A Secondary Packaging Solution Development Suitable for E-groceries through the Identification of Food Product and Logistic Requirements

A case study at deKrat.nl

Silvia D'Alesio
Rémi Vandichel

MASTER´S THESIS

Packaging Logistics
Lund University

This Master's thesis has been done within the Erasmus Mundus Master Course FIPDes, Food Innovation and Product Design.

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Lund, June 2015

Rémi Vandichel & Silvia D'Alesio

Abstract

Title (Eng) A Secondary Packaging Solution Development Suitable for E-groceries through the Identification of Food Product and Logistic Requirements

Title (Swe) En sekundär förpackningslösning Utveckling Lämplig för E-livsmedel genom identifiering av livsmedelsprodukt och logistikkrav

Authors: Rémi Vandichel and Silvia D'Alesio

Supervisors: Henrik Pålsson: *Packaging Logistics, Department of Design Sciences, LTH*
Michael Nieuwesteeg: *Managing Director NVC – Nederlands Verpakkingscentrum*

Issue of study: Secondary packaging solutions presently used to package food goods in e-commerce supply chain are either taken from old supply chains, or sub-optimally developed in a non-holistic manner. Because of this shift in supply chain, increased consumer needs in personalization and convenience, due to the increase use of internet to perform food purchases, secondary packaging must be adapted to meet these new needs. The logistic and food product requirements that a secondary packaging for food goods must meet are mandatory for consideration when creating such a packaging. Product quality assurance and efficient logistics are essential to deliver safe food goods to customers in large quantities.

Purpose: The purpose of this thesis is to develop a secondary packaging solution for home delivered food products. The packaging solution must fulfil both product and logistic requirements for e-commerce and address difficulties relating to the last mile in grocery supply chains. In order develop a secondary packaging solution for e-commerce that fulfils these requirements, the goal of this thesis is to identify food product and logistic requirements.

Method: **S**econdary research was done to map the current Dutch e-grocery market and the current packaging implemented for this market, trends in e-commerce, and packaging innovations previously implemented in the sector. The primary research was split into two main parts, a pre-study and a case study. They both aimed at gathering data on e-commerce for food, the packaging thereof and the logistics involved. The pre-study included interviews with professionals in the food and packaging industry, in conjunction with findings from secondary research. The case study allowed for the improvement of an existing secondary food packaging implemented by an e-grocer. During the case study, interviews and observations were made,

together with a packaging analysis: packaging scorecard and a packaging\logistics interactions chart, used to find the current secondary packaging solutions' strengths and weaknesses, foundation to the packaging development phase.

Conclusions: Food product requirements that have to be considered during the development of a secondary packaging for food in e-commerce benefit product quality assurance. These requirements are the control of temperature over time, the reduction of product damage and the separation of food product types. Temperature control over time assures that produce is kept at the correct temperature, significantly reducing possible biological damage. Product type separation reduces cross-contamination and inter-product damage risk during transportation, reducing the risk of product damage, mechanical degradation and biological degradation.

Logistics requirements that must be considered for secondary packaging solutions for food in e-commerce relate to last mile logistics. This entails fulfilment, transportation, delivery and return-logistics. Order fulfilment during picking can be facilitated through predetermined produce placement in the packaging. The reduction of excessive transportation packaging and improved use of volume are essential. The current use of sub-optimised packaging results in the transportation of large amounts of air. An e-grocer must therefore look into packaging aspects such as stackability and volume efficiency. Delivery systems can be improved by reducing the amount of proceedings that need to happen at the customer's door, facilitating more deliveries per time unit. The implementation of returnable packaging and deposit-refund system can reduce the need to continuously invest in new packaging, reducing costs for the e-grocers, and adding value to both their company image and environmental impact.

Applying the results during the secondary packaging development for a case study, deKrat.nl, resulted in the finding of suitable value-adding packaging features to address the above mentioned requirements. Separators in the secondary packaging facilitate eased fulfilment. Separators can increase the stackability of packaging, as it provides a larger surface area on which more crates can be stacked. Increased stackability influences volume efficiency and reduces the need for extra packaging levels. Time temperature indicators increase quality assurance and a deposit-refund system can induce incentive for customers to return the used packaging levels. These features indirectly effect the environmental impact during transportation and packaging production

Keywords: Secondary packaging, Food Product Requirements, Logistic requirements, Packaging Development, E-commerce, Web Retail Packaging

Executive Summary

Introduction

European e-commerce for groceries has seen steady growth. The annual amount of food delivered is forecasted to grow from 133.7 to 186.3 million by 2018, an increase of 40% (Internetworldstat, 2014). The geographic target market of this research is the Netherlands, where according to Rabobank Retail Trends (2014) the e-grocery market only reach 1% , yet it will grow to be 13% by 2020 (Thiuswinkel.org, 2014).

However, online grocery (e-grocery) shopping is a segment of e-commerce with difficulties all of its own. Most of these occur during the last mile, defined as the last leg of the business to consumer delivery service (Boyer et al., 2009). Issues concerning the last mile are related to the grocery business models employed. Currently there are three main e-grocery business models: ´brick and clicks´, ´ pure players´ and ´infomediaries´ that differ from each other due to the location and management of their logistic hubs (Reynolds, 2000). The use of outsourced logistics (third party logistic providers) aids e-grocery businesses with logistic activities such as receiving produce (from suppliers), stocking, picking, packing, transporting and delivering to customers and the packaging return management.

This in turn induces challenges in designing packaging solutions suitable for said logistic activities. In e-commerce many single-item orders to different delivery addresses on irregular occasion represent one shift of demand compared to regular marketplace (Olsson et al. 2004). Stock (1997) suggested integrating areas such as consumer behaviour and logistics in order to improve the packaging design for e-commerce, adopting an interdisciplinary method. Secondary packaging solutions currently used for e-grocery shopping are: shopping bags, boxes and crates. But their design should be holistically considered and improved based on the chosen last mile delivery model, involving the analysis of the overall distribution network and the redesign of packaging (Aubrey & Judge, 2012).

Further, e-groceries are subject to more sensitive parameters than other FMCG. For instance, time-temperature control for the assurance of quality food throughout the supply chain (Aung & Chang, 2014) and the effects of temperature changes to product quality (Tijskens & Polderdijk 1996) are of vital importance. Vibrations during transportation can also increase the risk of product damage. As proven by Colla and Lapoule (2012): "*choosing an efficient logistic model and a packaging solution are critical factors for efficiently protecting food products*" (Cagliano et al. 2014).

The purpose of this thesis is to develop a secondary packaging solution for home delivered food products. This solution must fulfil logistic and food product requirements for e-commerce and address difficulties relating to the last mile in grocery supply chain. The goal of this thesis is to identify the mentioned requirements. To aid the identification of said requirements and thus the development of the proposed secondary packaging solution, research questions such as "what type of food product and logistic requirements need to be considered for the development of a secondary packaging solution suitable for e-groceries?", and "which features could aid packaging solutions in meeting these requirements?", have been posed.

Methodology

Due to novelty of research towards the secondary packaging requirements in this sector, research was approached through an inductive manner, which aimed to condense qualitative data findings into summaries, and to establish links with the research questions and data.

The research performed was divided into two parts: secondary and primary research. Literature used was found in the fields of e-commerce, packaging logistic and supply chain management. Sources included articles, journals, publications and media as well as reports and newspaper form the NVC - Netherlands Packaging Centre- database.

The primary research was split into two parts: a pre-study and a case study. Both the studies aimed at gathering data on topic of Dutch e-grocery market, the packaging thereof and involved logistics.

The pre study was performed through interviews with packaging and food packaging professionals. The interviewing followed the seven-step process of gathering data and gaining knowledge from individuals (Kvale, 1996). The case study allowed for the improvement of an existing secondary food packaging implemented by an e-grocer, deKrat.nl, Amsterdam, which provides home delivered meal foodstuffs in wooden crates. The case study aimed to illuminate decision made by the company regarding their packaging system (Yin, 2003). Tools that were used included the packaging and logistic interactions chart (Hellstöm et al., 2006) and the packaging scorecard (Olsmats & Dominic, 2003).

The unit of analysis during the primary research was the secondary packaging solutions currently used in Dutch e-grocery market (pre-study) and the wooden crate (case study).

The reliability of data was possible through triangulation, which validates information gathered from the different sources. The sources of this thesis were literature, interviews with different packaging professionals, observations and packaging evaluation methods.

Results

Identification of Requirements

Results that has been derived from both primary and secondary researches were compared in order to assess similarities and identify food product and logistic requirements. Figure 1 summarizes main findings from both the researches and their conforming points.

Empirical data from primary research	Theoretical assumptions from secondary research
- Hub and spoke network affects delivery businesses' offer and consumers' choice - High density grocery stores decreases the number of e- grocery orders - Reputation is factor that influences consumer behavior toward shopping online - Some foods require to be delivered already packed (primary packaging) and this positively affects the fulfillment - Coolant packaging is being used to solve food product removal from the cold chain - Material affects the environmental value of packaging the most - Packaging solutions suitable for e- grocery do not need to be attractive or for informative purposes - Customizing could be improved through packaging elements	- Last mile delivery is the most costly and polluting echelon - There are environmental benefits based on emission and solid waste of returnable packaging - Traditional and online food packaging has same functions - A holistic approach is needed to develop packaging solution suitable for the e-commerce

Matching Points
- Last mile delivery is the most important element of the order fulfillment process - Difficulties arise when managing the packaging return system - Difficulties arise when controlling temperature along the last mile of food supply chain - Challenges for packaging design for e- grocery is the packaging of mixed loads

Figure 1: Comparative review of findings

Findings at deKrat.nl

An analysis of strengths and weaknesses of the packaging system of deKrat.nl was performed after an overview of the company itself, the product sold, the packaging used and its supply chain. The three levels of packaging within this system are: wooden crate, foldable plastic crate provided by third party logistics and EU pallet.

The pear crate was subject to improvement as it was the most used crate. The packaging's strengths included its incorporation in the company's branding strategy, as it displays the company's local and sustainable image. It is recognizable, classic, recyclable and has a low purchase cost. The most problematic areas included; volume efficiency, stackability, product protection, and packaging return management and used material.

The wooden crate used by dK showed to be unstackable when filled with produce, increasing delivery time due to many handlings, increasing inter-product damage during transportation, inducing a high percentage of transported air. This in combination with the face that the wooden crate is returned too little (30% of the entire flow), therefore susceptible to moisture and mould damage at the customers' homes revealed that there was room for improvement.

Requirements and Problem Alignment

The identified requirements were combined with the recognized problems within the case study in order to define features that the proposed solution must have to fulfil the identified food product and logistic requirements.

Product	**Logistics**
Consider the mixed load of different food goods (type, size and quantity) and/or primary packages and interactions amongst them	Consider the way groceries are delivered to consumer
Temperature control over time essential for product quality assurance	Facilitate the packaging fulfilment
Protect fragile product from mechanical damage	Reduce the number of truck freights

Proposed Solution Description

The proposed solution is an improvement of the Pear crate (500x300x200)) used by deKrat.nl in relation to the identified requirements and designated problems at deKrat.nl. This solution integrates three strategies: packaging, logistic and product. Respectively, the new solutions makes use of: two interlocking packaging separators sheets made by coloured EPS, a deposit-refund system (5 euros per crate), and a time-temperature indicator. The solution development process included three stages: planning, designing and developing of visualization models in both 2D and 3D.

The proposed improvements allow to avoid the use of the transportation packaging, thus increasing the area efficiency by 28.6 % and the volume efficiency by 31.1% (Cape Pack) of its palletisation. Finally trade-offs between the current and the new crate were analysed, showing that the increased packaging cost (from 0.30 to 5.00 euros) and the negative environmental impact of the material used (EPS) is in balance with improved product protection and transport efficiency.

Discussion and Further Research

Logistic requirements

Most of the difficulties related to e-groceries occur during the last mile: the home delivery process. In the context of e-commerce, the definition of secondary packaging (packaging that contains many primary packaging) expands, due to the presence of mixed load in e-groceries. It is critical to facilitate the fulfilment of the mixed load in secondary packaging for food in e-commerce, done by introducing packaging components that separate different food category inside the packaging itself. Transportation and delivery issues stress the need for stackable secondary packaging solutions, which in turn improves cube utilization and avoids the use of unnecessary packaging levels. Returnable packaging is a packaging system, suitable for e-commerce, which consists of elements such as the design of reusable packaging and deposit-refund management. A deposit refund system seems to be more efficient than electronic identification for food packaging, which fails to cover the low margin revenue of e-grocery sales.

Food product requirements

Food quality assurance does not depend on the supply chain (online vs. traditional), but on the distribution network for e-groceries Food produce needs to be kept the cold, in the cold chain, to reduce the possibility of microbial product damage. Current coolant packaging solutions show to be inefficient, and can only keep food at the correct temperature for a certain amount

of time. Temperature indicators ensure customer that the product has been at right temperature along the supply chain. Product protection refers also to reducing mechanical induced inter-product damage due to transportation. Separating and insulating the different food categories loaded within secondary packaging can ensure product stay protected from mechanical damage and possible moisture damage.

Features of secondary packaging suitable for e-grocery

Applying these results during the secondary packaging solution for the case study, deKrat.nl, resulted in finding suitable value-adding packaging features to address the above mentioned requirements. Separators that can be manually place in the secondary packaging facilitate eased fulfilment, as predetermined areas can be created for certain food types. Separators can increase the stackability of packaging, as it provides a larger surface area on which more crates can be stacked. This increased stackability influences volume efficiency and reduces the need for extra packaging levels such as transportation packaging. Time temperature indicators increase quality to assurance and a deposit-refund system can induce incentive for customers to return the used packaging levels. These features indirectly affect the environmental impact during transportation and packaging production.

Further research

The findings from performed research can be used as foundation for further research. A possible next step would be the implementation of the packaging solution into the supply chain of and e-grocer, and measure the packaging's performance in regards to the performance measures referred to in this thesis. Research could be done toward the primary packaging of food products, suitable for mixed loads in e-commerce. Other requirements that could be further researched are marketing requirements and direct environmental requirements related to e-groceries, as these can also influence the design, impact and functionality of a packaging.

The ever-changing trends in, and continuous evolution of e-commerce brings rise to potential study topics. Trends such as the use of omni-channel retailing in e-commerce, increased consumer need for personalized orders and the possibility of rapid globalization of start-ups, among others trends, drive the evolution of the packaging used in this sector.

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1 Introduction

This chapter includes the background to the study, its purpose, goal and delimitations.

1.1 Background

Approximately one third of the world's' Internet users are located in Europe. Internet is available to 70% of Europeans, whilst this Internet availability rests at an average of 38.6% for the rest of the world (Internetworldstat, 2014). The geographic target market of this research is the Netherlands, where according to the Dutch Central Bureau of Statistics (15/3/2015) 90% of inhabitants have access to the Internet. This accessibility to Internet inherently brings potential for online purchasing. Of the 90% mentioned above, 77% uses e-commerce for purchasing services and goods, which accounts for 17% of all purchases. This latter percentage is estimated to grow in the next five years, forecasted to reach 28% in 2017 and 36% in 2020 (Thuiswinkel.org).

European e-commerce for food products (e-groceries) has seen steady growth. The annual amount of food deliveries is forecasted to grow from 133.7 to 186.3 million by 2018, an increase of 40%. In 2014, the Dutch market for e-groceries only reached 1% (Rabobank Retail Trends), yet it is growing at a rate of 13% per year (Thuiswinkel.org). This growth, in combination with the oversaturation of grocery stores in the Netherlands, over 4400 supermarkets, has led to the possibility of introducing local pickup points and achieving faster home delivery.

Having food products delivered at home is not a new concept. Milk was once delivered fresh to doorsteps, and groceries were once delivered from the corner stores to customers' homes. Through the growth of large supermarket chains, this home delivery model for food products strongly diminished (Hays et al. 2005). The return of the home delivery concept came hand in hand with the arrival of e-commerce in the early 90's, and is a sector that has grown greatly in the last two decades due to the increased number of Internet users.

Types of e-grocery businesses such as 'brick and clicks', 'pure players' and 'infomediaries' differ from each other because of the location and management of their

logistic hubs, and their delivery systems (Reynolds 2002). This in turn induces logistical difficulties in the last mile, defined as the last leg of the business to consumer delivery service (Boyer et al. 2009), in terms of the design, fulfilment, transportation and return of packaging (Gevaers et al. 2011). This differentiation is also visible in the type of products offered to customers. While some companies offer the possibility to choose products (i.e. Amazon Fresh, Boni, Ocado), others offer a planned meal grocery box, which includes both a combination of food products and recipes for the use of said products (i.e. Hello Fresh, Beebox).

The handling, storage, transportation and delivery of e-groceries are subject to more sensitive parameters than other fast moving consumer goods. For instance, temperature control for the assurance of quality of food throughout the supply chain (Aung & Chang 2014) and the effects of temperature changes to product quality (Tijskens & Polderdijk 1996) are of vital importance. Vibrations during transportation can cause both intra- and inter product damage in mixed loads, which can be related to both the vibration due to the manner of transportation and the interactions of specific products due to their placement in the packaging. As proven by Colla and Lapoule, (2012): "*choosing an efficient logistics model and being able to manage it are critical factors for the success of e-commerce in this [groceries] industry*" (Cagliano et al. 2014). Products bought online must be packaged to facilitate solutions for all logistical issues including, among others, unitisation, return logistics management and the packing of mixed loads.

Current solutions used by large supermarkets for e-groceries commonly use old packaging solutions such as plastic bags, or implement packaging solutions that are sub-optimised through a non-holistic approach during packaging development. By not having a holistic approach companies' packaging solutions are frequently unfit for their (new) supply chains, and require additional handling steps and/or packaging levels. On the other hand, starting e-grocery businesses are uninformed of the logistical complexities that come paired with e-commerce and food packaging, and experience difficulties when combining this with their branding strategy. The trade-offs in e-commerce for food products lie in the complex synergy between packaging and logistics.

The main logistical differences between e-groceries and traditional groceries concern the last mile logistics including fulfilment and transportation to home. These two aspects differ greatly as both the steps are placed out of the hands of customers when purchasing through e-commerce. Companies pursuing to provide groceries via e-commerce must therefore adapt to these added logistic requirements. Companies can either alter their supply chain and/or the packaging used to holistically adapt to this change.

1.2 Problem Finding

In comparison to traditional food retailing, where supermarkets are the last echelon of the supply chain, e-groceries that are delivered directly to customers' homes have an additional supply chain link. This gives rise to the following issues:

- **Logistics**: the logistics activities that come paired with e-groceries are different to those in traditional food retailing. Logistic activities in e-commerce for food include, among others, the picking and packing of mixed loads into company specific packaging levels for single customers, instead of standardized pallet loads for delivery to traditional supermarkets. In addition, packaging return management remains an issue for e-grocers, due to the introduction of intensive extra labour with low profit margins.

- **Food products:** food products each have a specific sensitivity to temperature and susceptibility to mechanical or biological damage. Packaging mixed loads for an e-commerce supply chain is different to that of traditional retail, as one packaging must aim to meet the specific needs of different types of food products. In comparison to traditional retail, where food product quality is assured until supermarkets, e-groceries quality must be assured until it is delivered at home.

1.3 Purpose and Goal

The purpose of this thesis is to develop a secondary packaging solution for "home delivered meal foodstuffs". The packaging solution must fulfil both product and logistic requirements for e-commerce and address difficulties relating to the last mile in grocery supply chains. In order to develop a secondary packaging solution for e-commerce that fulfils these requirements, the goal of this thesis is to identify the food product and logistic requirements. To aid the identification of requirements and thus the packaging solution development, the following research questions have been posed:

1. What types of logistic requirements need to be considered for developing a secondary packaging solution for food in e-commerce?
2. What types of food product requirements need to be considered for developing a secondary packaging solution for food in e-commerce?
3. Which packaging features could aid secondary packaging for food in e-commerce in meeting these requirements?

1.4 Delimitations

When referring to a secondary packaging solution for mixed loads of food products in e-commerce, the potential product combination and variability is immense. To reduce potential misconception, a list of food products was chosen which would be assessed in this thesis. This can be seen in table 1. This table describes what is meant by "home delivered food products (see paragraph 1.3), which is split into four food categories. This list is takes the product portfolio of the case study into account.

Table 1: Food Categories and examples of planned meal grocery products

Food Category	**Examples**
Produce	Fresh fruits and vegetables, herbs and dry fruit
Perishables	Bread, cheese, dairy, eggs, meat and seafood, juice, yoghurt and milk
Pantry	Breakfast food, canned and jarred, condiments (oils/dressings), grains (pasta, rice)
Speciality	Wine, beer

The geographical target of the project was limited to the Netherlands, as this is the location of research designated by the authors. The reason for this being the geographical location of the supervising company. E-grocery packaging and logistics trends were geo targeted Western European (UK, Germany, Benelux and France) rather than globally, as trends concerning Internet can differ due to its availability.

The delimitations of product and packaging are also present. Since the improvements in packaging are meant for a case study, they are bound to that company's wished, demands and products. Moreover, the secondary packaging solution is thus meant for infomediary business model, which is one that provides the customer with a company selected range of products, unlike supermarkets, which also provide condiments and non-edibles. The solution was made to the current packaging of the case study, which is delimitation, seeing that the level of achievable innovation remains lower.

The development of the proposed secondary packaging solution was driven by food product (quality assurance) and logistical requirements (fulfilment, transportation, delivery and return flow). Partially excluded from this thesis were other requirements such as marketing (differentiation, promotion, value-adding features, informing and branding) and environmental requirements (disposal, recovery and reduction of

packaging). This research orientation is motivated by the fact that obtained data on logistic and product requirements was more abundant and reliable than marketing and environment oriented results. However the two aspects of consumer demands and environmental impact were roughly considered because of their inevitable connection to both others requirements (food products and logistic) as well as to packaging design development. Concluding, all the logistic operations and related requirements that were discussed in this study revolved around the last mile delivery management.

