services. An example of this can be to connect the food store's pricing systems with the DSLP service, so that the price is reduced when the BBD is approaching. As mentioned in the thesis, the dynamic shelf life can also function as a foundation for new pricing systems within the supply chain that are dependent on the actors' performances, which could be further investigated.

Furthermore, it would be interesting to make studies on if the dynamic shelf life would be suitable for drugs. These products seems suitable for the DSLP service since drugs are expensive and it is utterly important to know if the BBD is accurate, i.e. if the drugs still work or not. This is particularly interesting for humanitarian organizations, which might be able to use vaccines even if the static BBD has passed.

Since the DynahMat project is at an early stage of implementation, it is necessary to make additional studies in the future when the project and its possibilities are more clearly defined. The circumstances will most likely have changed in a couple of years since the market and the technology develops constantly, which should be taken into account. For example, the assumptions when making cost calculations are loosely based and can be better measured in the future.

8 CONCLUSION

In this chapter, a summary of the results is presented.

This thesis has concerned a study of the opportunities and challenges of implementing the DSLP service in a FSC and also the effect the implementation would have on the 4PL company's (Bring CS) business model.

Firstly, an implementation of the DSLP service offers all actors in the supply chain a possibility to uphold their objectives of being environmentally friendly and allows them to offer a value added service to the customers. The supply chain will be able to guarantee the quality of the supply chain and the goods it delivers. Also, each actor has the possibility to offer the same service to other companies and in this way keeping their customers or gaining new customers. Furthermore, other opportunities connected to dynamic shelf life are increased track- and traceability of the goods as well as increased transparency, collaboration and information sharing in the supply chain, which can have a positive effect on its performance. In addition, the DSLP service offers the possibility to easier measure the supply chain performance regarding both performance and quality. However, the study has not showed that there are possibilities for reducing food waste in the specific supply chain or at the consumers.

There are also challenges connected to the implementation of the DSLP service. First it will be a challenge to make the technology, including sensors, readers and the cloud service, work effortlessly in all parts of the supply chain. Secondly, a challenge will be to make all actors cooperate and invest in the technology. The actors are also more exposed due to increased transparency. Moreover, the shared investment causes a risk of Bring CS being too interdependent on their logistics suppliers. Finally, there are challenges in making the coordination of goods with dynamic BBD work as well as the need for more communication and information sharing in the supply chain.

Moreover, the findings show that there would be several changes in the 4PL company's business model if implementing the DSLP service. For example, Bring CS would probably attract new customer segments, like conscious companies (values traceability) and luxury companies (values quality). Since the transparency would increase, the customer will have more knowledge regarding the supply chain's performance, which can lead to more trust in Bring CS. The transparency will also

make each actor's performance visible and show room for improvement. The earnings logic and pricing strategies does not have to change, but the dynamic shelf life enables a pricing strategy based on performance. Another part of the operations that will change is the supply chain planning that needs a more reactive approach.

9 BIBLIOGRAPHY

Arbnor, I. & Bjerke, B., 1997. *Methodology for Creating Business Knowledge.* Newbury Park(CA): Sage Publications.

Armstrong, G., Kotler, P., Harker, M. & Brennan, R., 2009. *Marketing - An Introduction.* Harlow: Pearson Education Limited.

Bagchi, P. & Skjoett-Larsen, T., 2002. Integration of Information Technology and Organizations in a Supply Chain. *The International Journal of Logistics Management ,* 14(1), pp. 89-108.

Bamford, D. R. & Forrester, P. L., 2003. Managing planned and emergent change within an operations management environment. *International Journal of Operations and Management,* 23(5), pp. 546-564.

Beamon, B. M., 1999. Measuring supply chain performance. *International Journal of Operations & Production Management,* 19(3), pp. 275-292.

Becker, M. et al., 2009. *Challenges of Applying Wireless Sensor Networks in Logistics.* s.l., CEWIT.

Bowersox, D., Closs, D. & Stank, T., 2000. Ten mega-trends that will revolutionize supply chain logistics. *Journal of Business Logistics,* 21(2), pp. 1-15.

Bring Sverige, 2014. *www.bring.se.* [Online]
Available at: http://www.bring.se/hela-bring/produkter-och-tjanster/customer-solutions
[Accessed 11 04 2014].

Chesbrough, H., 2007. Business model innovation: it's not just about technology anymore. *Strategy & Leadership,* 35(6), pp. 12-17.