Consumer survey was not carried out due to the scheduled timeframe of this project of 20 weeks and the lack of direct access to consumers' data. Nevertheless a brief understanding of customers' behaviour toward grocery shopping online, related packaging and specifically toward the packaging solution of the case study was possible. This consumer insight was obtained through interviewing professionals and not directly through consumers influenced the design of the proposed solution.

The definition of feature as given by The Merriam-Webster dictionary: "*a prominent part or characteristic"* was use to define a packaging feature. In this report, any reference to a packaging feature therefore refers to an additional prominent packaging element that can aid in fulfilment of certain requirements by the packaging in which it is implemented.

Lastly companies that collaborated with this project provided limited access to data. During observations and visits used as data collection methods, the capturing of images was prohibited. This is a limitation seeing that visual aids can help the reader understand certain aspect of the supply chain and current packaging. However results gathered from visits and observations were reported in written form. The physical prototype creation of the proposed solution was not feasible because the lack of a close partnership with an EPS packaging supplier.

2 Methodology

The research performed was divided into two parts: secondary and primary research. The methodology describes how both research parts were performed, how data was collected and why means of data collection were chosen. Data collection methods, as described below, are a literature review, interviews, observations and a case study.

2.1 Secondary Research

The secondary research aimed at mapping the current Dutch e-grocery market and the current packaging implemented for this market, trends in e-commerce, and packaging innovations previously implemented in the sector. This was done through sources such as articles, publications, books, and media. By mapping this market and the current logistics and packaging used, the primary research could be better defined.

Literature used for secondary research was found in the fields of e-commerce, packaging logistics and supply chain management (see list below), of which a list of sources can be seen below. In addition to this list of journals, other sources, including reports, presentations and newspapers from the NVC – Netherlands Packaging Centre database were used.

(1) E-commerce

- *Business Strategy and the Environment;*
- *E-Logistics Magazine;*
- *International Journal of Electronic Commerce;*
- *The Innovation Journal;*
- *International Journal of E-Entrepreneurship and Innovation.*

(2) Packaging Logistics

- *European Journal of Operational Research*
- *International Journal of Environmentally Conscious Design and Manufacturing*
- *International Journal of Flexible Manufacturing Systems*
- *International Journal of Logistics Management*
- *International Journal of Production and Operations Management*
- *Journal of Business Logistics.*

(3) Supply Chain Management

- *Supply Chain Management International Journal*
- *International Journal of Retailing & Distribution Management*
- *International Journal of Physical Distribution & Logistics Management.*

2.2 Primary Research

The primary research was split into two main parts, a pre-study and a case study. They were both aimed at gathering data on the topics of e-commerce for food, the packaging thereof and the logistics involved.

The pre-study was performed through the execution of interviews with professionals (not part of the case study) in the food and packaging industry, in conjunction with findings from secondary research. By conducting this pre-study, the goal of this thesis, being the identification of logistic and food product requirements for secondary packaging, could be further researched. How these interviews were performed can be seen in paragraph 2.2.1.

The case study allowed for the improvement of an existing secondary food packaging implemented by an e-grocer. The literature review and pre-study on these topics were performed to strengthen the brainstorming and packaging development phase of the case study, as the packaging had to fulfil the identified secondary packaging requirements. Tools that were used during the case study can be seen further in this paragraph 2.3. The secondary packaging solution was developed to answer to the purpose of this thesis. Finally the unit of analysis during the primary research was crates as secondary packaging solution currently used in the Dutch e-grocery sector, and specifically a wooden crate during the case study, as this was the type of crate used.

2.2.1 Interviews with Professionals

Interviewing is a seven-step process of gathering data and gaining knowledge from individuals with mutual interests (Kvale 1996). These seven steps: thematising, designing, interviewing, transcribing, analysing, verifying and reporting, all aim to achieve optimum interview results, and were followed during the primary research phase. The previously performed secondary research was helpful during the thematising and designing phases of the interviews, as more specific topics and concepts were chosen. The performed interviews were transcribed, facilitating a more accurate analysis.

Interviews can be complex, but according to (Hoyle et al. 2002) posed questions aim at motivating precise replies and avoiding biases due to prejudice and social aspects. Data gathered through interviews was on the topics of consumer, food produce, packaging and logistics. The semi-structured interviews were performed with consumer, packaging, food and logistics professionals. The use of semi-structured interviews was encouraged, as some posed questions were not formerly anticipated. Table 2 lists the interviewees, the company they work for and the topic discussed.

Table 2: List of interviewees, not associated to the Case Study

Code	Name	Position	Company	Employees	Topic
C1	Michiel Elshout	Associated consultant and account executive custom FMCG research	GfK	13,000	Consumer\ retailer behaviour towards e-grocery.
F1	Vincenzo Fogliano	Food Science experise at the Subdivision of food quality and design	WUR	6,500	Food product requirements, packaging and food interactions.
P1	Dennis Peters, Ewout Mouthaan, Ronald Kunst	Account and Sales Manager	DS Smith Packaging	20,000	Packaging materials and chilled transports.
L1	Jan Leensen	Manager Channel Development	Jumbo	30,000	Grocery packaging and online supermarket logistics.
E1	Alan Campbell, Agnieszka van Batavia	Technical Director, Sales Executive	The LCA Centre	200	Packaging, LCA, Food Packaging.

A description of the discussed topics is provided in order to better understand their boundaries and related results as reported in chapter 4. Advantages and disadvantages that consumers and retailers perceive as consequence of the switch from traditional to online grocery shopping were analysed. This insight was searched in order to holistically understand what the consumers and retailers demands are towards e-grocery shopping rather than directly analysing specific consumer requirement (e.g. packaging branding and the return deposit). This approach allowed deducing what consumer perceive as benefits of doing grocery shopping online including packaging related characteristics (e.g. the return system and foods protection). In order to structure these interview a template questionnaire was followed and can be found in annex 10.

2.2.2 Case Study

The purpose of this thesis is to develop a secondary packaging solution for a single-case study. The company chosen for the case study was deKrat.nl, (dK), a company in the Netherlands, providing home delivered meal food products in wooden crates. A case study was chosen as to illuminate decisions made by dK regarding their packaging a supply chain (Yin 2003). The unit of analysis during the case study was their secondary packaging solution: a wooden crate, produced by Kist en Co (KC) delivered to its customers by dK's Logistics provider Leen Menken Food Service Logistics (LM). Descriptions of these companies can be found in paragraph 2.4. During the case study, interviews and observations were made, together with a packaging system analysis, by means of the packaging scorecard and a packaging\logistics interactions chart. Both interviews and observations were performed to gather information on the supply chain and possible weak points. The latter two were implemented to find the current secondary packaging solutions' strengths and weaknesses.

2.2.2.1 Interviews

Interviews were performed within the case study, at different levels within the supply chain. These interviews were aimed at obtaining vital information on the supply chain, and how the packaging used by dK flows through this system. The methodology of these interviews are analogous to paragraph 2.2.1., yet were aimed specifically towards the unit of analysis, the wooden crates.

A template questionnaire was used as guide to collect in depth information about the three companies' involved in the case study's supply chain. This template was based on questions about: a) the company (e.g., founding date, size, lines of business, products and services provided); b) the nature of the e-commerce as marketplace of the company (e.g. the company position compared to competitors, and the role of the other players involved in firms´ transactions); c) potential sources of value creation (e.g. offered products,

consumer demands and importance of packaging and/or complementary delivery services). In order to identify specific firms´ demands toward the wooden crate, each stakeholder was interviewed following a dedicate template questionnaires, which are reported in annex 10.

Table 3: List of interviewees within the Case Study

Code	Name	Position	Company	Employees	Topic
dK1	Eefje Brugman	CEO	deKrat.nl	7	Food and packaging interactions and logistic operations. Consumer behavior toward the online grocery shopping.
dK2	Tijmen Verkooijen	Account Manager	Leen Menken Foodservice Logistics	200	Food and packaging interactions and logistic operations.
dK3	Marcel Zevenbergen	Sales Manager	Kist en Co.	50	Packaging production line and wooden crates strengths and weaknesses

2.2.2.2 Oservations of the Existing Supply Chain

Observations were made at dK throughout their supply chain. The observations provide information on the influence of packaging on logistical interactions, and according to (Yin 2003), findings were useful in providing additional information about the topic being studied, thus the requirements of secondary packaging. The goal of making observations was to analyse the supply chain through which the products and packaging move, and identify the strengths and weaknesses of the current packaging. Benefits of performing observations include the incorporation of all observed data into the packaging scorecard and packaging/logistics interactions chart, as well as the verification of data gathered from interviews.

2.2.2.3 Packaging and Logistics Interactions Chart

Packing and supply chain interaction charts in the supply chain were made. These charts pinpoint areas in the supply chain, at which each individual packaging system is handled (Hellström & Saghir 2007). All packaging levels were mapped in the interactions chart,

as they are all mandatory in the supply chain of e- groceries, yet the main importance is to analyse the wooden crates used as secondary packaging for food products. This provided a basis for decision making during the creation of a packaging solution, as these charts provided a comprehensive overview of the physical environment the packaging is subjected to in the supply chain.

2.2.2.4 Packaging Scorecard

The packaging scorecard, a packaging performance evaluation method, as devised by (Olsmats & Dominic 2003) was the main tool of assessing the perceived strengths and weaknesses of the current packaging used in dK's supply chain. The packaging scorecard was used to provide a more clear understanding of their current packaging system's performance. As mentioned in the delimitations, section 1.4, the physical mock-up development was not achieved; therefore the packaging scorecard was not used to estimate performances of the proposed solution. This method's foundation is the need for a holistic view on packaging from three main standpoints; logistics, environment and business. This method was useful for mapping the packaging's benefits and drawbacks within these three aspects. The packaging scorecard was completed with the three main stakeholders that come into contact with the wooden crate: dK, LM and KC. The criteria chosen for the packaging score card were; machinability, product protection, flow information, volume and weight efficiency, right amount and size, handle ability, reduced food waste, product information, selling capability, sustainability, mixed loads packaging, minimal use of hazardous substance, packaging cost, minimal amount of waste, customer handling convenience, stack ability and return flow of packaging. An explanation of these packaging characteristics can be seen in the annex 9.4.

2.3 Analysis Strategy

The analysis strategy occurred in two main steps: secondary and primary research. This latest was divided into two sub steps: pre-study and the case study, which differ against each other in terms of used tools and aims. The pre-study was based on interviews, while the case study was based on interviews, observations, packaging-logistics interactions chart and the packaging scorecard. Finally the aim of the pre study was to identify requirements for developing a secondary packaging solution suitable for e-groceries while the aim of the case study was to identify weakness and strengths of the current packaging system within the selected company, in order to develop the a more promising packaging solutions that fulfils the identified requirements.

Empirical data collected in this research was of qualitative nature, for that reason the research followed an inductive approach. This approach aims to condense data findings

into summaries and establish links between the research questions and collected data. The data collected from interviews with professionals and the literature review produced results that combined experience, knowledge and personal views with objective data. These were rigorously examined to find patterns and insights towards both the logistic and food product requirements that a secondary packaging solution must fulfil.

The last part of the analysis was to introduce the findings from literature, interviews with professionals and the case study into a secondary packaging solution. This packaging solution development phase was therefore backed by three different sources.

2.3.1 Analysis Credibility

Gathered data was subjected to triangulation, which validates information gathered from different sources. In the case of this thesis, sources include literature, interviews with different professional, observations and packaging evaluation methods.

Figure 2: Method for data triangulation to achieve analysis credibility

2.4 Collaboration

The following paragraphs give a short introduction to the involved companies, from which valuable data was gathered. All these companies were asked to contribute to this project with competences in packaging development, food packaging and logistics for e-commerce. Sections 2.4.1 - 2.4.4 presents collaborators defined as professionals with whom interviews were performed. The remaining collaborators are companies that supported the case study.

2.4.1 NVC – Netherlands Packaging Centre

The NVC -- Netherlands packaging centre, founded in 1953 is an association of companies devoted to thought leadership, addressing the activity of packaging throughout the supply chain of packaged products. The NVC membership, projects, information services and education programme stimulate the continuous improvement of packaging.

2.4.2 DS Smith Packaging

As one of the leading contenders in corrugated board and plastic packaging, and with a focus on "the Power of Less", DS Smith Packaging provides packaging solutions worldwide. DS Smith's focus on recycling and reusing packaging is crucial to design out waste and enable a circular economy.

2.4.3 LCA Centre – Paardenkooper

The LCA Centre, part of the Paardekooper – Van der Windt group, helps companies to formulate environmental claims. Their focus on the Life Cycle Assessment of packaging and the embodied energy it carries provides a foundation for credible eco-innovation. On site, their lab allows for the assessment of packaging materials, and the mechanical properties they carry.

2.4.4 GfK

GfK is a source of relevant market and consumer information that enables its clients to make strategic decisions. Since GfK operates in several industry sectors including consumer goods, market opportunities and innovation, online pricing, retailing strategy, retail sales and tracking, supply chain management, it was chosen as trustable sources for

gathering empirical data during this research. GfK´s data reliability was based on its audience measurements, consumer panels, trends and forecasts and brand insight. To be exact, GfK significantly supported this research providing relevant data on retailers and consumers behaviour in the online grocery shopping scenario within the Netherlands.

2.4.5 DeKrat.nl

Dekrat.nl (dK) is a provider of home delivered food products, together with recipes. Dekrat.nl, an infomediary, provides locally sourced foods from throughout the Netherlands to consumer s in the Netherlands in amounts for 1-4 people. The food produce is accompanied by a booklet containing recipes, which can be used to cook meals, using the produce provided. All produce provided by DeKrat.nl is local, seasonal, and organic, and comes in a crate, providing a "from farm" feeling to the customer. Dekrat.nl a five year old company was one of the first infomediaries in the Netherlands, and due to its growth has started outsourcing its logistics to Leen Menken Foodservice Logistics.

2.4.6 Leen Menken Foodservice Logistics

Leen Menken Foodservice Logistics (LM), a company based in Zoetermeer is a provider of Logistics for food oriented companies. Provider of inventory and transportation solutions for all company sizes and delivery types. By providing temperature controlled inventory and transportation, either frozen or chilled, food products' temperature profile can be maintained, and produce can be shipped to further destinations. Leen Menken has grown steadily in the last years, increasingly due to the growth of e-commerce and their adaptability to provide for this sector.

2.4.7 Kist & Co.

Kist & Co (KC) is a producer of high-quality wooden boxes used for the transportation of fruits and vegetables. Based in Ridderkerk, this company provides not only crates, but many other wood products, including pallets wooden planks. Kist en Co works in a "Just in time" fashion, reducing inventory and making products on order. Delivery is possible with 48 hours.

3 Frame of Reference

This chapter presents the theories that drove the research framework of this thesis. This theoretical frame focuses on packaging solution that addresses difficulties of the last mile in the grocery supply chain, identifying product and logistic requirements for secondary packaging for food in e-commerce. The chapter ends with the description of the packaging solution development process used. The aim of this frame of reference is to validate the reliability of results and proposed improvements based on the new insights into food packaging development for e-commerce.

3.1 E-grocery models

Mapping the current business models of e-grocery was necessary to get a deep insight of logistical difficulties that might arise whether grocery businesses introduce e-service within their portfolio.

Among the myriad of experiments that have occurred in web home delivery of food goods during the late 1990s there are three different types of electronic retail (e-tailer) systems can be distinguished (Reynolds, 2000). The quickest and cheapest to establish is called the "brick and click" method, which uses in-store fulfilment, where an existing retailer utilizes its already working store network (Murphy, 2002, 2003; Currah, 2002; Oinas, 2002). The most extensive and expensive method is to fabricate a purpose-built fulfilment warehouse for e-commerce. This is called a "pure player" if the firm has no physical retail points. Finally a third option is for (usually small enterprise) existing retailers to outsource the web ordering and customer management functions to an intermediary called an "infomediary" and utilizes third party logistics providers (Mendelson, 2001, Kämäräinen, 2001; Wrigley et al., 2002). An informediary's core functions are to pass stock, order and delivery information between customer and retailers and suppliers, while a third party logistics provider performs the above mentioned logistic tasks.

A number of grocery companies are expanding into e-commerce due to their unique position to step up and take advantage of online trends. Such examples include: Tesco, Ocado and Sainsbury (UK); Safeway and Amazon Fresh (US); Carrefour (FR); Ahold,

Vershuys, Albert Heijn and Jumbo (NL); and Bol (BE). An impressive example is Hello Fresh (DE), which raised $125 million in its latest round of financing (pehum.com, 2005). Nevertheless the e-grocery industry's net margin deteriorated to 0.29% in 2014 due to increase in total costs and despite revenue increase of 4.63% (CSIMarket, 2014). Thus not all virtual opportunities become tangible profits, an example is the bankruptcy of Webvan (US) in 2011 (CNET, 2001).

3.2 The last mile delivery model

Of particular concern to supply chain management in e-commerce is the last mile delivery (LMD), which is defined as the last-leg of the business-to-consumer delivery service (Boyer et al. 2009). The LMD includes delivery to the physical address of the end customer from the location (depot or pickup point) where the purchased items are kept. LMD it is considered as a key element of the order fulfilment process (Bromage 2001; Lee and Whang 2001). From an environmental point of view, LMD is estimated to be one of the most costly and highest polluting echelons of the supply chain (Gevaers et al. 2011), (Ülkü 2012). While costs vary with population density, product type, package size, and package weight, LMD has proven to acquire the highest transportation costs in the supply chain (Chopra 2003). (Goodman, 2005) notes that up to 28% of all transportation costs are incurred in last mile delivery.

Pertaining to the last mile are the types of delivery models and grocery businesses available to consumers. Currently these models are: attended, unattended, in-store pickup and third party pick up points (Hays et al. 2005). Home deliveries can either be attended or unattended, meaning that the customer is either home or not, respectively. Attended deliveries require a time window at which the customer is at home. These windows can be long or short, depending on the deliverer and can be quite the task of scheduling and routing. This form of delivery is also dependant on traffic and travel time uncertainties. The use of a privately owned delivery fleet would be an advantage if this model were to be implemented, yet few e-grocers use company owned delivery vehicles, as investment in such a fleet is more expensive than outsourcing logistics. Unattended deliveries remove the need for a time window, as the customer does not need to physically receive the goods, and adds flexibility to the routing and time schedule (i.e. orders can be filled at night, when traffic is lowest). A “time-poor” lifestyle of customers would therefore suit this delivery model well (Murphy 2007). A 44-53% cost reduction could be realised though unattended deliveries compared to attended deliveries with a time window of two hours (Siikavirta et al. 2003)). Lastly the third type of delivery system is not *per se* a delivery system. In this model, the third party pickup points, groceries are picked up by the customer in-store, where an employee has previously picked the customers’ selected

groceries (Hays et al. 2005). This model only removes the physical picking of products by the consumer allowing them to pick up their groceries at any time.

3.3 The packaging return system

The incorporation of a returnable packaging system is a heavy investment for companies, which face challenges in creating packaging suitable for return logistics as well as managing the flow of the empty packaging. (Kroon & Vrijens 1995) discussed the organisational methods for such returnable containers, stressing the importance of information flows throughout the supply chain in which these containers are implemented. The extents to which benefits of implementing a returnable packaging system can be reaped are strictly bound to the company implementing the system (Daut n.d.). For instance companies providing products with long product lead times and small volume flows are not ideal for returnable systems.

According to Mattsson (2012) returnable packaging allows packaging suppliers to save on packaging costs and conform to the packaging waste regulation (EC, 2004) applied to e-commerce (EURlex, 2000). However packaging return management remains an issue for e-businesses (O. Johansson et al., 2007 and Kärkkäinen et al., 2004). Within the grocery sector, these issues are: (1) the need to build their own return management system due to a lack of system integrators, (2) disputes about sharing costs and benefits along the supply chain and (3) lack of standardisation (Martínez-Sala et al., 2009).

Traditional echelons in the grocery supply chains are: (1) from food suppliers to distribution centres, where products are packaged (primary and secondary), put on pallets (tertiary) and delivered on trucks; (2) from warehouses to supermarkets: the received batches are inventoried, stored and shipped when a retailer orders are received; (3) from retailer to consumers. The introduction of the return management, defined by Rogers et al. (2002) as that part of supply chain management includes returns, reverse logistics, gatekeeping and avoidance, within the above described grocery supply chain adds intensive extra labour with low profit margins (Martínez-Sala et al., 2009).

Nevertheless environmental benefits, based on emissions, water consumption, pollution and solid waste, of returnable packaging can be seen when the packaging is used a minimum amount of times during its lifetime (Kroon & Vrijens 1995).

3.4 Packaging for Food products

Compared to FMCG supply chains, food supply chains are often more complex and more difficult to manage because food products are perishable due to their inevitable shelf life. Temperature controlled supply chains or the cold chains provides the essential facilities to maintain the quality of foods (Aung & Chang 2014). Foods are time and temperature sensitive in nature, they need to be properly taken care throughout harvesting, preparation, packaging, transportation and handling steps; in other words, throughout the entire food chain. Temperature is the most important factor in prolonging or maintaining the shelf life of perishables. Proper control and management of temperature is crucial in delivering perishables to consumers and ensuring that those perishables are in good condition (Tijskens & Polderdijk 1996).

For that reason traditional food packaging functions do not differ from functions of food packaging in e-commerce (Yam et al. 2005). Table 4, lists these basic functions.

Table 4: Description of the four main packaging functions of food packaging

Function	**Description**
Protection	Food packaging keeps food products in a limited volume, prevents it to leak or break-up and protects it against possible contaminations and changes
Communication	Food packaging communicates important information about the contained food product and its nutritional content, together with guidelines about preparation
Convenience	Food Packaging is designed toward individual lifestyles through for example portability and multiple single portions
Containment	Food packaging is designed for easy transportation or handling

To conclude food product interactions, food and packaging interactions, mechanical, chemical and physical hazards are all factors that must be taken into account when handling e-groceries along the supply chain.

3.5 Packaging design and development

E-commerce faces challenges on packaging design from perspectives such as consumers, retailers, and environment. In e-commerce, many single-item orders to several delivery addresses on irregular occasions and different geographical positions represent one shift of demands as compared to regular retail (Olsson et al. 2004). (Stock 1997) suggested integrating the aspects of the three areas of consumer behaviour, logistics and marketing in order to improve the research of e-commerce and packaging logistics, adopting an interdisciplinary method. As an outcome of the integrated research approach, the resulted solutions have to be weighed against the efficiency of the whole system from economic and environmental perspectives. In other words within the packaging development process, relevant factors such as product requirements, information needs, distribution issues and consumer usability needs should be considered and balanced against environmental aspects (Olsson et al. 2004). Packaging solutions currently used for the e-grocery shopping are: the shopping bags, the boxes and the crates. Examples of these solutions and the respective companies that use them can be found in Annex 9.1. Finally, the challenges of packaging design for e-grocery should be holistically considered and improved based on the chose last mile delivery model, which involves analysing the overall distribution network, redesigning the packaging solution and\or establishing more efficient transportation routes (Aubrey & Judge, 2012).

3.6 The theoretical frame

The literature research conducted was the starting point of developing the theoretical frame of this thesis, which is described in this section. This theoretical scheme aims to set research boundaries concerned fields that might influence the online food packaging system. And these fields are:

- E-grocery business: the businesses' participation to the online grocery marketplace for sales of food directly to customers. Business models differentiate from each other on providing different type of grocery products and delivery services, meeting related demands.
- Packaging logistics: the analysis of operations and difficulties of the last mile in the food and grocery supply chain, and identification of related logistic requirements such as handling, transportation and distribution.
- Food packaging: the food goods quality assurance along the e-grocery supply chain.

- Packaging design and development: the purposeful sequence of stages to create better packaging solution.

The axiom for this theoretical frame is the scenario named “e-grocery packaging”, where the use of online technology for food purchasing has become a trivial matter. In this scenario, advance digital technology and innovative logistics technology are able to adapt to packaging requirements such as marketing (meeting consumer demands, design layout and communication) and logistics (reusable, optimized use of packaging material and minimizing transportation costs). In this context, the consumers’ perception of food product value toward packaging might also change, and packaging will no longer be the unique key branding mechanism. In addition, consumers have become increasingly concerned about the environmental impact of the foods they consume, recognizing the value of environmental sustainability and energy-efficient packaging (Fletcher, 2015). The large amount single-item orders performed in e-commerce has shifted the packaging requirements compared to traditional packaging. In e-commerce, the basic functions of primary food packaging can be reduced to three primary functions of containment, protection, and preservation of products. In relation to this, the role of secondary packaging can be improved in terms of relevance to its functions. In other words, the definition of secondary packaging stated by (Johansson K., et.al. 1997), which is a packaging designed to contain a number of primary packages at the sales outlet, seems to be too narrow in the context of e-commerce. Figure 3 below summarizes and visualizes the described theoretical frame.

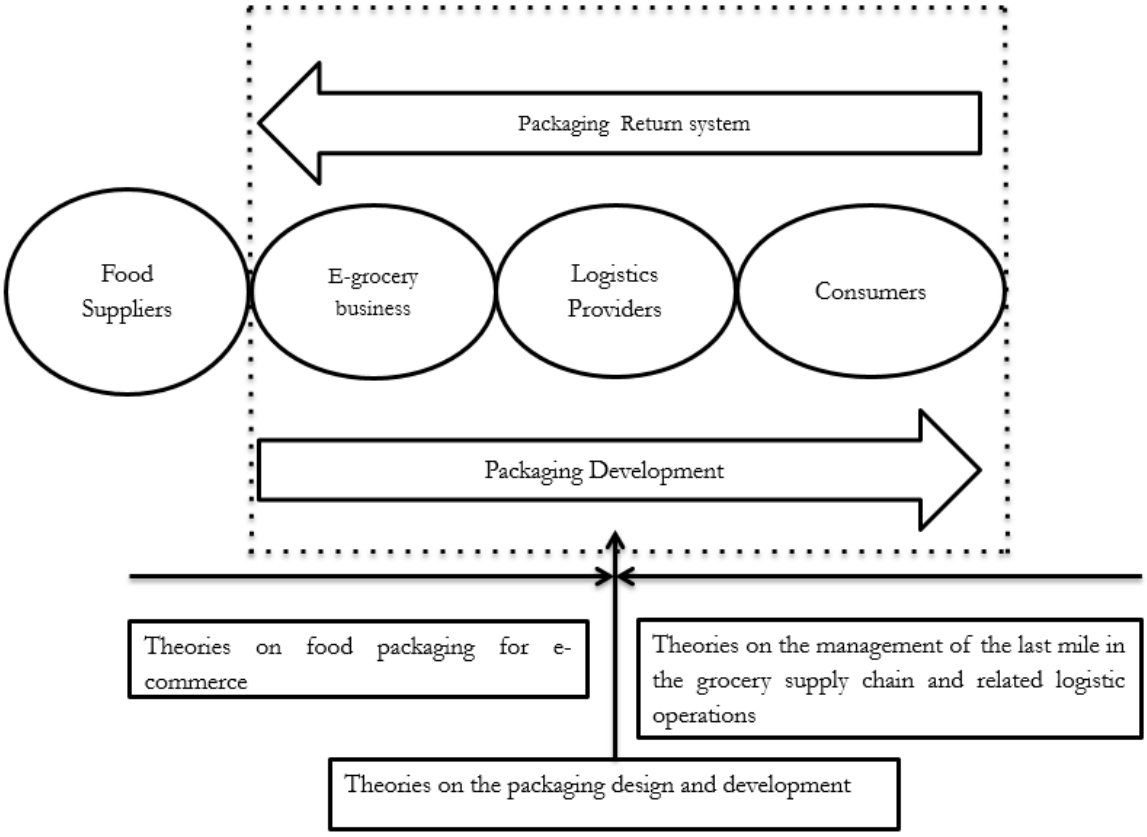

Figure 3: The supply chain and the theories frame of this thesis

3.7 Packaging solution development process

This section describes how the purpose of this thesis, which is to develop a secondary packaging solution for planned for meal grocery products that fulfil product and logistic requirements for e-commerce, was achieved. Solution design and development followed the process illustrated in figure 4. This development process aims to validate the analysis of data gathered from the case study, professionals and literature (see chapter 2), in order to strike a comparison between them and achieve both the purpose and the goal of this thesis. Finally the new solution was developed based on the current packaging system of the case study in order to apply the identified logistic and product requirements to packaging functions and featrures as feasible as possible. Chart 2 shows the three main undertaken steps along this process development, each with specific procedures and criteria.

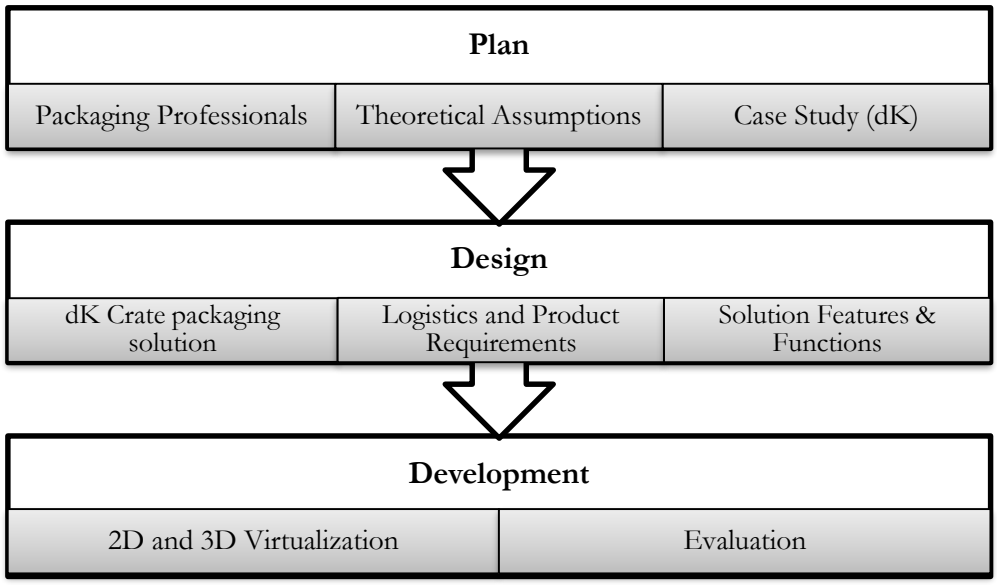

Figure 4: The solution development processes

A complete picture of the current online grocery models was sought for, in order to better map the business environment of the case study. According to (Stainback & Stainbak, 1988), a holistic description of events, procedures, and philosophies occurring in natural settings is often needed to make accurate situational decisions. Citing (Buchenau & Suri 2000): "*Experience Prototyping or in other words, the concept design is described as a form of prototyping that enables designers and users to gain first-hand appreciation of existing or future conditions through active engagement with prototypes."*

Software used to develop both virtualizations were Auto-cad for 2D drawings and Sketch-up for the 3D visualisation.

To conclude table 5 lists the analysed contents considered along the design stage of this development process.

Table 5: Different aspects for consideration during the packaging solution development phase

Packaging Features	**Packaging Functions**	**Product Requirements**	**Logistics Requirements**	**Environment Requirements**	**Marketing Requirements**
Material	Protection	Storage Conditions	Handling	Reduction	Marketing
Shape	Communication	Quality Attributes	Storage	Reuse	Differentiation
Ergonomic	Convenience	Perishability	Transportation	Recovery	Promotion
Measures	Apportionment	Hygiene	Distribution	Disposal	Value-add
Efficiency	Unitization		Return flow		Inform
Stack ability	Containment				Branding

4 Identification of Requirements for Secondary Packaging in e-groceries

This chapter reports data gathered during the pre-study, packaging professionals, and from interviewees in the case study. This data was combined and evaluated in order to lay the foundation for the design phase of the proposed packaging solution development.

4.1 Data

In this paragraph gathered data was both summarized and grouped based on the main research topics (see table 2 and 3). These topics were used as guidelines for developing questionnaires and performing interviews. The unit of analysis was secondary packaging solutions currently used in the Dutch e- grocery market. The aim of data collection was to identify requirements that need to be considered for the development of a secondary packaging solution suitable for home delivered food products.

The collected data was grouped into the following topics:

- T1: Consumers and businesses behaviour toward the online grocery shopping
- T2: Food product requirements and food-packaging interactions
- T3: E- grocery logistic and packaging logistic requirements
- T4: Features and functions of packaging suitable for online grocery shopping

Interviewees were cited with their code (see table 2 and 3) and grouped depending on topic in question.

4.1.1 T1: Consumer and business behaviour toward online grocery shopping.

T1 includes interviewees C1, L1 and dK1.

As described in section 2.2.1, consumer and retail behaviour toward e-groceries was chosen as topic in order to holistically consider what their demands are towards e-grocery shopping, rather than directly analysing specific consumer needs (e.g. packaging, branding and the deposit – return system). This approach allowed to deduce what consumer generally perceive as benefits of doing grocery shopping online (e.g. returnable packaging and foods quality). T1 includes as subtopics: retailing strategy and consumers purchasing habit.

Factors that affect both consumers and businesses behaviour toward online purchasing of groceries mainly regard the convenience aspect of e-commerce. Convenience is indirectly linked with the urbanization of grocery retailers. For instance, the supermarket density in the Netherlands is higher compared to other European countries, such as France. Thus people are more motivated to do grocery shopping daily and physically rather than one per week and over the Internet [C1]. Convenience for e-grocery business concerns the different business models employed (pure player, brick and click or infomediary) and logistics including the order fulfilment (the mega-warehouse, in-store order fulfilment, and the hybrid store-warehouse) and the delivery model (to home or pick up points) [dK1 and C1].

Grocery shopping differs from other FMCG shopping, as people demand to see and touch food products before purchase. Therefore product display is more challenging for e-grocery business than for physical supermarkets. Reputation (i.e. product quality and time delivery) is almost mandatory for a winning online grocery business [C1]. For instance pure players such as Super DiRect face more challenges to gain and maintain reputation rather than bricks and clicks (i.e. Jumbo) because consumers cannot experience and trust in products before purchase [L1]. The difference between the traditional customers' grocery basket and the e-grocery basket has had an impact on firms' sales figures: this is due to customer selectivity in bought products, and the reduced amount of impulse purchases [C1]. Therefore packaging display can add value to do grocery shopping online.

Finally, traditional grocery shopping is a deep-rooted habit difficult to rapidly change. These changes relate to personal planning of grocery shopping, picking and delivery time [C1]. Consequentially the online grocery shopping needs to provide consumers with a new experience. dK's packaging solution, the wooden crate, emphasizes a direct connection from farm to people's homes and relates freshness of offered produce [dK1].

4.1.2 T2: Food E-grocery product requirements and food-packaging interactions.

T2 includes dK2, dK1, F1, and E1.

As reported in paragraph 3.4, food packaging for traditional grocery shopping does not differ from food packaging for e-commerce in terms of functions. Since the last leg of the business-to-consumer delivery service has been prolonged, problems related to assuring food quality have risen. In this section data was gathered on food protection through packaging along the last mile. The aim was to specifically identify requirements for preserving foods. Subtopics were food protection from mechanical hazards due to transportation (i.e. the stability of fragile products) through packaging material; and from biochemical hazards linked to the control of both storage temperature and delivering time (i.e. keeping products in the cold chain until delivery to end users) through packaging solutions. Concluding, since the complex system of EU food regulations, food quality assurance is a needed along all echelons involved in the e-grocery supply chain.

The analysis of interactions between packaging materials and food is crucial to assure food safety. In the case of wood, issues arise for keeping condition (i.e. mould) rather than food interactions (i.e. splinters hazard) [E1]. In contrary to leading e-grocery businesses, small enterprises sell large amounts of fruits and vegetables rather than animal products (fish and meat) and bottled or bulky products as these cause difficulties during transportation. In order to prevent product damage, some types of vegetables requires primary packaging (i.e. plastic bag) and this can facilitate both filling and packing processes. In many cases, fragile (i.e. eggs) or scattered (i.e. potatoes) products are already packed in a primary packaging, facilitating an easier fulfilment during the packing stage, as well as reducing product damage [dK1].

Figure 5: Example of Coolant Packaging

The branding function of packaging material was discussed. For instance, although foam crates perform well in keeping food goods chilled [E1], the material use could conflict

with a brands' sustainable\nature image. Insulation materials for food packaging, including flexible plastics such as polyurethane, could be perceived as harmful to the environment [E1 and F1].

Food safety is closely linked with the control of time and temperature. For example, coolant packaging made from insulation material containing cooling elements is currently used in the Dutch e-grocery market (i.e. Vershuys.com, see figure 5), prolonging products' shelf life. To keep the cold chain along the last mile is a distinguished challenge for e-grocery because supermarkets are not the last echelons of the grocery supply chain. Refrigerated trucks might not assure the continuation of the cold chain. Cooling elements prolong chilling for few hours, yet risk creating a false expectation about removing of packaging from the cold chain because the icepack inside. Moreover, intelligent packaging that records temperature during transports and time/temperature indicators were suggested [F1].

In e-commerce, mixed loads pose other challenges for food packaging development because each food category has specific requirements. Packaging separators can help the control of temperature of each contained food category [F1]. As well as fragile product can be more protected through compartments filled with shock absorbent layers. Considering trade-offs between packaging cost and function is important: the more packaging elements the more the expenses and logistics operations [E1].

4.1.3 T3: E-grocery logistic and packaging logistic requirements.

T3 includes dK2, dK3, C1 and L1.

Based on the theoretical frame of this thesis (see chart 1, section 3.6), the management of the last mile in terms of logistic operations was analysed through empirical data. This section reports findings on transportation, delivery and return management of e-groceries packaging in the Dutch market. As described in paragraph 3.7, these contents were considered during the design phase of this thesis project. Finally the above mentioned findings were analysed from a logistics [dK2, dK3 and L1] and consumer & retailer [C1 and dK1] point of view. Again, all the logistic operations that were discussed in this section revolve around the last mile delivery management.

Centralization through the use of hubs is a key factor for food packaging logistics in e-commerce. Hubs might be located within the existing supermarkets (i.e. Jumbo), or in separate parking lots and/or e-commerce specialized distribution centres (i.e.Albert Hejin). This affects the delivery system, which in turn affects packaging logistics cost and timing [L1]. The factor that mostly affects the delivery choice is investment costs. The most frequently used options are home delivery and the pickup points. The first has

higher average spends per user and is more popular in terms of frequency. However in term of penetration the delivery is almost equal to the use of pickup. The reason is that pick up points are cheaper. For instance the delivery by Albert Hejin includes a minimum order amount of 70 €. On the other hand, the pickup points have service charges, which vary between € 4.95 and € 12.95 depending on the time slot for pick-up and purchase amount. Leading online supermarket such as Albert Heijn, use their own logistics in contrast to small businesses, which need a third party logistics provider [C1]. To conclude, distinguished point of e- vs. traditional grocery concerns the logistic of the last mile delivery in term of order fulfilment process, distribution to physical address of the end customer and transportation emissions.

Returnable packaging is a trend in e-commerce but its management remains a big issue [L1]. Data showed that when consumers are pushed there is an improved (90%) return of empty and potentially not damaged crates [dK2]. But communication between consumers and delivers has been shown to not be efficient in order to return packaging. Thus these packaging must be re bought, avoiding packaging cost saving. Discussion on social networking sites, such as Facebook, about what are consumers doing with the empty package are attempts to provoke, motivate and encourage them to return their used packaging [dK1].

A good example of successful return management is Albert Heijn, where all items for which a deposit is paid and all empty crates used for deliveries cannot be returned to the grocery retailer. When the folding crates are picked up or dropped off, Albert Heijn refunds credit to bank accounts, rather than with cash. The empty crate can be returned through three different modalities:

1. Arrange pick up crates: contacting the customer service consumer will make a pick-up appointment. To pick up the crates, customers pay the normal fees associated with the delivery time they choose.
2. Placing an order last: if consumers want to place a final order they can immediately submit all crates. The customer service will pass information to the delivery person.
3. Handing in a pickup point: consumers can submit their folding crates at one of Albert Heijn pick up point locations within their opening hours. If the pickup point location is closed, the crates cannot be delivered in the nearby shop. People can find the map of pick up points on the Albert Heijn website [C1].

Figure 6 illustrates the customer service of Albert Hejin as key figure in the return management.

Figure 6 Customer service of Albert Heijn, an actor of the return management

Nudging customers to contribute to the environmental impact through the use of returnable packaging might increase the importance of communication as packaging function [F1]. Incentives to return packaging seems to be the only way to achieve improved rates of return flow. It might include discount: paying for the next order 5€ less. A customer is more likely to repurchase at the same company because they have invested 5€ and that is something they would like to see back [F1]. Alternatives for improving the return system include scanning tags (i.e. RFID). But logistical complexity risks to be increased and margin do not match revenues [L1]. Finally, stack ability of both filled and empty secondary packaging is essential for logistic providers, as inventories that are stacked are more volume efficient. However, this is not so for consumers, as they find a packaging's brand of more importance than a packaging's ability to stack [dK3 and dK1].

4.1.4 T4: Features and functions of packaging suitable for online grocery shopping.

T3 includes P1, E1, dK1, C1, F1 and dK3.

The unit of analysis of this research was crates as current secondary packaging solution used for e-grocery in the Dutch market. Interviewed professionals and stakeholders of the case study were asked to define the distinguished packaging characteristics for online grocery shopping and potential improvements. Results were on the topics of the secondary packaging and packaging features, as defined in section 1.4.

Secondary packaging suitable for an 'e-grocery scenario' (see chapter 3) do not need to be attractive, appealing and/or product informative because consumers do not experience it before the purchase.

It must be reusable or returnable such as the Albert Hejin's solution (see figure 7), which works with a deposit of 6 € per crate, this amount is detracted from the bill when consumers return it [C1].

Figure 7: Current Packaging solution by Albert Heijn for e-commerce

The online delivery often requires that orders are packed in a transportation packaging, resulting in a more consumption of packaging. For example, Amazon resolves this challenge by utilizing Amazon certified frustration-free packaging, where suppliers pack orders into specially designed packaging, directly at their facilities. This means that consumers receive products that avoid excessive packaging, as they are found on store shelves. The example below highlight the improvements Fisher Price made when designed a frustration-free packaging option for their product [E1].

Figure 8: Frustration-free packaging, reducing one level of packaging

Customizing orders through packaging is another distinguished point of e-groceries. Packaging separators are an example: even the risk of losing inside space they allow to predetermine slot sizes for dividing food categories. Flexible separators could expand the product portfolio i.e. bottled beverages and sauces, as they keep bottles away from the fragile produce. Finally the picking process of different food categories for mixed loads can be facilitated by colouring the separators [F1]. Commonly people purchase grocery online on a weekly basis. These groceries are of high quality and large quantity. dK needs to minimize the risk to provide crates that appear empty [dK1].

4.2 Data Analysis

Section 4.1.1 shows that in both delivery models, home delivery and the pickup points, consumers perceive online grocery shopping as convenient due to the reduced distance between them and their order. This perceived convenience depends on urbanization (large or small municipality) and is related to the grocery store density of that area. In the Netherlands, the number of supermarket has grown into over saturation, risking the decrease of e-grocery orders. In order to boost end-users' perceived advantages, e-grocery firms need to increase reputation and customer experience. People are likely to buy food products different from those findable in traditional grocery store (i.e. seasonal, local, homemade, organic, natural etc.). Activities such as planning time window and location of the delivery and receiving the deliver at home are changing people's habits of doing grocery shopping, proving customers with a unique experience. The used packaging by dK empathizes the 'food from farm' product strategy of the firm. This insight is interesting for comprehending consumer demand, and motivate the decision of improving the current dK wooden crate rather than completely changing it.

Section 4.1.2 stresses the importance of food quality assurance. Food supply chains are more complex to manage than other FMCG supply chains because of food's perishability. Basic food requirements for both traditional and electronic grocery purchases do not differ from each other. They mostly are: the control of time and temperature along the supply chain, and the prevention of damage and deterioration (mechanical and/or biological) due to food and packaging material interactions.