CHILL-ON, 2012. *Final Report.* [Online]
Available at: http://www.chill-on.com/final-report.html
[Accessed 28 May 2014].

Chopra, S. & Meindl, P., 2013. *Supply Chain Management: Strategy, Planning, and Operation (Global Edition).* Harlow(Essex): Pearson Education Limited.

Churchman, C. W., 1979. *The Systems Approach.* New York(NY): Laurel.

Ciganek, A. P., Haseman, W. D. & Ramamurthy, K., 2014. Time to decision: the drivers of innovation adoption decisions. *Enterprise Information Systems,* 8(2), pp. 279-308.

Ejvegård, R., 2003. *Vetenskaplig metod.* 3rd ed. Lund: Studentlitteratur.

Ellram, L. & Cooper, M., 1990. Supply chain management, partnerships and the shipper-third party relationship. *International Journal of Logistics Management,* 1(2), pp. 1-10.

Fries, J. L., Turri, A. M., Bello, D. C. & Smith, R. J., 2010. Factors that influence the implementation of collaborative RFiD programs. *Journal of Business & Industrial Marketing,* 25 Aug.pp. 590-595.

Gailly, B., 2011. *Developing innovative organizations - A roadmap to boost your innovation potentia.* Basingstoke(Hampshire): Palgrave Macmillian .

Gammelgaard, B., 2004. Schools in logistics research? A methodological framework for analysis of discipline. *International Journal of Physical Distribution & Logistics Management*, 34(6), pp. 479-491.

Giguere, M. & Householder, B., 2012. Supply Chain Visibility: More Trust than Technology. *Supply Chain Management Review.*

Guillory, M. & Standhardt, G., 2012. *NVC World Review on Supply Chain Applications of RFID and Sensors in Packaging,* s.l.: NVC Netherlands Packaging Centre .

Gustavsson, J. et al., 2011. *Global Food Losses and Food Waste.* Rome, Food and Agriculture Organization of the United Nations.

Göransson, M. & Jevinger, Å., 2014. *A field test study on a dynamic shelf life service for perishables.* Copenhagen, Nofoma .

Göransson, M. & Nilsson, F., 2013. *The Role of Biosensors in Future Food.* Lund: Division of Packaging Logistics.

Haflidason, T., Ólafsdóttir, G., Bogason, S. & Stefánsson, G., 2012. Criteria for temperature alerts in cod supply chains. *International Journal of Physical Distribution and Logistics Management,* 42(4), pp. 355-371.

Hall, B. H., 2005. Innovation and diffusion. In: *The Oxford Innovation Handbook.* Oxford: Oxford University Press, pp. 462-481.

Horvath, L., 2001. Collaboration: the key to value creation in supply chain management. *Supply Chain Management: An International Journal,* 6(5), pp. 205-207.

Höst, M., Regnell, B. & Runeson, P., 2006. *Att genomföra examensarbete.* Lund: Studentlitteratur.

Jensen, C., Stenmarck, Å., Sörme, L. & Dunsö, O., 2011. *Matavfall 2010 - från jord till bord,* Norrköping: Sveriges Meteorologiska och Hydrologiska Institut.

Johnson, G., Scholes, K. & Whittington, R., 2008. *Exploring Corporate Strategy.* Harlow(Essex): Pearson Education Limited.

Kovács, G. & Spens, K. M., 2005. Abductive reasoning in logistics research. *International Journal of Physical Distribution & Logistics Management,* 35(2), pp. 132-144.

Lambert, D., Cooper, M. & Pagh, J., 1998. Supply Chain Management: Implementation Issues and Research Opportunities. *International Journal of Logistics Management,* 9(2), pp. 1-20.

Lambert, D., Emmelhainz, M. & Gardner, J., 1999. Building successful partnerships. *Journal of Business Logistics,* 20(1), pp. 165-181.

Lambert, D. & Pohlen, T., 2001. Supply Chain Metrics. *International Journal of Logistics Management,* 12(1), pp. 1-19.

Lee, H., 2004. The Triple-A Supply Chain. *Harvard Business Review,* 82(10), pp. 102-112.

Lee, H. & Whang, S., 2000. Information Sharing in a Supply Chain. *International Journal of Manufacturing Technology & Management,* 1(1), pp. 79-93.

Lewin, K., 1958. Group decisions and social change. In: G. Swanson, T. Newcomb & E. Nartley, eds. *Readings in Social Psychology.* New York: Holt, Rinehart & Winston.