In the last mile of the grocery supply chain, temperature control and the prevention of hazards must be assured until the food products arrive at consumer homes or pickup points. Other challenges for designing a secondary packaging suitable for e-groceries regard fulfilling specific requirements of different products in a mixed load, in one single solution. Analysis of the currently used food packaging solutions for the e-grocery sector in the Netherlands was performed. Results showed that coolant packaging made from

insulation material and cooling elements are the most used solutions but can be misleading because this type of solution only works for a few hours, when products have been removed from the cold chain.

As part of this topic-analysis it was also seen that logistics affect profits, strategy and type of offers (food product and delivery service) of e-grocery businesses. Main logistics operations that affect profits and cost saving are: fulfilment and delivery of orders; the hub and spoke network (centralize and/or dedicate or in-store hub); and the type of partnership with logistics providers (third party or own delivery fleet). Packaging return management is also dependant on logistic provider.

Seeing that the complete return of wooden crate return flow is not achieved in the dK packaging logistic system and dK purchases new wooden crates monthly (the 30% of the entire flow), an analysis of the customer retention was performed. The results of this analysis showed the need of customers to be incentivized in improving their returning behaviour. The deposit refund system is a solution that currently seems to be efficient (i.e. depot crate of Albert Heijn).

The last analysis aimed to define features of secondary packaging solution for e-grocery that fulfil the found product and logistic requirements. The results of this analysis revealed that the solution does not need to be appealing or informative because people experience packaging after the purchase. Consumers recognize the environmental value of packaging material, neglecting a material's function. For instance even though insulation materials assure product freshness of chilled goods, they are not accepted as environment-friendly. Another aspect is that the display of different food categories with in the packaging improve both the fulfilment during warehouse packing, product protection and brand recognition.

4.3 Analysis Summary

In this paragraph data that has been derived from both primary and secondary research were compared in order to assess their coherency and to identify similarities between the two.

The findings of both empirical data, as shown in the red box, and theoretical assumptions, as shown in the blue box, can be found in figure 9. Similarities are listed in the purple box.

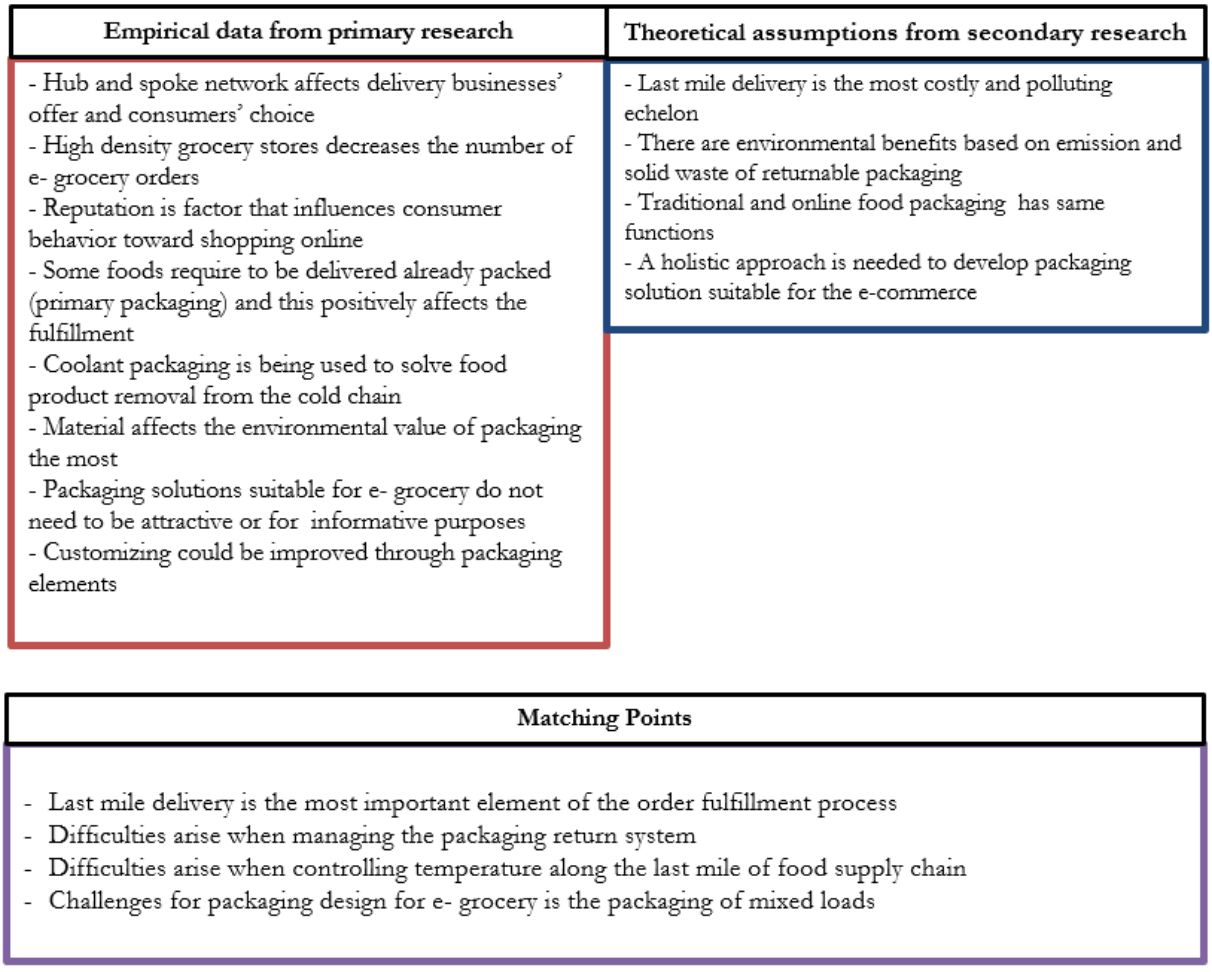

Figure 9: Packaging requirement findings from empirical data, literature and theoretical assumptions

By analysing the matching points between theoretical assumptions and empirical data, requirements were identified, which were used to develop a secondary packaging solution suitable for home delivered e-groceries. Although several aspects were considered during the data collection, in the continuation of this thesis, identified requirements concerned logistic and food products. To be exact, the identified logistic requirements are: order fulfilment, transportation, delivery and the return system. As well as product requirements, referring to both food protection, in terms of controlling storage temperature related to delivery time, and protection from mechanical hazards due to transportation. Other requirements, such as marketing and environment were partially considered. For instance environmental benefits were considered as an indirect effect of returnable packaging. This identification allowed to focus only on logistic and food product aspect in order to develop the most promising secondary packaging solution suitable for e-groceries during the case study, of which the explanation follows in the next chapter.

5 Empirical Findings at deKrat

In this chapter, the case study is further explained. Firstly, a company overview provides more information of the company itself, the products sold and the packaging they use. After this, the supply chain is depicted and the stakeholders' roles are noted. The aim of this chapter is to analyse the packaging and supply chain used currently by dK in order to identify strengths and weaknesses of their secondary packaging solution. Further, a packaging logistics interaction chart and a packaging scorecard were used as a tools for this analysis.

5.1 The Company

In the last five years, dK has grown from providing home delivered food crates for a small region in Amsterdam, to a national provider of home delivered meal crates. dK differentiates itself from the competition by sourcing all its high quality produce within the Netherlands. All 54 of dK's suppliers are within the Netherlands, thus within 250 kilometres of their distribution centre in Zoetermeer. "De Krat" literally means "the crate", therefore its packaging constitutes as its main branding tool and provides to consumer a rustic and cosy experience which is the unique selling point on which the business thrives. More information on the company's background and organisational hierarchy can be found in the annex 9.2.

5.2 The Product

dK supplies four crates: the convenience, weekend, the weekend extra, and the weekend vegetarian crates, respectively called Gemakskrat, Weekendkrat, Weekendkrat Extra, Weekendkrat Vega. The Gemakskrat is only available in Amsterdam, The Hague, Utrecht and Haarlem. The three weekend crates are available for purchase and delivery throughout the Netherlands.

The crates contain local and seasonal food ingredients including a recipe booklet and are delivered to peoples' homes. People are thus informed of what and how much food

products they received, and what they can prepare with this amount. The crates contain ingredients for three to ten meals for one to four persons, depending in on the type of crate that is ordered and the specified amount of people, respectively. The suppliers working with dK are all located within the Netherlands and provide seasonal, organic/biological products, including dairy, meats, fish, vegetables and fruits.

Table 6: Comparison of crates types, amount of recipes, extent of delivery and cost

Crate type	**#Recipes**	**Delivery**	**Persons**	**Cost (€)**
Convenience Crate	3	Cities	2	37
			3	47
			4	57
Weekend Crate	8	Nationwide	1	30
			2	37
			3	47
			4	57
Weekend Crate Extra	10	Nationwide	1	34
			2	44
			3	56
			4	70
Weekend Crate Vega	6	Nationwide	1	30
			2	37
			3	47
			4	57

5.3 The Supply Chain

Due to strong growth in the last five years, dK decided to outsource all their logistics to Leen Menken (LM). This has allowed dK to ship their product to a national level. LM provides inventory, picking, packing, and shipping and return logistic services and is located in Zoetermeer (south-west of the Netherlands). As informediary, dK collects the customers' purchase order and specific choosing of the delivery time window and location. Thus dK informs LM on what time the crate must be delivered, including a 30 minutes of gap for possible errors. In addition, dK has one pick up point in Amsterdam, at the headquarters, where customers can both pickups their orders and return previously used crates.

The supply chain of dK is depicted below in figure 10. It describes all logistical processes, outsourced by dK to LM Foodservice Logistics. Three large incoming products streams are present: food suppliers, wooden crates and purchasing orders. The latter is an information stream containing order information, including date of purchase, desired delivery window and address of the customer. LM compiles this information, after which transportation routes are made for the drivers.

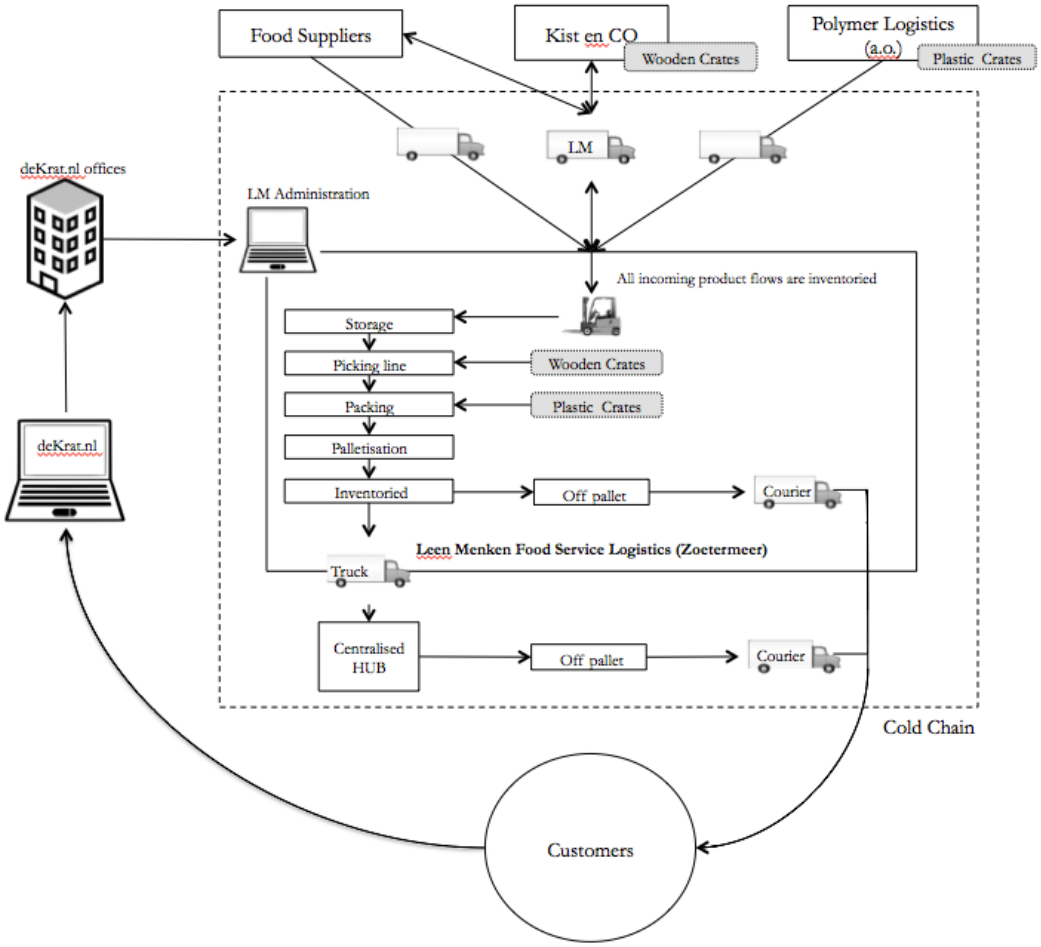

Figure 10: Supply Chain of dK

The incoming food produce is stored in a chilled inventory. The produce comes in throughout the week from fifty-four different food suppliers/farmers/wholesalers, of which a list can be seen in annex 9.3. Once inventoried, food products are stored until the correct day for picking and packing, i.e. one day before shipping to customers.

At the picking and packing station, the boxed produce is placed on a shelf (top shelf) with rollers. The rollers allow gravity to move boxes from the back of the shelf, where they are fulfilled, to the front of the shelf, where the picking occurs. This shelf has 15 slots, each design to accompany one product, from one supplier, to be picked and packed. At the front of the top shelf, there is a conveyer with rollers whose direction is perpendicular to the top shelf. It is about 30 cm lower than the top shelf, and is where the wooden crates (from left to right) are filled and moved towards the next step. A different picker handles each specific product. One must remember that the picking and packing occurs according to the orders provided by dK, and that there can be four possible crates, in four different sizes. After the wooden crates have been filled, they are placed within a foldable plastic transportation crate, with the dimensions 600x400x280mm. These transportation crates are placed onto half pallets for which they are designed, organised per delivery location; two crates per layer, four layers high. The pallet is put in shrink-wrap, and with the use of a fork truck, the pallet is placed into a temperature-controlled van and either sent to the customer, or to a distribution hub.

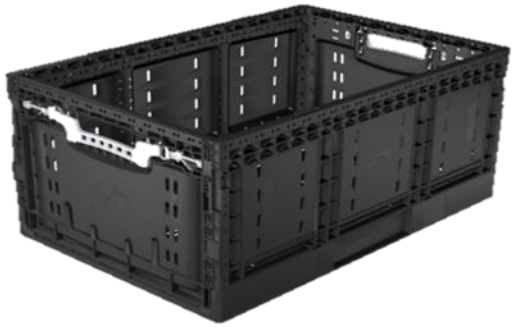

Figure 11: Transportation packaging used by Leen Menken Foodservice Logistics

When at the customer, the driver has the following tasks:

- Take the plastic crate containing the wooden crate out of the truck
- Take the wooden crate out of the plastic crate
- Fold the plastic crate, place it back in the truck
- Deliver the wooden crate to the customer, ask for the old crate back
- Place wooden crate in the truck
- Go to the following delivery

When the driver returns to LM, the foldable plastic transport containers and wooden crates are inventoried. The plastic crates are put back with the other plastic crates. The wooden crates are returned to the stockpile of wooden crates remaining at LM.

5.1 Current Packaging

Kist&Co (KC) is the packaging supplier of dK. It is a company specialized in providing packaging made from wood for the transportation of fruits and vegetables and located in Ridderkerk in the western Netherlands. After production, which happens in a just-in-time fashion, the crates are placed on a pallet and shrink-wrapped as to stabilize them. Once on pallets, they are picked up by LM and stocked at the LM's distribution center (DC) in Zoetermeer.

Table 7: The Current packaging solutions used by dK

Crate Name	Dimensions (mm)	#Persons	Image
Tomato	400 x 300 x 95	1 person	
Radish	400 x 300 x 160	2 persons	
Pear	500 x 300 x 200	3-4 persons	

Depending on the quantity of food purchased, the packaging dK uses for customers varies in size. The three packaging types used differ in size, and are given the following names and have the corresponding dimensions: Tomato (600 x 400 x 160 mm), Radish (400 x 300 x 160 mm) and Pear (500 x 300 x 200 mm), which are used for one, two and three/four persons respectively. The packaging is made of wood, and has a lifespan of around three months, yet this depends on the frequency of reuse and how customers handle the crates.

5.2 Analysis of current packaging system

This paragraph shows results of the analysis of dK´s current packaging system. This analysis was performed through observations, in deep interviews, packaging logistic activities interactions chart and the packaging scorecard.

5.2.1 Packaging Levels

As described in paragraph 5.4, there are three main types of packaging used: the wooden crates supplied by KC as secondary packaging for the food products, and the plastic crate used as transportation crate provided by LM, and as tertiary packaging, EUR pallets used for solely transportation. However the wooden crates are subject to analysis. The reasons for this are twofold: the larger amount of gathered data and they are the most handled packaging along this supply chain, as it has the most interactions with logistics activities (see section 5.5.2). Further in depth interview with the CEO of dK reported that performance of the Pear crate is not satisfactory. This due to its inability to consistently contain the correct volume and weight of products.

5.2.2 Packaging and Logistics Interactions

Packaging and logistic interactions occur in all supply chains, yet they are not always efficient. In table 8, the packaging and logistics interactions can be seen

The need for a transportation crates (foldable plastic crates in which to place the wooden crates for transportation) increases: the amount of interactions the wooden crate undergoes, the amount of time that is needed to complete an order and the delivery time, as a lot of proceedings are needed at the customer to complete a delivery.

Table 8: Packaging Logistics Interactions Chart

Supply Chain Members	**Suppliers**	**LM**						**Customer**	**LM**		
Logistical Processes	Transport	Receiving	Storing produce	Picking and packing	Packaging	Shipping	Transport	Delivery	Return	Transport	
Packaging System											
Primary Packaged Foods	x	x	x	x	x						
Wooden Crate	**x**	**x**	**x**	**x**	**x**			**x**	**x**	**x**	
Plastic Crate	x			x	x	x	x	x	x	x	
EU pallet						x	x	x	x	x	

5.3 The Packaging Scorecard

Results from the packaging scorecard can be seen in the figures 12, 13, 14 and 15. This data was gathered from the three major stakeholders in the supply chain; dK, LM and KC. From this, the wooden packaging's performance in certain packaging characteristics can be derived, and a total packaging score can be given. The weight of importance represents the importance of that specific characteristic to that stakeholder. 0 is of no importance, 100 is extremely important. The data provided is also colour coded, according to the performance of the packaging in the specific criteria: red, orange, yellow and green respectively represent not approved, approved, well approved and met excellently.

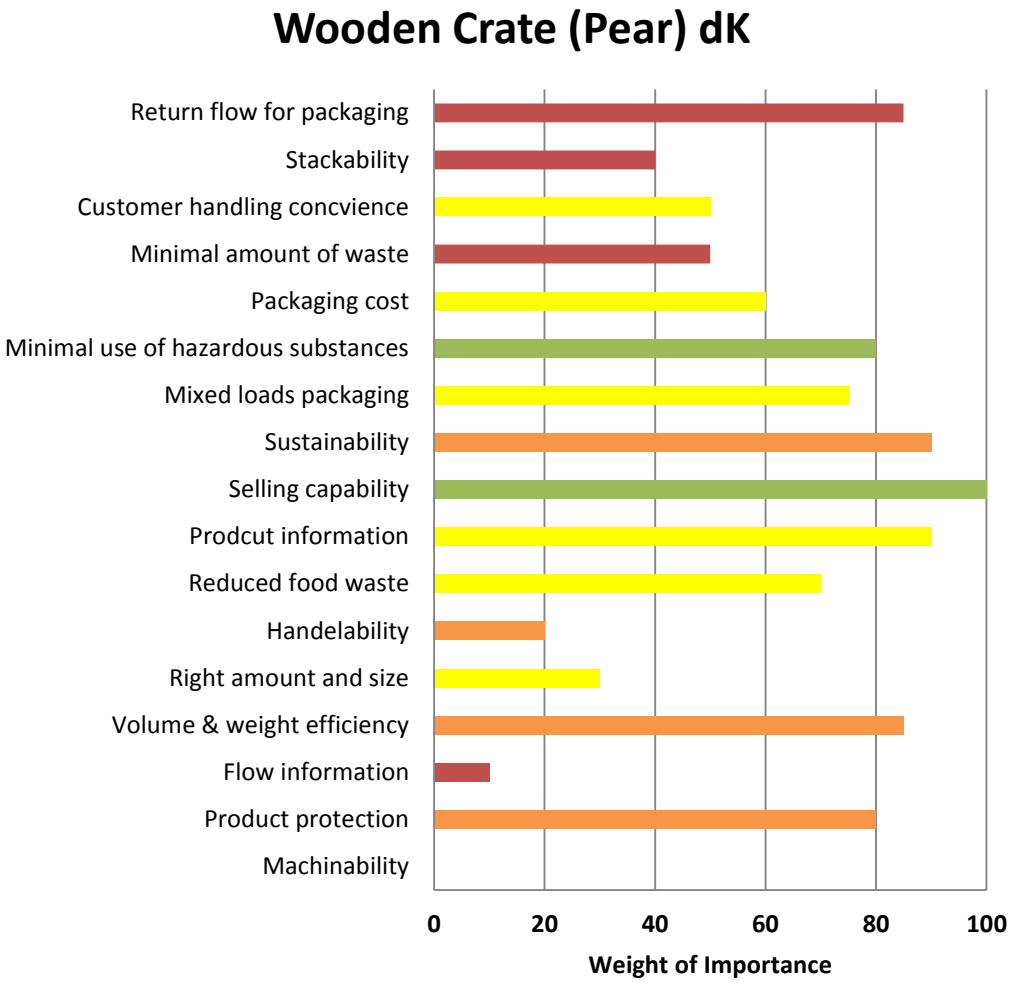

Figure 12: Packaging Scorecard Results from deKrat

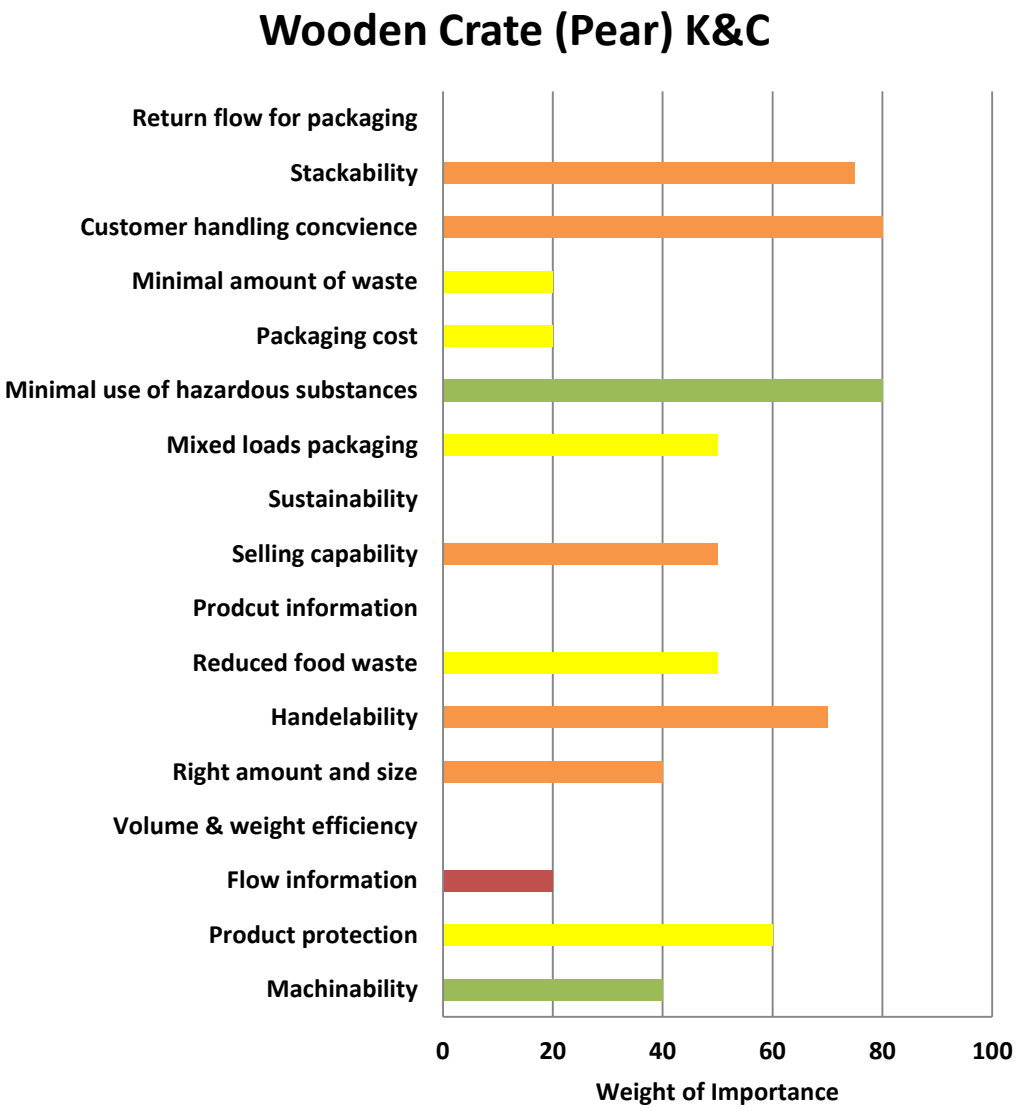

Figure 13: Packaging Scorecard Results from Kist en Co.

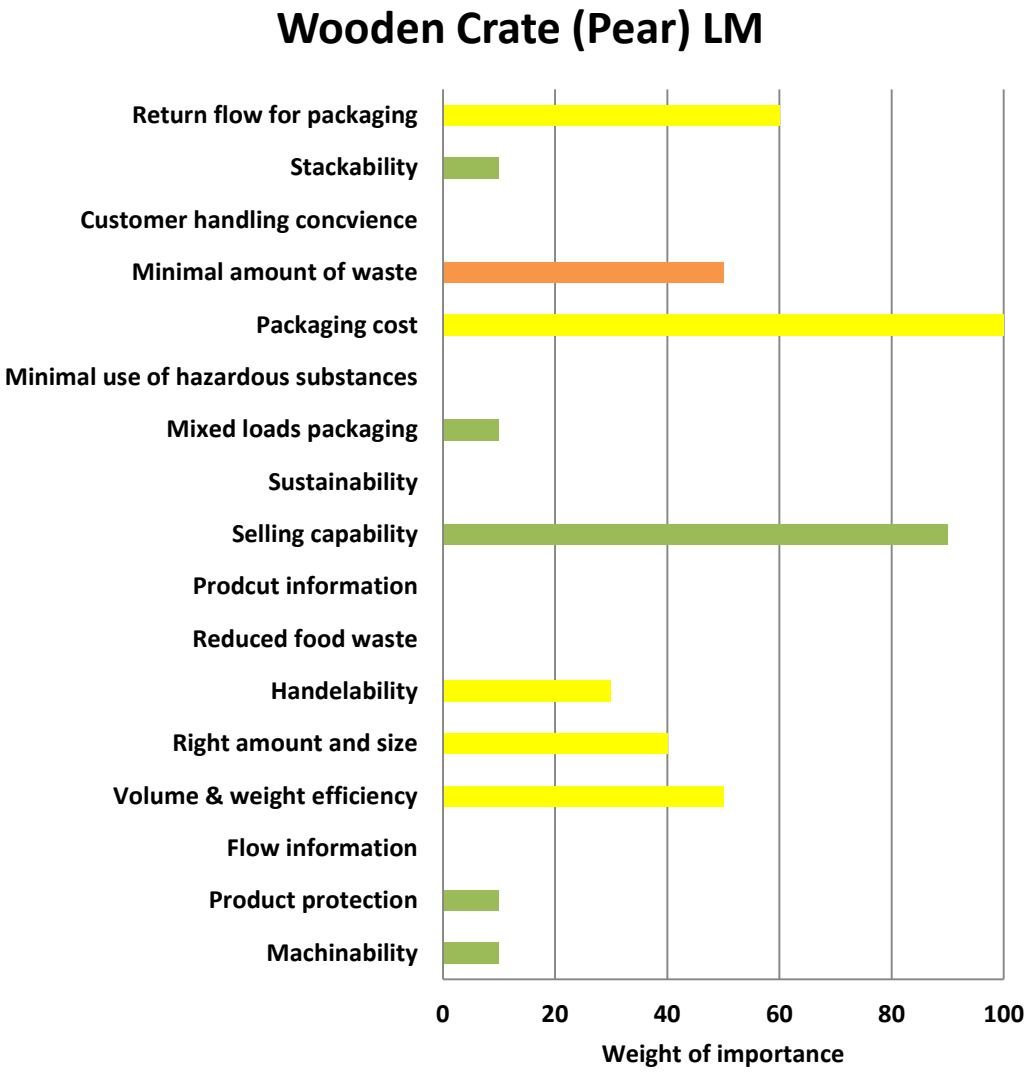

Figure 14: Packaging Scorecard Results from Leen Menken Foodservice Logistics

The results show room for improvement. A threshold for selection criteria was set. This threshold was a minimal weight of importance of 40, and a performance ranking of "not approved" and "approved" (red and orange respectively).

The wooden crate (pear) used by dK performs insufficiently on the criteria: return flow of packaging, stackability, minimal amount of waste, product protection and right volume and weight. The former three relay back to logistical issues of the wooden packaging level.

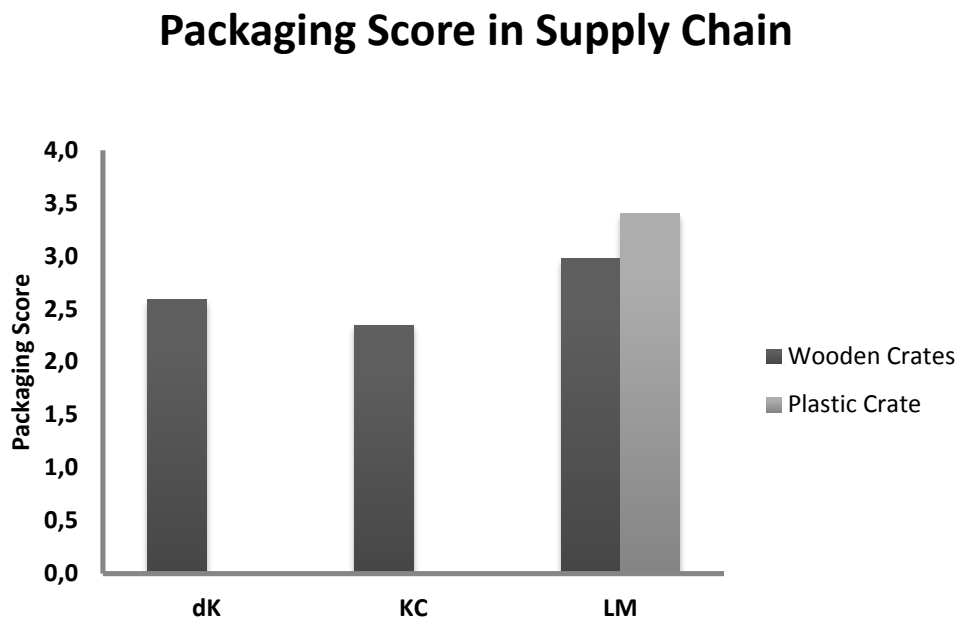

Figure 15: Packaging Scorecard comparison for dK, LM and KC

As can be seen in figure 15, the packaging's score is different for the three major stakeholders. The packaging is perceived as better performing by dK and LM, than it is by KC.

5.4 Packaging Strengths and Weaknesses

The selected criteria in which that packaging insufficiently performed during the packaging scorecard analysis are explained in this paragraph.

5.4.1 Strengths

The most important part of dK's packaging is the crate itself, including the packaging shape and material, both useful in the companies branding strategy. Wood as material and the crate shape are packaging characteristics, which differentiate dK's brand and is perceived by customers as environmentally friendly. The use of e-commerce allows for easy food track and traceability, as the suppliers can easily be found online.

5.4.2 Weaknesses

5.4.2.1 Return Flow

Customers are expected to return the wooden packaging after use. The truck drivers should ask the customer for the old crate, which are then returned to LM. In reality, this doesn't happen optimally. Miscommunication between customers and deliverers could be the reason for this, resulting in packaging not returning to LM. Another explanation for this could be the lack of information on the packaging, or incentive for the customer to return the packaging. Because of this limited return management, new packaging is bought from KC two times a month. Finally the crates have quite a long life, and their replacement is required when they are dirty or broken. Forum-discussion on social network such as Facebook about what are consumers are doing with the empty crate are attempts to provoke and push them to give back the empty crates.

5.4.2.2 Weight, Volume and Size

The wooden crate doesn't perform optimally at all times. When used for three persons, it appears empty but when used for four persons, it can be overly filled. The crates' weight and volume change every week: from very heavy (i.e. within potatoes and juice/ yoghurt) to light (salad, fresh fruits etc.). Although a maximum kg per load is present, there is no average weight and volume per crate. Because of the ever-changing produce inside the crate, the weight and volume distribution is also always changing. Challenges arise when special occasions such as Christmas or Easter because the increased amount of products that each order contains as well as the type of products (i.e. bottle of Prosecco).

LM's use of transportation crates poses a volume issue. The amount of transported air, as can be seen in table 9, is very high due to the use of this crate. This is because of the large difference in dimensions between the wooden crates and the transportation crate.

Table 9: Volume Comparison and amount of transported air per crate type of dK

Assumption: Crate is 100% full 100% of the time						
	Dimensions (mm)					
Crate	L	W	H	V (m^3)	Transported Air (m^3)	%air
Pear	500	300	200	0,0300	0,029	49
Radish	400	300	160	0,0192	0,040	68
Tomato	400	300	95	0,0114	0,048	81
LM	572	372	278	0,0592		

5.4.2.3 Stackability

The ability to stack the crates, is in both cases; empty or full not present. The crates aren't stackable because they aren't made to stack when filled, and the food products can extend past the dimensions of the crate. For example when the crate contains a bottle of yogurt, the crates can't be stacked seeing that the height of the bottle is larger than the height of the crate.

The crates' lack of stackability when full, also poses a problem during delivery. The delivery of the dK crates takes quite a long time because the crates are packed within the foldable transportation crates of LM (28cm high). Each delivery requires the delivery man to take a LM crate, put it on the ground, take out the DK crate, fold the LM crate, put this back into the truck, walk to the door to deliver the DK crate, receive an old DK crate, and put this back into the truck. It's very important the delivery is performed correctly, as consumers are very critical about this aspect.

5.4.2.4 Product Protection

In relation to the contained food products, there is the possibility of product damage. Fragile products such as eggs are liable to mechanical damage due to vibration or inter-product damage during transportation. This inter-product damage can also be related to the difference of dimensions between the two packaging types, wooden / transportation. The pear crate has 7.2 cm of room in the length and width when placed in the transportation packaging. During transportation, this could allow for the building of speed during the transportation vehicles' acceleration or cornering, subjecting the wooden crate to collisions with the transportation crate.

Produce that is placed closer to the cooling mechanism of LM's chilled transport vehicles can obtain freezer burn, to which vegetables are very sensitive. Because the mix of food products (meat, fish, vegetables and dairy) the storage temperature needs to be differentiated. At the moment an average storage temperature is used for all of the products during transportation.

The presence of bulky products, such as oil, juice, yoghurt and beer in dK's product assortment make the location of products in the packaging important, as these could cause damage to more fragile products.

5.4.2.5 Packaging Material

In relation to the packaging material, the crates sometimes break. If they break, there is an increased risk of the presence of splinters, which could potential enter the food products, causing both mechanical and biological damage. If the crates aren't taken care of at the customers' home, mould can start growing on the wooden crates. Crates can be affected by mould if they are kept outside or subjected to moisture.

Most of the products supplied to dK are void of a primary packaging in order to have a 'from farmer' appearance. Some food products must be packaged during storage and transport, and are therefore supplied in a primary packaging. Consumers are refracted to the use of plastic bags (i.e. MAP) and because of this, dK tried to minimize the amount of plastic used. A previous attempt to use paper bags was not successfully due to the presence of moisture, making the bags soggy by the time they arrived at customers' houses. Products that are packed in plastic include bok choy, fresh herbs and some salad types. The primary packaging material depends on the food suppliers, and how they pack their products.

For example, for the packing of the potatoes, there is a demand to deliver them already packed. This saves time during the picking and packing step. Finally the primary packaging solutions could be plastic or paper bag but is not the dK's final decision. dK is mostly concerned with facilitating the fulfilment process at LM. Although asking food suppliers to use primary packaging for the products is more expensive, yet it might be time saving during logistics.

5.5 Summary of Packaging Scorecard

The relation between the underperforming packaging criteria and the related problems can be seen in table 10.

Table 10: Summary of the pear crate's weaknesses and the problems related to this

Characteristic for improvement	Related Problems
Stackability	Transportation crate needed due to crate instability Increased Delivery Time due to many handlings
Product Protection	Vibration during transportation Inter-product damage during handling and transportation
Volume Efficiency	High percentage of air transported Surplus room can lead to product damage
Packaging return Management	Packaging is Returned too little Requires investment in new packaging
Packaging Material	Wood is sustainable, yet not so durable Susceptible to moisture and mould damage

6 Solution

In this chapter the most promising secondary packaging solution for the implementation in dK's packaging system is presented. The idea of said solution was generated through the identified product and logistic requirements and the recognized problems of dK's current packaging system. The aim of this chapter is to describe both the proposed secondary packaging solution and motivations and modality of its development.

6.1 Requirements and Problems Alignment

The identification of requirements and the problems recognition of the current packaging system of the case study is reported in chapters 4 and 5 respectively. This was the foundation of the packaging design phase of this packaging solution development process. Identified requirements were combined with recognized problems of dK's packaging system in order to define which packaging features the proposed solution must have for consequentially fulfilling the requirements and solving dK's packaging related problems. Table 11 illustrates the identified requirement (see chapter 4) that the proposed solution must fulfil.

Table 11: Representation of the identified requirements for developing secondary packaging solution for e-grocery

Product	**Logistics**
Consider the packing of mixed loads of different food goods, and/or primary packages and interactions amongst them	Consider the way groceries are delivered to consumer
Temperature control over time essential for product quality assurance	Facilitate the packaging fulfilment
Protect fragile products from mechanical damage	

The above listed requirements were aligned with the recognized characteristics for improvement (table 7) of dK's packaging system, which are:

- Return logistics of crates;
- Temperature control system along the home delivering;
- Protection of food products in term of mechanical damage and interactions among them (the mix load); and
- Discomfort of logistics operations (i.e. fulfilment of the crates and/or of the trucks) due to the current crate's features.

The alignment of both empirical findings allowed to define characteristics that aid the proposed packaging solution to meet identified logistic and product requirements. Table 12 summarizes the process of data alignment and deduced packaging features, which will be further will be explained more in detail in this chapter.

Table 12: Identified packaging weaknesses with ideated resolutions

Problems at dK	**Requirement**	**Proposed solution feature**
Improper storage temperature control over the delivery link	Product	- Time Temperature Indicators - Insulating packaging material (EPS)
Mechanical damage due to transportation and interactions among different products	Product	- Shock absorbent packaging material (EPS) - Product Separation with the packaging
Uncomfortable fulfilment process (time and operations)	Logistic	- Predesigned fulfilment areas within the packaging
Delivery and delivery proceedings	Logistic	- Removal of Transportation crate - Increased supporting surface of packaging
Improvable volume and area efficiency during transportations	Logistic	- Remove need for transportation crate - Stackable crates trough the introduction of interlocking separators
Defective return flow of the used crate	Logistic	- Deposit Refund System

6.2 Brainstorming

The idea generation focused on assessing which type of solution best addressed the weaknesses of dK's packaging and fulfilled the identified requirements. Brainstorming and sketching, which are defined as powerful creative techniques employed in the early design process (Herring et al., 2009) were used during this stage. The aim of brainstorming was to design a packaging solution for dK.

Sketching (Palus & Drath, 1993) was the technique mostly used during the design phase. In this phase, graphical interactions and 3D design software was used to design and virtualize images, and to combine the non-structured information in order to explain the proposed packaging in term of functions and features. In addition, other used tools for idea brainstorming included web-based applications (i.e. the NVC's Twitter platform and the forum of the NVC International Working Group of Web Retail Packaging) that enabled the exchange of ideas. Finally interviews with packaging professions (see chapter 2) provided useful inputs in ideating.

However, the option of completely changing the current packaging solution was rejected because the agreement between dK and its packaging supplier, KC. In fact all the suggested solutions were aligned with the KC's production line and packaging range.

Ideas were selected, and they were filtered, evaluated and either accepted or rejected. The sections below further explain possible solutions and the reason for their rejection.

6.2.1 Plastic crates

The implementation of plastic crates was considered. Plastic crates are a stronger, more durable packaging solution. Their use as packaging solution in the e-grocery sector is frequent. For example, they are used by companies such as BeeBox (figure 16) AmazonFresh, and Albert Heijn.

Figure 16: The plastic crate used by BeeBox

Because the packaging would be new in the case study's supply chain, they could be designed to best fulfil both logistic and food product requirements. Their design could facilitate the packaging return system, due to their durability and washability. If the packaging was designed to be collapsible, nest-able, or stackable, the packaging could make the transportation packaging used by LM unnecessary, reducing both the amount of transported air and proceedings needed during delivery.

However, there are two main problems leading to this solution's rejection. Firstly, there is a high investment cost. Current packaging would have to be discarded and new packaging would have to be bought. Secondly, a plastic crate does not comply with the branding strategy of dK, as its look and feel don't resemble the "from farm" image.

6.2.2 Mushroom Packaging

Mushroom packaging, produced by Ecovative Design is a high-performance, cost-effective and sustainable material in comparison to plastic. The packaging material is 25% fungi, with a minimum width of 1.9 cm. The use of fungi in to create packaging would be a promising solution, as it can be moulded into any shape, is biodegradable, compostable, and a sustainable alternative to plastic.

Figure 17: Mushroom Packaging made by EcovaticeDesign

Both the fact that the packaging material is not FDA approved for direct contact with food products, and that this packaging material is only in production in America make a possible solution that must be rejected for further evaluation.

6.2.3 Addition of a lid

If a lid were to be made, the stackability of the crates would improve. Food products are also better protected from mechanical damage from above. The material that would be used for the lid would be plastic. A lid would be difficult to place on the current packaging, as it is not designed for a lid. These last two characteristics, material and function, deem the lid a negligible solution for further elaboration.

6.2.4 Packaging tracking technology

Using packaging tracking solutions could improve return logistics management for dK. Keeping track of packaging could solve the solution of losing packaging, thus reducing the need for packaging to be continuously bought. Yet for dK, this would be a cost inefficient solution, as the average price for both the RFID tags or barcodes together with the IT system and hardware to handle them is high. Moreover, the current volume of sold crates is not enough to provide an interesting return on investment.

6.2.5 Coolant Packaging

The use of coolant packaging could be implemented to ensure that produce is kept at the right temperature during the last mile. Coolant packaging as explained in section 4.1.2 can be placed on top of the food products, keeping them cold when out of the cold chain. Yet this packaging feature can create a false image, as its use has some drawbacks. Coolant packaging can only cool products for a certain amount of time when placed outside of the cold chain. Coolant packaging, when used, is frequently at a temperature below zero, meaning it can cause freezer burn on produce. The presence of moisture due to condensation on the outside of the coolant packaging is also not preferable. For these reasons it was rejected.

6.3 Solution Description

The proposed solution is an improvement of the secondary packaging used by dK, to be exact, the crate named dK Weekend crate (crate model Pear). This proposed solution integrates three strategies: packaging, logistics and product. Respectively, the new solution makes use of: two interlocking separators, the deposit-refund system (DRS) and the time-temperature indicator.