Livsmedelsföretagen, 2013. *Livsmedelsföretagen.* [Online]
Available at: http://www.livsmedelsforetagen.se/wp-content/uploads/2013/07/Märkningshandboken.pdf
[Accessed 03 March 2014].

Maurer, R., 1996. Using resistance to build support for change. *Journal for Quality & Participation,* 19(3), pp. 56-63.

Mentzer, J. et al., 2001. Defining Supply Chain Management. *Journal of Business Logistics,* 22(2), pp. 1-25.

Min, S. et al., 2005. Supply chain collaboration: what's happening?. *The International Journal of Logistics Management,* 16(2), pp. 237-256.

Moberg, C., Cutler, B., Gross, A. & Speh, T., 2002. Identifying antecedents of information exchange within supplt chains. *International Journal of Physical Distribution & Logistics Management,* 32(9), pp. 755-770.

Moran, J. W. & Brightman, B. K., 2001. Leading organizational change. *Career Development International,* 6(2), pp. 111-118.

Naraynan, V. & Raman, A., 2004. Aligning Incentives in the Supply Chain. *Harvard Business Review,* 82(11), pp. 94-102.

Norway Post, 2014. *Our vision.* [Online]
Available at: http://www.postennorge.com/about-norway-post/vision-and-value-platform/vision-and-value-platform/our-vision
[Accessed 11 04 2014].

Norway Post, 2014. *The Norway Post environmental policy.* [Online]
Available at: http://www.postennorge.com/corporate-social-responsibility/the-environment/environment-policy
[Accessed 11 04 2014].

Packaging Logistics, 2013. *DYNAHMAT - Dynamiskt hållbarhetsdatum för minimerat matsvinn.* Lund: Packaging Logistics.

Pålsson, H., 2007. Participant observations in logistics research - Experiences from an RFID implementation study. *International Journal of Physical Distribution & Logistics Management,* 37(2), pp. 148-163.

Ramanathan, U., Gunasekaran, A. & Subramanian, N., 2011. Supply chain collaboration performance metrics: a conceptual framework. *Benchmarking: An International Journal,* 18(6), pp. 856-872.

Rogers, E., 1995. *Diffusion of innovations.* New York: Free Press.

Simatupang, T. M., Wright, A. C. & Sridharan, R., 2002. The knowledge of coordination for supply chain integration. *Business Process Management Journal,* 8(3), pp. 289-308.

Simatupang, T. & Sridharan, R., 2005. Supply chain discontent. *Business Process Management Journal,* 11(4), pp. 349-369.

Stank, T., Keller, S. & Daugherty, P., 2001. Supply chain collaboration and logistical service performance. *Journal of Business Logistics,* 22(1), pp. 29-48.

Storbacka, K., Frow, P., Nenonen, S. & Payne, A., 2012. Designing Business Models for Value Co-Creation. *Review of Marketing Research: Special issue - Toward a Better Understanding of the Role of Value in Markets and Marketing,* Volume 9, pp. 51-78.

Swedish Environmental Protection Agency, 2012. *Nyttan av att minska matsvinnet,* Stockholm: Swedish Environmental Protection Agency.

Swedish National Food Agency & Swedish Environmental Protection Agency, 2013. *Minska matsvinnet i kommunen,* s.l.: Swedish National Food Agency.

Todnem, R., 2005. Organisational change management: A critical review. *Journal of Change Management,* 5(4), pp. 369-380.

Törnberg, U., 2014. *Chip i maten kan få svinnet att försvinna.* [Online]
Available at: http://www.sydsvenskan.se/sverige/chip-i-maten-kan-fa-svinnet-att-forsvinna/
[Accessed 03 02 2014].

Waddell, D. & Sohal, A. S., 1998. Resistance: a constructive tool for change management. *Management Decision,* 36(8), pp. 543-548.

Wadhwa, S. & Saxena, A., 2007. Decision knowledge sharing: flexible supply chains in KM context. *Production Planning and Control,* 18(5), pp. 436-453.

Wallén, G., 1996. *Vetenskapsteori och forskningsmetodik.* Lund: Studentlitteratur AB.

Vowels, N., Thirkell, P. & Sinha, A., 2011. Different determinants at different times: B2B adoption of a radical innovation. *Journal of Business Research,* pp. 1162-1168.

Yigitbasioglu, O. M., 2010. Information sharing with key suppliers: a transaction cost theory perspective. *International Journal of Physical Distribution & Logistics Management,* 40(7), pp. 550-578.