It aims to improve the stack-ability and the fulfilment of dK's wooden crate and prevent food products from mechanical and biological hazards. These criteria were chosen after the analysis of the packaging scorecard compiled by dK (see chapter 5). This solution development includes its design and virtualization but excludes its mock up because the project's time restriction and the lack of a close collaboration with a packaging supplier suitable to carry it. However interviews and observations with the LCA Centre and the DS Smith allowed defining packaging material characteristics and specifications. As well as the consulting with the Wageningen University of Agro technology and food sciences, subdivision of Food quality and Design allowed to set features and measures of this solution in order to protect the content of the crate

6.3.1 **Separators**

Packaging dividers for separating food products within the crate are comprised of two axially linked separators. These are packaging separator sheets (also called layer pads or tier sheets) that have been recognized and used by many leading food-packaging manufacturers. Each separator is formed to have preselected measures (length x width x height), are placed perpendicularly in the wooden crate. The separator sheets are manually handle-able and fitted in the crate by a picker on the picking line at LM. They form a 90 degree angle, as to increase the supporting surface for crates to be stacked.

Figure 18 illustrates a 3D representation of the separators and the resulting wooden crate.

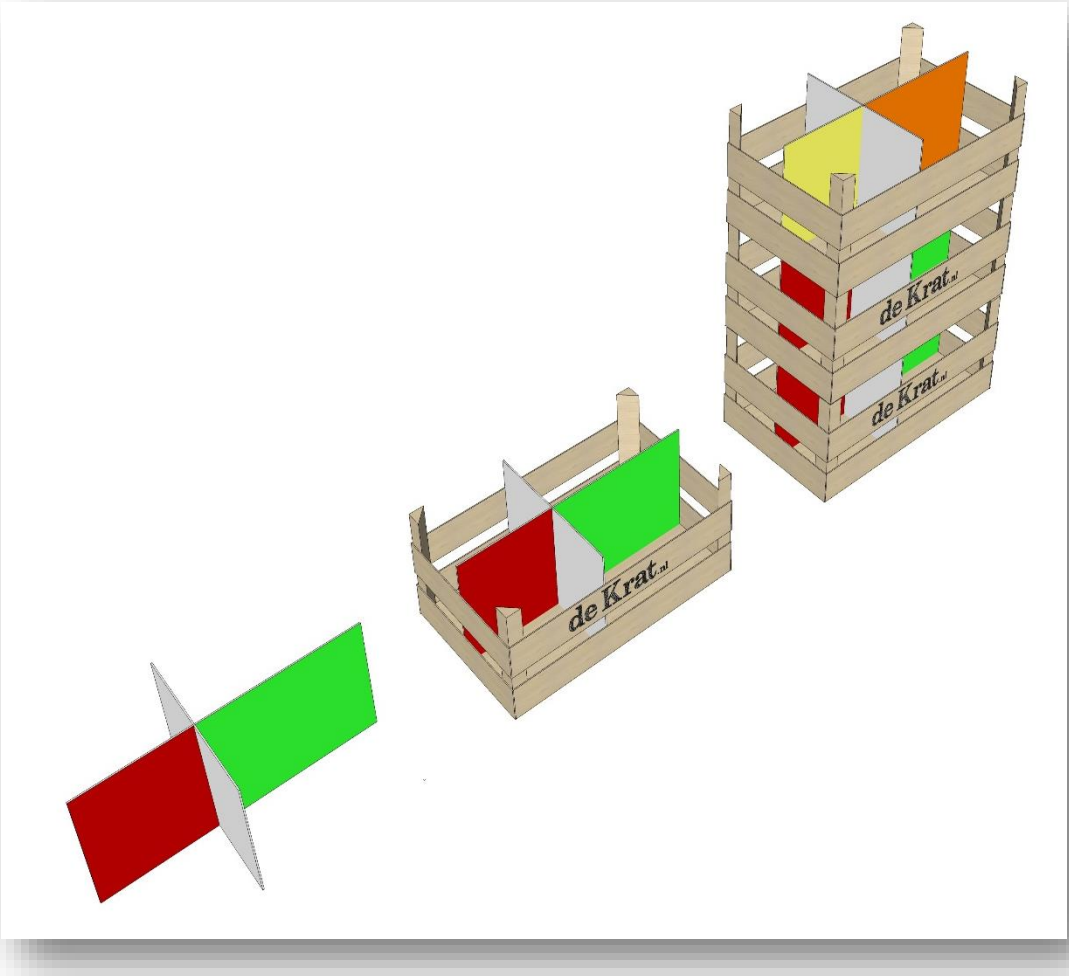

Figure 18: 3D virtualization of the separators in the dK crate

6.3.2 Measure of the Separators

The measures of the two separators are illustrated in figure 19 and table 13.

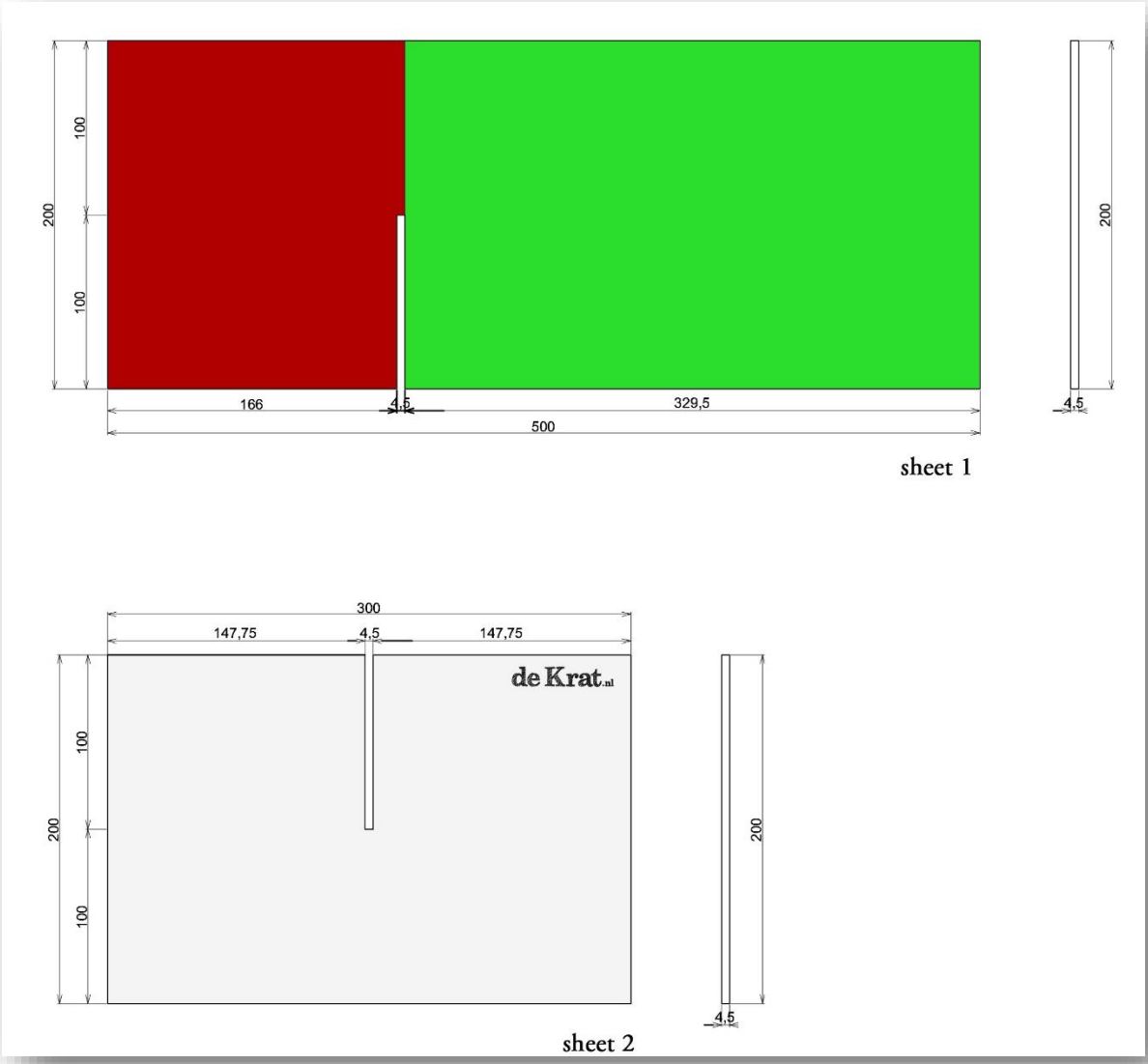

Figure 19: Measurements of the separator sheets

Table 13: Dimensions of the separator sheets and created spaces for produce

Separators	Dimensions (mm)		
	Length	Width	Height
Sheet n.1	500	4.5	200
Sheet n.2	300	4.5	200
Split (same for both sheets)	4.5	4.5	100
Red compartment	166	147.5	200
Green compartment	329.5	147.5	200

The method of separating food products positioned within the crate depends on volume and quantities of the produce. Vegetables and fruit occupy the higher volume and unit numbers within the crate and they have irregular shapes. In order to facilitate their positioning, the slit in separator sheet n.1 is positioned at 166 mm (one third of the length of the separator) from the edge of the crate. Creating four compartments of two different shape and dimension. All compartments are rectangular, the smaller compartments are 166 x 147.5 x 200 mm, and the larger compartments are 320,5 x 147.5 x 200 mm in size. In addition the different compartments are colour coded (green, orange, yellow and red), which is printed on the surface of separator sheet n.1. Table 14 provides the colour legend for the positioning of different type of food goods:

Table 14: the colour legend for the food products positioning

Colour		Product category	Product quantity per Pears crate for two persons
Red		Meat and fish	2
Yellow		Extra (i.e. cheese, yoghurt, eggs or a special jam, paté, buffalo mozzarella and bread)	2
Green		Vegetables	7 to 8
Orange		Fruits	7 to 8

6.3.3 Material

The separators will be made from extended polystyrene (EPS), a lightweight, slightly compressible and resilient material. It consists in a type of plastics materials converted into the foam structure.

Outstanding characteristics of EPS are that it: protects (i.e. shock absorbency and compression resistance), insulates (i.e. retaining food product freshness), is durable (i.e. unaffected by moisture or heat), lightweight: (it is 98% air). These outstanding qualities make EPS the most promising material for manufacturer the designed separators. EPS packaging separators are the most durable, reliable, and cost effective solution to securely stack and handle semi-finished or finished products such as fresh or packed food goods. They offer maximum load stability, reduced contamination and greater product protection. In addition, they are: washable, sanitary (moisture and bacteria resistant) and odourless (no flavour migration).

On the other hand wooden crates are manufactured and repaired locally, relatively resistant to different weather conditions and (sea) water, used on more than one journey, have a higher efficiency for larger fruits and the possibility of good ventilation and fast pre-cooling.

Although other materials were taken into account for developing the separators, they were rejected due to their low contribution to added value for dK. Mostly the other material options were bio-plastic, biodegradable plastic and other plant based materials (i.e. wood and cardboard). The first is typically made from maize or sugar, which are from respectively central USA and Brazil. These areas record extreme droughts and dangerously depleting resource. In addition UNEP states that fuels and materials produced through agriculture are of higher relative impact compared to fossil based materials (Source). Finally the German Council of Humus & Soil Producers (VHE), the German Compost Council (BGK) and the German Environmental Protection Agency (EPA) have withdrawn support of bio-plastics because the new soil amendment German regulation (DüMV) requires that ingredients for manufacturing soil amendments to have “intrinsic value for soil and plants” and this is not the case with bio-plastics [E1].

6.3.4 Environmental Impact

Packaging can imply both a negative and positive environmental impact (EI). The production of packaging uses energy and creates emissions, though packaging can be designed to reduce environmental impacts in areas such as transportation and food waste. The study of the EI of the proposed solution was based on dK's current packaging and on EPS packaging separator sheets rather than an intended study to lower the final EI. However the intention to optimize the EI of the final solution was achieved because the selection of separators' material, the improvement of the crate returned flow and the increased number of loaded crates per truck freight. In addition the estimation of the packaging's EI is of little value if their functionality is not considered. In other words the packaging's functionality has to be totally aligned in a pack/ product based study. In this case study wooden creates and EPS separators have same functionality such as keep the freshness of food contained, stack efficient and be reusable.

The estimation of the Life Cycle Assessment (LCA) for the new better dK crate is out of the scope of this research. However a rough "cradle-to-grave" investigation, the whole life cycle of the EPS packaging system for separator sheets has been considered. Firstly it is important highlight that EPS is composed almost entirely of air (98%). Thus reducing the resources usage. EPS uses pentane, which is a natural gas, as primary production chemical without adding chlorine such as CFCs or HFCs. EPS is completely recyclable, and it is safe for food contact. The whole system from production of virgin raw material (expandable polystyrene) to the management of used packaging has been broken down into 7 steps (see figure 20).

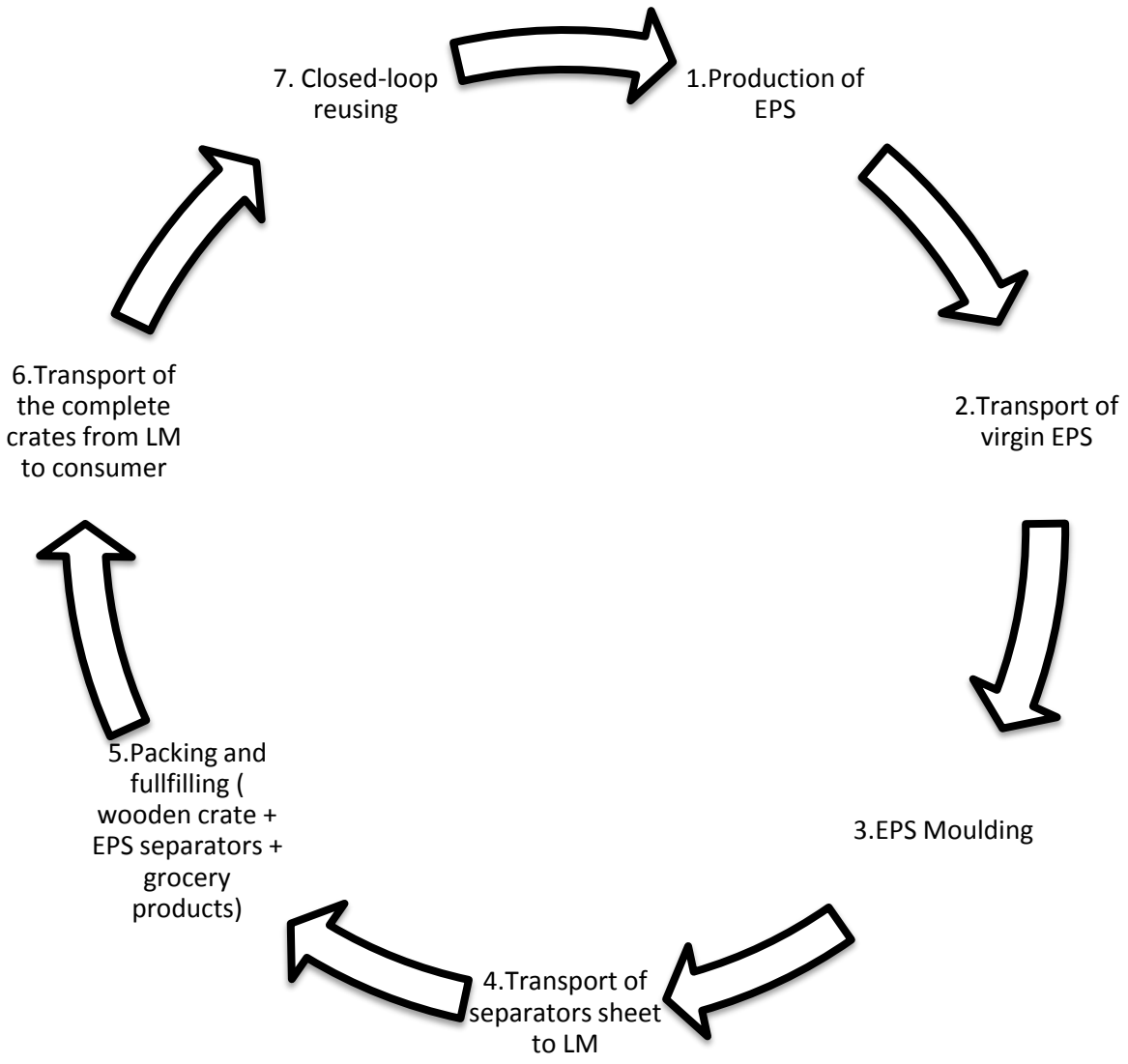

Figure 20: The LCA of EPS separator sheets

6.3.5 Deposit-refund system (DRS)

dK has outsourced its logistic to LM which includes the return logistics management of the crates. On delivery the deliverers should ask to customer to return the crate after use. At the moment this return management is defective. Responsibility of miscommunication between LM's stakeholders and consumers is not yet clear. This results in dK having to buy new crates, twice a month on average. As mentioned in chapter 4, the implementation of a deposit system for the crates is the most promising in order to push customers to return empty crates. Without incentive, people aren't be inclined to respect the return agreement.

Proposed solution includes the introduction of a deposit-refund system (DRS). This can be in which consumers pay a deposit fee, added to the price of their first purchase (price of crate + deposit). Upon return of this crate, they can either have the deposit returned, or the next crate at a reduced price (Price of crate + deposit new crate – deposit old crate).

Consumers are continuously asked to give back the empty crates during each delivery they receive. This system is one of the economic instruments that are expected to have environmental benefits (i.e. preventing litter and promoting packaging reuse).

Since the delimitations on collecting financial, a cost model was roughly estimated based on fixed and variable costs such as vehicle, personnel, crate and emission costs. Each element is divided into parameters, which include kilometres; fuel usage, time and quantities in such a way that cost factors can be allocated. Considering the mentioned above parameters the deposit value for the new crate might be around 5.00 €.

This proposed return logistic system was based on Albert Heijn's efficient and successful model of returnable packaging (see section 4.1.3).

6.3.6 Time temperature indicators (TTI)

A time temperature indicator (TTI) is a device that can show an easily measurable time-temperature dependent change that reflects the full or partial temperature history of food products to which is attached (Taoukis & Labuza, 1989). The principle of TTI operation is mechanical, chemical; electrochemical, enzymatic or microbiological irreversible change usually expressed a visible response in the form of mechanical deformation colour development or movement. The rate of change is temperature dependent, increasing at higher temperatures. The visible response thus gives a cumulative indication of the storage condition that the TTI has been exposed to. According to Schoen and Byre's (1972) TTI's categories, the selected indicator for the packaging solutions is a critical temperature-time indicator (CTTI) that shows a response to the cumulative time-temperature exposure above a reference critical temperature (4°C- 7°C) Above these

critical temperatures, biological reactions such as microbial growth or enzymatic activities can occur. TTI examples can be seen in the annex 9.8.

The TTI would be added to the exterior of the packaging, thus not being in contact with the food products and being easily readable. The TTI proposed for use is the 3M MonitorMark 9860B, and is sold between €1.65 and €2.65 each, depending on the order quantity. The 3M MonitorMark 9860B is a single use time temperature indicator that can have 2 programmed temperatures to indicate, a high and a low. (This data was gathered through a quotation from Introtech, a Cold Chain Specialist and Solutions Provider 21/5/2015) For application in this solution, the proposed temperatures to indicate are 0°C and 7°C. Products must not be subjected to temperatures below 0°C, as this can cause freezer burn on fresh produce, or above 7°C, as this can induce microbial spoilage [F1].

6.3.7 Palletisation

The insertion of separators within the existing Pear crates improves their stackability in terms of increased support surface. The proposed improvement makes it possible to removal the transportation packaging, the foldable plastic crate provided by LM. Cape Pack was used to calculate and visualize how to place the dK crates on a pallet, excluding the use of transportation crates. It helped to estimate the utilization of EUR standard pallet and how to position dK crates as efficiently as possible. Figure 21 illustrates how the pear crates are placed in the transportation crates, on onto pallets. Figure 22 illustrates how the pear crates might be arranged if no transportation crates are used.

Improvements were analysed through comparing the area and volume efficiency. The removal of the transportation crate increases the area efficiency by of pallets by 28.6 % and of the volume efficiency of cubes by 31.1%. Concluding, it is important to emphasise the economic benefits linked to the removal of plastic transportation crates. In other words, the estimated efficiency by the saving of transported air (%) might be express in number of transported wooden crates. Figure 21 and 22 show that roughly 32 more wooden crates can be transported if the they are stackable, thus removing the need for that transportation crate.

Product Name Design Group
Product Code Cartons/Bags/Ovals
Datafile Name lm pear (21/04/2015)
Load Ref. 1 C
Cube Used 58.6 %
Area Used 62.7 %
Pallet type EURO1

1	Crate / LM transport
10	Crate / Load
2	LM transport / Layer
5	Layer / Load
10	LM transport / Load

	Length	Width	Height	Net	Gross
Crate (OD)	499.0	301.0	199.7 mm	1.0000	1.5000 Kg
LM trans(OD)	601.0	501.0	281.0 mm	1.5000	2.3618 Kg
Product	1002.0	601.0	1405.0 mm	15.0000	23.6180 Kg
Load	1200.0	800.0	1550.0 mm	23.6180	48.6180 Kg

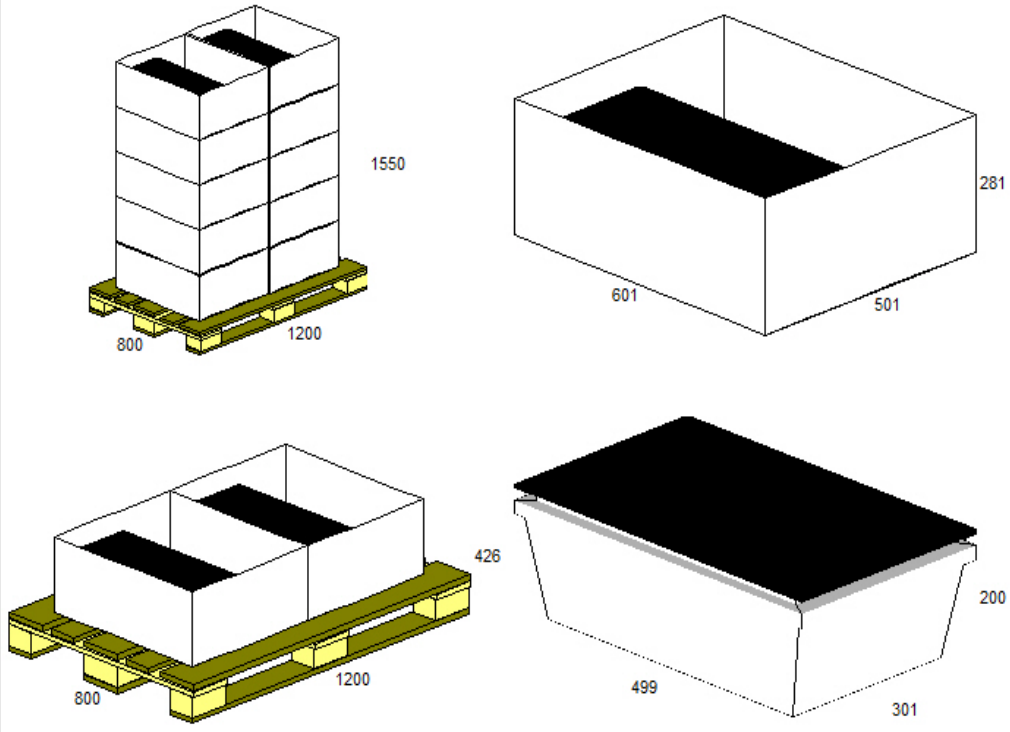

Figure 21: CapePACK results of the pear crate and transportation crate compbination

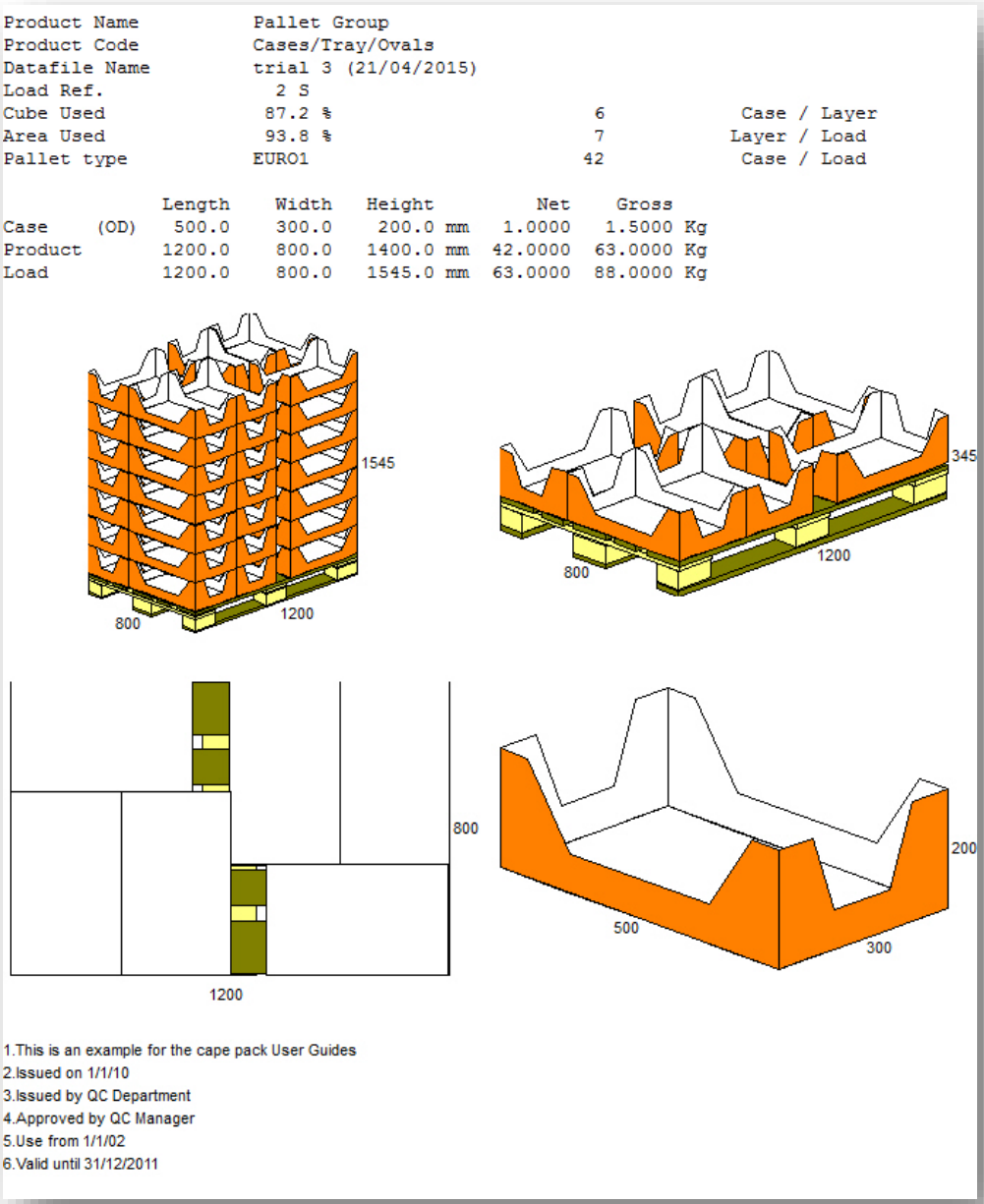

Figure 22: CapePACK results of the pear crate without transportation crate

6.4 Costs

The cost of the proposed solution was estimated based on the sum of pear crate costs (data provided by KC) and the assumption of the EPS separators costs (data provided by the collaboration with DS Smith Netherland). Finally the assumed cost of the proposed solution is roughly 5 €, of which the wooden crate's represents 12%. Since its high production of wooden crates per day (around 60 000 crates per day), KC provided generic crates costs data. Crate production cost without counting the discounts through bulk purchase depends on raw material, labour and overhead. The latter two are valued around 0.2 € per m^3 of used wood. In order to estimate price of separators the DS Smith provided an average price of EPS. More details about calculations are in the annex 9.7.

6.5 Trade offs

The aim of concept virtual prototyping is to define and test the new solutions prior to fabrication investments. By integrating packaging trade-off analysis with design it was possible to create a complete virtual prototyping solution for improving the packaging of dK. This analysis estimated how far the virtual prototype extends into the packaging system for e-grocery trough a set of variables such as packaging performance; costs etc. compared to all the design activities as manufacturability, environment, and testability. Capabilities for packaging trade-off analysis are limited to the manufacture of a new single crate. Nevertheless its economic viability depends on both the life cycles of the crate packaging and of food products contained inside. Figure 23 shows trade-offs between the current dK packaging solution and the new proposal. A value range from 1 (to be optimised) to 4 (optimized) was set in order to valuate variables. The adopted definition of optimization was "*the management framework within which all the partitioning and design analysis activities are performed"* (Sandborn & Vertal, 1998). It does not necessarily mean that the system must automatically choose the optimum design specification without user involvement. Rather, it represents tools that collaborate with the user to optimize the design's physical implementation. It includes objective functions, formulation, allocating, budgeting and constrain and requirement management. A brief description of each trade off ends this paragraph.

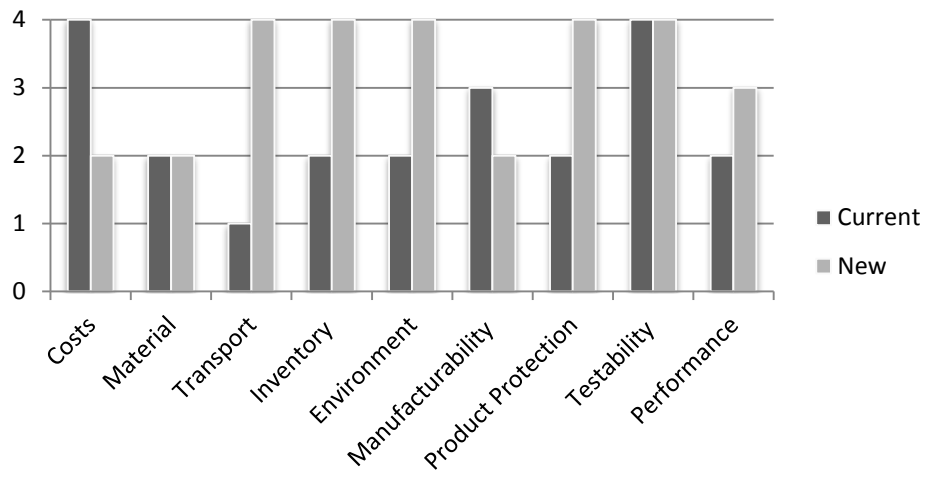

Figure 23: Tradeoffs between current and new solution

- Packaging Costs: the new solution sacrifices packaging cost savings to meet time-to-project requirements. The introduction of EPS separators increases crate's production cost from 0.30 to 5.00 €. However separators facilitate the fulfilment, increase stackability and foods products protections as well add appealing to the brand for consumers.

- Material: both materials; wood and EPS are completely recyclability. Consumers perceive wood as "from farm", which is a branding strength and recognition strategy but its performance for food is not optimum. Wood may not infinitely reusable as moisture damages and mechanical hazard occur when it is not properly kept. On the other hand EPS is perceived as not environmental friend from user but its properties in term of preservation food safety, stacking and reusability are very high.

- Transport: the current solution includes the plastic crate of LM, which reduces the efficiency of palletisation, and trucks' fill rate. This is improved through increase crate stackability provided by separators. More products can be shipped per truck.

- Inventory: time consuming for order fulfilment is reduced because product placement indicators provided by the new solution. On the other hand the introduction of separators and the TTI implies and extra labour in term of packing, unpacking and washing.

- Environment: the new solution improves logistics operations such as the return flow and the trucks fill rate, which indirectly and positively affect the EI.

- Manufacturability: the new solution needs to be supplied from two suppliers rather than only one as the current packaging. It adds cost and transportations but EPS separators increase food products safety and this might boost the consumer perception of quality toward the brand.

- Product protection: the introduction of TTI and separators increases total costs but decrease hazards (mechanical and physic-chemical) for boosting food safety.

- Performance: the new solution requires extra labour within the warehouse of the logistic providers but timing consuming for operations is estimated to be lower than the current one.

7 Discussion and Further Research

This chapter discusses results as regards to the research questions of this thesis as presented in the section 1.3. The aim of this chapter is to answer and discuss the questions along with the findings in the thesis. Further research is concludes this chapter.

7.1 Research questions

In this paragraph the research questions addressed in section 1.3 are discussed. Table 15 describes, in short, both the research questions and the answers to these research questions. Sections 7.1.1, 7.1.2 and 7.1.3 provide a more detailed description of these answers.

Table 15: Summary of Research Questions and Answers

Research Question		**3. Aiding Packaging Features**
1. Logistic Requirements for secondary packaging in e-groceries	Volume Efficiency	Stackable crates
	Packaging Return Logistics	Deposit Return Systems
	Fulfilment Of Mixed Loads	Separators with Designated Areas
	Facilitation of Eased Delivery	Removal of transportation packaging through crate stackability
2. Food product Requirements for secondary packaging in e-groceries	Food Product Protection	Packaging Separators
	Temperature Control	Time Temperature Indicators

7.1.1 RQ1: What types of logistic requirements need to be considered for developing a secondary packaging solution for food in e-commerce?

How e-grocery businesses manage customized orders is a challenge, which is directly related to the logistics of filling these orders. The use of outsourced logistics aids companies with logistic activities such as receiving produce (from suppliers), stocking, picking, packing, transporting and delivering to customers and the packaging return management. The orders' information (type of products, delivery address and time) are provided by an 'infomediary', which reaps many benefits from this use of outsourcing.

Most of the difficulties related to e-groceries occur during the last mile: the home delivery process. This thesis reports data that shows the extreme difficulty of managing the e-grocery delivery model. It is driven by customer demands, food quality assurance, picking issues, varying storage requirements of different food products. In the context of e-groceries, the definition of secondary packaging (packaging that contains many primary packages) expands because the food products to be packed are both not formerly packaged, and are part of a mixed load. Critical to facilitate the fulfilment of these mixed loads in secondary packages for food in e-commerce is to introduce packaging components that separate different food category inside the package itself. The current package solutions (shopping bag, box and crate) do not have this type of packaging element. An increased amount of products increases handling times at logistics providers, thus increasing fulfilment time. In this thesis, improved ease of fulfilment can be achieved by introducing packages separators inside the secondary packaging solutions.

Not all e-grocery business use a similar secondary packaging solution in term of type, shape, size and volume capacity. Thus food logistic providers' transport and deliver grocery orders through their own transportation packaging (foldable plastic crate). This results in an excess of unnecessary packaging, resulting extra labour in terms of operations such as handlings during fulfilment and delivery. The use of transportation packaging also results in the shipping of air, due to reduced volume efficiency, this surplus of room can lead to mechanical product damage during transportation. Transportation and delivery requirements stress the need for stackable crates. Not only does this stackability allow for a greater cube unitisation, it can also avoid the use of the transportation packaging (the foldable crate). The use of a secondary packaging that is stackable reduces the amount of space needed to store and ship products. Packaging solutions that are not stackable, a shopping bag for instance, can only be layered to a certain extent (one or two layers before product damage can be noticed). The large reduction of the area needed to store and transport the same amount of food produce is a

major driver in the use of stackable crates. Through the holistic optimisation of a packaging level, one can reduce the need of other levels of packaging, implemented to compensate for mal-performing packaging levels, which in turn, can reduce both the overall environmental impact that a product has, and the financial impact that the amount of packaging has on the company, either through the reduced need of storage, transportation and shipment. The proposed packaging solution, introducing packaging separators into the secondary packaging can increase stackability, increasing the amount support surface. This can eliminate the need of transportation crate, reducing the amount of air during transportation and increasing the number or orders per truck.

Finally, returnable packaging is a sustainable packaging system whereby previously delivery packages can be conveniently and easily returned, and then reused. The return system consists of two elements: designing reusable packaging and the deposit management, and implementing a track and trace system. In this thesis, findings shows that electronic identification (i.e. tag and RFID) for food packaging seems to be an excessively expensive option, which fails to cover the already low margin revenue of e-grocery sales. Rather than this kind of solutions, the implementation of a deposit-refund system is suggested. In this system, customers pay a deposit that is added to the price of the first purchase.

7.1.2 RQ2: What types of food product requirements need to be considered for developing a secondary packaging solution in e-commerce?

It is of importance to keep food mechanically, biologically and chemically safe along all links of the grocery supply chain. This does not depend on the market on which the said supply chain is contextualized (traditional or online).

Mechanical induced inter-product damage as result of transportation and bad organisation of products within secondary packaging can be reduced through the addition of packaging features, which will be discussed below (RQ3).

Biological food damage can be induced by time and temperature fluctuations, as well as cross contamination between different product types and as indirect reaction of previous mechanical damage.

Packaging solution features found in during the research of this thesis found that the introduction of coolant elements in secondary packaging can only prolong the time of chilling for a few hours, yet not control the time-temperature required. On the other hand, the use of time-temperature indicators ensures customers that their food products have been at the correct temperature throughout the supply chain. Food produce can be

sensitive to both high temperatures, resulting in both condensation and microbial spoilage. If food produce has been subjected to non-optimal temperatures, is must be deemed unfit for consumption. Commonly each food product category has own time-temperature requirements.

In this thesis, the food categories that require the cold chain are perishables and produce. Pantry products do not need to be in the cold chain, and frozen products are excluded. Results show that food service logistics providers use refrigerated vans, chilled to a preselected temperature (4 °C-7°C) for transporting groceries along the hub and spoke network. The distribution network for e-groceries is larger, yet less dense than traditional retail, meaning that produce is in transportation vehicles for a longer period of time. Separating these food categories within the secondary packaging solution facilitates both the fulfilment of quality requirements specific for each said category and the protection of fragile products from mechanical hazards.

7.1.3 RQ3: Which packaging features could aid secondary packaging for food in e-commerce in meeting these requirements?

The introduction of packaging separators facilitates time reduction through improved ease of fulfilment. Packaging separators, consist of two perpendicular sheets, which fit together. Each of the two sheets is designed to have preselected measure, as to create sections when positioned within the secondary packaging.

Types of food products offered by the option of home delivered foodstuffs include fragile products (i.e. eggs) and scattered products (i.e. potatoes, tomatoes, strawberry etc.) and the separators would provide a solution to inter product protection, through the separation of products that could inflict mechanical damage to more sensitive food produce.

The packing of mixed loads also refers the order time (season, week and/or day) thus the standardization of the load is excluded within the context of e-grocery. Further the fulfilment process can be ease by colouring the packaging separators. Further, by colour coding these packaging separators, food category separations can be realised to improve product quality assurance.

Introducing separators improves transportation and delivery, increasing the stack ability of the secondary packaging solution in which they are fitted. Improving secondary packaging stack ability make it possible to avoid unnecessary packaging such as, in the

case of this thesis, transportation packaging, increasing volume utilization rate and increasing the truck freight volume.

Packaging material is a feature that must be taken into account during the packaging development process. In this thesis results show that the EPS can protect, can insulate and is durable and lightweight. These characteristics make EPS the most promising material for manufacturing of the designed separators. The use of EPS carries two main trade-offs, is it positively effects the between product protection and logistic operations, yet they increase packaging costs and sustainable branding recognition.

A secondary packaging suitable for e-grocery needs to be returnable. In this research the implementation of a deposit refund system on the crates is proposed as incentive for consumers to return the packaging. Even though the deposit refund system is not a packaging feature, the finding of this thesis demonstrated that it is more effective than electronic identification (i.e. tag and RFID).

To conclude, in order to fulfil the food product requirement of time-temperature control, TTIs are proposed as packaging feature. TTI give a visible response of temperature changing as indication of storage condition contrarian to coolant packaging that extend the cold chain for a limited amount of time.

7.2 Further Research

The findings from performed research can be used as foundation for further research. A possible next step would be the implementation of the packaging solution into the supply chain of and e-grocer, and measure the packaging's performance in regards to the performance measures referred to in this thesis. Research could be done toward the primary packaging of food products, suitable for mixed loads in e-commerce.

The secondary packaging requirements defined for this thesis were food product requirements and logistic requirements. Other requirements that could be further researched are marketing requirements and direct environmental requirements related to e-groceries, as these can also influence the design, impact and functionality of a packaging.

Due to the geographical (NL) and business strategy (infomediary) delimitations of this study, the research topic could be extrapolated to different regions, countries or company sizes.

The ever-changing trends in, and continuous evolution of e-commerce brings rise to potential study topics. Trends such as the use of omni-channel retailing in e-commerce,

increased consumer need for personalized orders and the possibility of rapid globalization of start-ups, among others trends, drive the evolution of the packaging used in this sector.

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9 Annex

9.1 Current Solutions

Table 16: Current packaging solutions and companies using them in their supply chain

Current Packaging Solution	Examples
Shopping bags 	Instacart (US); Shopwing (DE); Amazon Fresh (US)
Boxes 	Hello Fresh (NL); FreshDirect (US)
Crates 	BeeBox (NL); Amazon Fresh (US); Albert Hejin (NL); Tesco (UK); Safeway (US);

9.2 Company Overview (Detailed)

Company Background

The idea was born from a conversation about how receiving a parcel within the right products and reducing the time to do grocery shopping. Prioritizing product quality (especially vegetables and meats) and having food goods that are not available in supermarkets is one of the unique selling points of the company. dK started up in a local market in Amsterdam presenting only the idea: the crate, at which dK found twenty customers, who signed up for a trial subscription of four crates (which has now been reduced to two). After these four crates, customers could say whether they enjoyed the crates and continue with the service. Through word of mouth new customers were acquired. Competitors were some farms that provided own fresh seasonal and local produce through bags, yet there was no service that delivered groceries directly to peoples' houses, containing the right amount of ingredients (vegetable, cheese, bread, meat etc.) and recipes for preparing meals. In the beginning, the company did all the logistics themselves: picking, packing and warehousing. When the company started growing, the warehouse needed to be larger for assembling the crates. Due to the increased amount of crates to be fulfilled, difficulties arose concerning the size of the warehouse, the cost of the warehouse and the efficient time management between picking and delivering.

Business Currently

The venture decided to outsource our logistics to (LM) and now the picking and delivering are possible twice per week. The food suppliers deliver their produce to LM in Zoetermeer, where it is stored, picked and put into the crates. Thanks to the improved logistic possibilities of LM, dK expanded its delivery service the whole Netherlands. Considering the scattering of dK's food suppliers the third part logistic (LM) implies that if a customer in Groningen orders one crate containing food products from the same city, that this goes through Zoetermeer (456 km). The use of several distribution points was too expensive to implement on such a small scale: as the larger the volume is the higher the margin on the products, yet this isn't realisable by dK. Consequently the centralisation of logistics results to be an efficient strategy. Usually as well for dK the agreements with the third part logistic are based on the ratio per crate or per pick; and negotiation is often used to the estimate the final costs of packaging. For example the price per crate includes time for the fulfilment, for the deliver etc.