Yin, R. K., 2003. *Case Study Research: Design and Methods.* 5th ed. Thousand Oaks: Sage Publications, Inc.

Zikmund, W. G., Babin, B. J., Carr, J. C. & Griffin, M., 2009. *Business Research Methods.* s.l.:South-Western Cengage Learning.

APPENDIX – EU AND EG REGULATIONS REGARDING FOOD SAFETY

EU regulation no. 1169/2011 – Article 24

Minimum durability date, 'use by' date and date of freezing

1. *In the case of foods which, from a microbiological point of view, are highly perishable and are therefore likely after a short period to constitute an immediate danger to human health, the date of minimum durability shall be replaced by the 'use by' date. After the 'use by' date a food shall be deemed to be unsafe in accordance with Article 14(2) to (5) of Regulation (EC) No 178/2002.*
2. *The appropriate date shall be expressed in accordance with Annex X.*
3. *In order to ensure a uniform application of the manner of indicating the date of minimum durability referred to in point 1(c) of Annex X, the Commission may adopt implementing acts setting out rules in this regard. Those implementing acts shall be adopted in accordance with the examination procedure referred to in Article 48(2).*

Comment: Annex X is not included, but this part states in specific how the minimum durability, the "use by" date and the date of freezing should be indicated on the packaging.

EG regulation no. 178/2002 – Article 14

Food safety requirements

1. *Food shall not be placed on the market if it is unsafe.*
2. *Food shall be deemed to be unsafe if it is considered to*
    a. *injurious to health;*
    b. *unfit for human consumption.*
3. *In determining whether any food is unsafe, regard shall be had:*
    a. *to the normal conditions of use of the food by the consumer and at each stage of production, processing and distribution, and*
    b. *to the information provided to the consumer, including information on the label, or other information generally available to the consumer concerning the avoidance of specific adverse health effects from a particular food or category of foods.*
4. *In determining whether any food is injurious to health, regard shall be had:*
    a. *not only to the probable immediate and/or short-term and/or long-term effects of that food on the health of a person consuming it, but also on subsequent generations;*
    b. *to the probable cumulative toxic effects;*

c. *to the particular health sensitivities of a specific category of consumers where the food is intended for that category of consumers.*

5. *In determining whether any food is unfit for human consumption, regard shall be had to whether the food is unacceptable for human consumption according to its intended use, for reasons of contamination, whether by extraneous matter or otherwise, or through putrefaction, deterioration or decay.*
6. *Where any food which is unsafe is part of a batch, lot or consignment of food of the same class or description, it shall be presumed that all the food in that batch, lot or consignment is also unsafe, unless following a detailed assessment there is no evidence that the rest of the batch, lot or consignment is unsafe.*
7. *Food that complies with specific Community provisions governing food safety shall be deemed to be safe insofar as the aspects covered by the specific Community provisions are concerned.*
8. *Conformity of a food with specific provisions applicable to that food shall not bar the competent authorities from taking appropriate measures to impose restrictions on it being placed on the market or to require its withdrawal from the market where there are reasons to suspect that, despite such conformity, the food is unsafe.*
9. *Where there are no specific Community provisions, food shall be deemed to be safe when it conforms to the specific provisions of national food law of the Member State in whose territory the food is marketed, such provisions being drawn up and applied without prejudice to the Treaty, in particular Articles 28 and 30 thereof.*

<u>EG regulation no. 2073/2005 – Article 3</u>

General requirements

1. *Food business operators shall ensure that foodstuffs comply with the relevant microbiological criteria set out in Annex I. To this end the food business operators at each stage of food production, processing and distribution, including retail, shall take measures, as part of their procedures based on HACCP principles together with the implementation of good hygiene practice, to ensure the following:*
    a. *that the supply, handling and processing of raw materials and food-stuffs under their control are carried out in such a way that the process hygiene criteria are met,*
    b. *that the food safety criteria applicable throughout the shelf-life of the products can be met under reasonably foreseeable conditions of distribution, storage and use.*
2. *As necessary, the food business operators responsible for the manufacture of the product shall conduct studies in accordance with Annex II in order to investigate compliance with the criteria throughout the shelf-life. In*

particular, this applies to ready-to-eat foods that are able to support the growth of Listeria monocytogenes *and that may pose a* Listeria monocytogenes *risk for public health.*

Food businesses may collaborate in conducting those studies.

Guidelines for conducting those studies may be included in the guides to good practice referred to in Article 7 of Regulation (EC) No 852/2004.