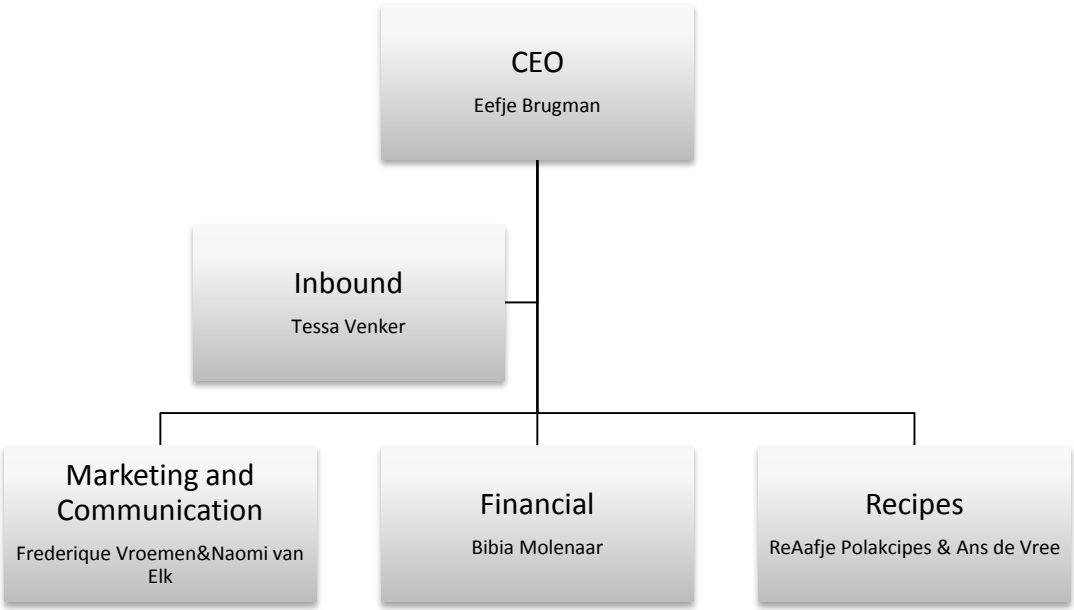


Figure 24: deKrat's organisational structure

9.3 List of dK's suppliers

Table 17: List of dk's Suppliers, their location, and distance to the Logistics Centre

Company	Location	Distance to LMFL (km)
Aardappelboer	Zwanenburg	61
Ad en Marjolein Brandwijk	Molenaarsgraaf	55
Arabic Bread	Almere	92
Bartje Bomeboe	Amsterdam	60
Bastiaansen	Molenschot	87
Bioromeo	Ens	145
Brood van Menno	IJsselstein	38
Brouwerij t'ij	Amsterdam	60

Buffalo Farm Twente	Denekamp	196
Cees de Bouter	Amsterdam	60
Cono Kaas	Midden Beemster	89
Country Home Cooking	Graft	91
De Groene Hart Cooperatie	Alphen aan de rijn	30
de nieuwe band	Marum	215
De Terschellinger	Oosterend	151
discover fresh		31
Drentse Aa Zuivel	Rolde	219
Driessen food	Bunnik	55
Dutch Angus	Amsterdam	60
Familie Speelman	Gasselternijveen	235
Frank's Smokehouse	Amsterdam	60
Greenage	Nieuw Vennep	43
Hanketien	Mantinge	197
Henno Hak	Abcoude	70
Henny's Homemade	Amsterdam	60
Hottie Sambal	Rotterdam	16
House of Taste	Leeuwarden	197
Jan Meijer	Vreeland	68
Koeckebackers	Amsterdam	60
Krispijn van den Dries	Emmeloord	148
Kwekerij Osdorp	Amsterdam	60
Le Salonard	Maastricht	217
Maartens Marktkraam	Marknesse	155
Mekkerstee	Oud dorp	90
Olmenhorst	Lissebroek	47
Only Pasta	Bussum	78
Onoff Spices	Amsterdam	60

Pompie	Leimuiderbrug	40
Portabella paddenstoelen	Velsen	71
Prince Pie	Oene	133
Pure Wagyu	Schaarl	99
Puur Noord Nederland	Noord Holland	83
Rootfold	Amsterdam	60
Schmidt zeevis	Rotterdam	16
Smits Groentekwekeij B.V.	de Heurne	153
Smorenburg fruitteler	Woerden	32
Vegetarische slager	Amsterdam	60
Waddenmax Biologische Zuivel	Horn Huizen	249
Walter Abma	Amsterdam	60
Waterlants weelde	Oosthuizen	92
Weerribben zuivel	Weerribben	98
Wild van Wild	Amsterdam	60
Zaai -ster	Leek	225
Zuiver Zuivel	Limmen	82
Average km		**97,6**

9.4 Packaging Scorecard Characteristics Explanation

Table 18: Packaging Scorecard Characteristics and the explanation of these characteristics

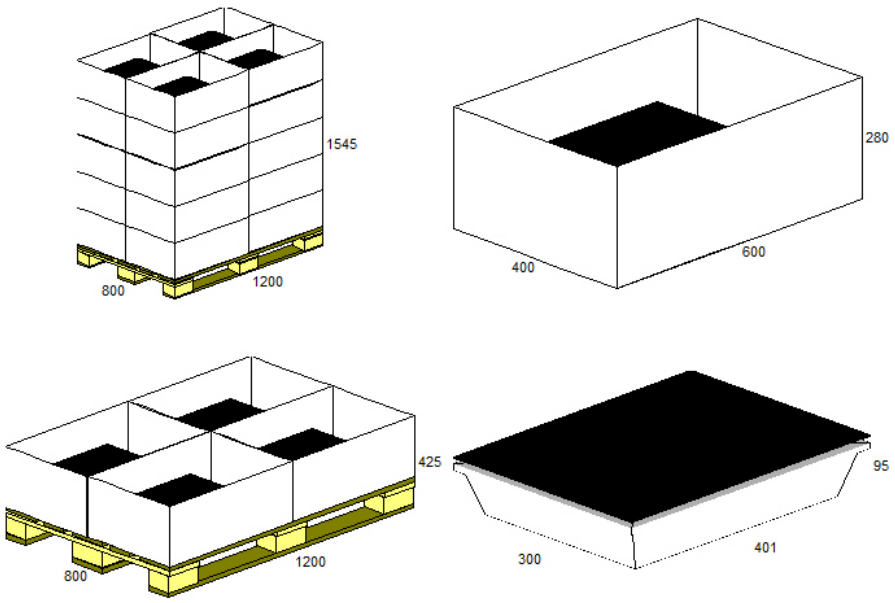
Packaging characteristic	**Explanation**
Machinability	Ability of packaging to be processed effectively in the production lkine
Product protection	Ability to protect the produt
Flow information	Ability to inform in the supply chain
Volume and weight efficiency	Ability to make use of all the abiliable volume and load capacity
Right amount and size	Adapt to right quanitity and turnover
Handel ability	The ability to facilitate handling
Reduced food waste	The ability of the packaging to induce reduced food waste
Product information	Ability to display product information
Selling capability	Ability to see and advertise the product
Sustainability	Ability to be produced and disposed in a sustainable manner
Mixed loads packaging	Ability to pack different combinations and varieties of products
Minimal use of hazardous substances	Amount of hazardous substancs in the ackaging
Packaging cost	The cost of the packaging
Minimal amount of waste	Amount of waste from the packaging
Customer handling convenience	Ease of handling for the customer
Stack ability	Ability to stack
Return flow for packaging	Ability to adapt to return flow logistics.

9.5 Packaging Scorecard Results

Scored by: deKrat				
	Weight	**Score**	**Normalized weight**	**Weighted score**
Wooden Crate				***2,53***
Machinability	0	0	0,00	0,0
Product protection	80	2	7,88	15,8
Flow information	10	1	0,99	1,0
Volume & weight efficiency	85	2	8,37	16,7
Right amount and size	30	3	2,96	8,9
Handelability	20	2	1,97	3,9
reduced food waste	70	3	6,90	20,7
Product information	90	3	8,87	26,6
Selling capability	100	4	9,85	39,4
Sustainability	90	2	8,87	17,7
Mixed loads packaging	75	3	7,39	22,2
Minimal use of hazardous substances	80	4	7,88	31,5
Packaging cost	60	2	5,91	11,8
Minimal amount of waste	50	3	4,93	14,8
Customer handling convenience	50	2	4,93	9,9
Stackability	40	1	3,94	3,9
Return flow for packaging	85	1	8,37	8,4

Scored by: Kist en Co				
	Weight	**Score**	**Normalized weight**	**Weighted score**
Wooden Crate				***2,35***
Machinability	40	4	5,67	22,70
Product protection	60	3	8,51	25,53
Flow information	20	1	2,84	2,84
Volume & weight efficiency	0	2	0,00	0,00
Right amount and size	40	2	5,67	11,35
Handelability	70	2	9,93	19,86
reduced food waste	70	1	9,93	9,93
Product information	0	1	0,00	0,00
Selling capability	50	2	7,09	14,18
Sustainability	0	4	0,00	0,00
Mixed loads packaging	80	1	11,35	11,35
Minimal use of hazardous substances	80	4	11,35	45,39
Packaging cost	20	3	2,84	8,51
Minimal amount of waste	20	3	2,84	8,51
Customer handling convenience	80	2	11,35	22,70
Stackability	75	3	10,64	31,91
Return flow for packaging	0	1	0,00	0,00

9.6 CAPE Pack Results



9.7 Packaging Cost Estimation

2.1 Wood Cost estimation per Pear crate

Crate's section	**Type of wood**	**Cost (€/m^3)**	**Amount of wood / Pear crate (m^3)**	**Wood costs/ Pear crate (€)**
Bottom	Triplex	660,00	3.75e-3	0.25
Feet	Particleboard	200,00	1.6e-4	0.032
Side strips	Hardboard	300,00	5e-4	0.015
				Total 0.297

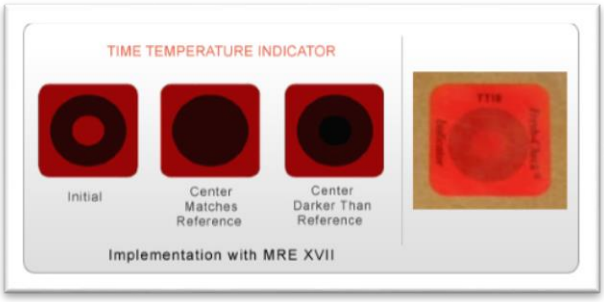
2.2 Average price of EPS

	Length (cm)	**Width (cm)**	**Thickness (cm)**	**Density (kg/m^2)**	**Price (€)**
EPS sheet	100	50	2	15	70

2.3 Separators Surface

- Sheet 1 (S1)= 450 cm^3
- Sheet 2 (S2)= 270 cm^3
- Cost of S1= 3,15 €
- Cost of S2= 1,89 €

9.8 Examples of TTI



9.9 Cape pack results

PEAR CRATE, STACKED IN DIFFERENT PATTERENS: Assumption: No Bulge above Separators									
Solution	Pattern	Total Load	#per layer	#layers		Cube Efficiency (%)	Area efficiency (%)	length under	width under
1	I	42	6	7	H	87,2	93,8	100	0
2	S	42	6	7	H	87,2	93,8	50	150
3	T	35	5	7	H	72,7	78,1	100	100
4	T	35	5	7	H	72,7	78,1	50	150
5	T	35	5	7	H	72,7	78,1	200	150
6	S	35	5	7	H	72,7	78,1	200	0
7	C	28	4	7	H	58,1	62,5	100	100
8	C	28	4	7	H	58,1	62,5	0	150
9	I	28	4	7	H	58,1	62,5	50	150
10	D	28	4	7	H	58,1	62,5	200	0
11	D	28	4	7	H	58,1	62,5	200	0
12	D	28	4	7	H	58,1	62,5	200	0
13	D	28	4	7	H	58,1	62,5	200	0
14	C	21	3	7	H	43,6	46,9	150	150
15	I	21	3	7	H	43,6	46,9	200	150
16	C	14	2	7	H	29,1	31,3	100	250
17	C	14	2	7	H	29,1	31,3	300	150
18	C	7	1	7	H	14,5	15,6	350	250

LEEN MENKEN CRATE, STACKED IN DIFFERENT PATTERENS									
Solution	Patten	Total Load	#per layer	#layers		Cube Efficiency (%)	Area efficiency (%)	length under	width under
1	C	20	4	5	H	93	100	0	0
2	C	15	3	5	H	69,8	75	0	100
3	I	15	3	5	H	69,8	75	100	100
4	C	10	2	5	H	46,5	50	0	200
5	C	10	2	5	H	46,5	50	200	100
6	C	5	1	5	H	23,3	25	300	200

ONLY RADISH CRATE, STACKED IN DIFFERENT PATTERENS: Assumption: Nu Bulge above Separators								
solution	pattern	Total Load	#per layer	#layers	Cube Efficiency (%)	Area efficiency (%)	Length under	Width under
1	C	72	8	9	95,7	100	0	0
2	I	63	7	9	83,7	87,5	0	50
3	T	63	7	9	83,7	87,5	100	50
4	T	63	7	9	83,7	87,5	50	50
5	C	54	6	9	71,8	75	0	100
6	C	54	6	9	71,8	75	150	0
7	I	54	6	9	71,8	75	100	100
8	I	54	6	9	71,8	75	50	100
9	I	54	6	9	71,8	75	50	100
10	T	54	6	9	71,8	75	50	100
11	T	54	6	9	71,8	75	100	100
12	S	54	6	9	71,8	75	300	50
13	S	54	6	9	71,8	75	50	50

14	S	54	6	9	71,8	75	100	50
15	S	54	6	9	71,8	75	50	50
16	D	54	6	9	71,8	75	50	50
17	C	36	4	9	47,8	50	200	100
18	C	36	4	9	47,8	50	0	200
19	D	36	4	9	47,8	50	250	50
20	D	36	4	9	47,8	50	250	50
21	D	36	4	9	47,8	50	250	50
22	D	36	4	9	47,8	50	250	50
23	C	27	3	9	35,9	37,5	0	250
24	C	27	3	9	35,9	37,5	150	200
25	C	18	2	9	23,9	25	200	250
26	C	18	2	9	23,9	25	300	200
27	C	9	1	9	12	12,5	400	250

TOMATO CRATE, STACKED IN DIFFERENT PATTERENS: Assumption: No Bulge above Separators								
Solution	Pattern	Total Load	#per layer	#layers	Cube Efficiency	Area efficiency	length under	width under
1	C	120	8	15	94,7	100	0	0
2	I	105	7	15	82,8	87,5	0	50
3	T	105	7	15	82,8	87,5	100	50
4	T	105	7	15	82,8	87,5	50	50
5	C	90	6	15	71	75	0	100
6	C	90	6	15	71	75	150	0
7	I	90	6	15	71	75	100	100
8	I	90	6	15	71	75	50	100
9	I	90	6	15	71	75	50	100
10	T	90	6	15	71	75	50	100
11	T	90	6	15	71	75	100	100
12	S	90	6	15	71	75	300	50
13	S	90	6	15	71	75	50	50
14	S	90	6	15	71	75	100	50

15	S	90	6	15	71	75	50	50
16	D	90	6	15	71	75	50	50
17	C	60	4	15	47,3	50	200	100
18	C	60	4	15	47,3	50	0	200
19	D	60	4	15	47,3	50	250	50
20	D	60	4	15	47,3	50	250	50
21	D	60	4	15	47,3	50	250	50
22	D	60	4	15	47,3	50	250	50
23	C	45	3	15	35,5	37,5	0	250
24	C	45	3	15	35,5	37,5	150	200
25	C	30	2	15	23,7	25	200	250
26	C	30	2	15	23,7	25	300	200
27	C	15	1	15	11,8	12,5	400	250

10 Interview guides

10.1 deKrat

- Person
  - Name, age, background
- Company
  - Company name
  - what was the main reason the company started (need finding, problem solving)
  - What is the business conducted by Dekrat
  - Hierarchy
- Food Products
  - What are the kinds of products are packed?
    - Which are the most sensitive to damage
    - How is the packaging designed to reduce this damage
    - Since your strategy is based on high quality product, how do you assure this? Quality by DK?
  - Who provides the food products that Dekrat supplies to its consumers
  - What are the problems encountered concerning the shipping of food products
    - How are these problems dealt with?
  - With the growth of e-commerce, how is deKrat preparing to increase the company size and distribution amount whilst still keeping the same level of sustainability (e.g. Returnable system?)
- Consumer
  - How would you describe your consumers
    - how would you describe your consumers
  - What are the biggest concerns for customers
  - Which Are much ordered between the Gemakskrat or the Weekenderkrat ? And are there some correlations btw the different ordered crates and the relative consumer profile and demands?

- E-commerce
    - How did DK create a niche for market penetration? Was is supposed to be only online?
    - When starting the company, what problems were come across through the use of e-commerce and how were these solved?
    - How do you consider the margin of your business (high or low)?
    - Is the DC one location (Amsterdam) a located strategy that do you want to continue for adopting or are you thinking to switch in a decentralised strategy? Why?
- Logistics
    - How is the logistics system now? To what extent is DK partaking in these logistic processes? Describe the supply chain from beginning to end?
    - Where are the bottlenecks, where do logistical problems lie: For instance transportation of crates to LM? Produce delivery days? Just the Weekly delivery?
    - Where do you see room for improvement on the logistics? Fewer deliveries in larger trucks, more deliveries in smaller trucks
    - How are problems usually solved
    - Who do you deliver to?
    - how is this set up: Transportation routes / Delivery systems (Time windows) , mixed routes for multiple order types
    - What changes have been made to support increased sustainability
    - What is the fulfilment procedure of HD boxes
    - How the two different ways of delivery (Gemakskrat on Monday morning and the Weekendkratten on Thursday evening up to and including Saturday morning) are planning?
    - How are you managing the “Depending on the zip code the moment of delivery”?
- Packaging
    - What type of packaging levels are being used now
    - for incoming produce, for outgoing produce, where is this filled
    - Have there been previous improvements to the packaging levels, and what problems did these resolve?
    - Where do you see room for improvement?
    - return flow?
    - pickup points (like Jumbo)
    - A part business- strategy differences (Gemaskrat = convenience and Weekendkratten) btw the two crates that you

have, what are the main differences between the two?
Measures? Kg load average (volume per unit)

10.2 Leen Menken Food Service Logistics

- Person
- Name, age,
- Company
    - Company name
    - What is the business conducted by LMFL
    - Function
    - With which other companies do you collaborate
        - how is this collaboration
        - who provides the packaging systems that you use
        - does this include return logistics
- E-commerce
    - What innovations has Leen Menken made towards improving the support of online bought food products
- Logistics
    - How is the logistics system now?
    - Where are the bottlenecks?
    - Where do you see room for improvement?
    - How are problems usually solved within Leen Menken Foodservice Logistics
    - Who do you deliver to?
        - how is this set up: Transportation routes / Delivery systems (Time windows) , mixed routes for multiple order types
    - What changes have been made to support increased sustainability
    - What is the fulfilment procedure of HD boxes
- Food Products
    - What are the kinds of products are packed?
    - Which are the most sensitive to damage
    - How is the packaging designed to reduce this damage
    - Who provides used food products
    - What are the problems encountered concerning the shipping of food products
        - How are these problems dealt with?
        - …
- Packaging

    - What type of packaging levels are being used now
    - Environmentally sustainable
    - handle ability
    - …
- Consumer
    - How would you describe your consumers
    - how would you describe your consumers
    - What are the biggest concerns for customers
    - …

10.3 Kist en co

- What is the minimum amount of crates which can diminish a company?
- The crates of Kist en Co., to what extent are these stackable? Has there ever been researched to make them stackable?
- What is the production / purchase price of 1 crate (without counting the discount cleared for bulk purchase)?
- What are the negative aspects of the caskets?
- What are the positive and negative aspects of the crates?
- How are these boxes sent to Leen Menken Food Service Logistics, are they retrieved?

10.4 Professional Interviewees

- Consumer
    - Which factor influences the delivery choice?
        - Cost, speed, flexibility, reputation, service
    - What delivery method is most used by them?
        - To home via post or courier or retail
        - To the shop you order it from or different shop from the order
        - To neighbour or friend
        - To locker or collection point
    - What of above method is preferable?
    - What is the importance of the following across aspects of delivery process:

        - Service; speed; price; innovation (range of solution delivery as locker or drones, how to promote + message and technology)
    - Do consumer spend more money by online rather than in-shop purchasing?
    - Are they willing to order online if delivery service are more suited to your needs?
    - Do they use mobile device to?
        - Locate the store
        - Search product
        - Search service
    - Which problem do you have with online retailers
        - Product presentation and trials
        - Delivery time
        - Instant gratification
        - Security concerns

- Retail
    - What can cause capacity issue in store through online sales?
    - How delivery from online purchase has impacted firms' sales
    - Which delivery method is preferable? And why?
        - Own click and collect (purchase opportunity when consumer collect in store) ;
        - To home via post or courier (speed, reliability service);
        - Own van;
        - Collection point
    - Among these areas of concern, which one is the most to be improved? Why? There are other areas?
        - Coping with peak time;
        - Integrating system (across retail platform and demands forecasting);
        - Coping with seasonal times (Christmas);
        - Managing costs;
        - Demand forecast;
        - Meeting consumers expectation;
        - Handling return;
        - Customer service;
        - Manage inventory;
        - Manage courier firm;
        - Warehouse capacity
    - Do retailer have a single stock keeping file solution (optimization of multiple platform)?

- Are they able to efficiently track goods across outlet and warehouse? How?
- By online sales, are they avoid the central stock delivery to store that already offer goods?
- Are they concern that consumer can use their web store just to collect information on it and then buying the more competitive option?
- What is their new vision and how are they thinking to achieve it?

- Logistic providers
  - How many delivery options are usually offered?
  - What are they?
  - What is the importance across challenges in delivery process
    - Consumer not being in to receive delivery;
    - managing peak time and seasonal peak time (Christmas);
    - manage costs;
    - poor packaging;
    - consumer claim;
    - retail expectation; wrong item from retail;
    - keep track; system and technology;
    - warehouse capacity;
    - other
  - As above rank the satisfaction
  - What should be improved for future development
    - Tracking; text message or email or app alert;
    - redelivery option;
    - Sunday delivery;
    - delivery to safe place;
    - premium options;
    - consumer book specific time;
    - integration with click and collect
  - What are threats to growth?
    - Coping with increase in capacity required;
    - increased growth of grocery retail own deliver;
    - increased price sensitive consumer;
    - increased demanding of consumers and retailers
- Packaging
  - How can secondary packaging features potentially meet and help fulfil these requirements for e-grocery?