

Evaluating Packaging Logistics Development at IKEA for Improvements in Product and Packaging Development

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Master Thesis in Engineering

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Preface

This Master Thesis is the final and a compulsory part of the Masters of Science Degree in Mechanical Engineering at Lund Institute of Technology, Lund University, Sweden. The thesis has been conducted in cooperation with the Division of Packaging Logistics at the Department of Design Sciences at Lund Institute of Technology and IKEA of Sweden in Älmhult, Sweden.

We would like to offer our thanks and express our gratitude to our supervisors at the Division of Packaging Logistics, Lund Institute of Technology, Jenny Klevås and Caroline Bramklev for their enthusiasm for the topic of our thesis as well as for their guidance. Also, our supervisor at IKEA of Sweden and doorway into the company, Mattias Eriksson, has been a source of inspiration due to his great passion for packaging logistics.

Finally, we would like to thank all IKEA personnel and others who in some way have assisted us in carrying out this thesis. Without their help and the help of our supervisors, this Master Thesis would not be what it is today.

March 8th 2006, Lund, Sweden.

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Abstract

- Title:** Evaluating packaging logistics performance at IKEA for improvements in product and packaging development
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- Purpose:** There are two purposes of this master thesis. The first is to develop a method for evaluating different packaging solutions from a logistical Supply Chain perspective. The second is to create a checklist for the product- and packaging designers at IKEA consisting of the most significant logistical demands put on a packaging solution from a Supply Chain perspective.
- Method:** The base of this master thesis is a case study, beginning with a descriptive approach to create an overall view of the studied Supply Chain and continuing with a normative approach since the aim of the thesis is to provide IKEA with tools to guide their packaging and product development process. Qualitative data were collected during interviews and observations as well as in questionnaires.
- Conclusions:** An evaluation method for logistics performance – the IKEA Packaging Scorecard – has been developed with the prerequisites of the IKEA Supply Chain in mind. The Packaging Scorecard consists of the most critical packaging logistical factors for each part of the Supply Chain, together with weightings that express their importance. The packaging solutions can thereby be evaluated on how well they fulfil the packaging related demands placed at different stages in the IKEA Supply Chain. The method also provides the possibility to pinpoint areas of improvement for the packaging solutions as well as it functions as a tool for comparing different packaging solutions.
- In order to support the product and packaging development process at IKEA from a logistical point of view already at an early stage, a checklist with the most prominent packaging logistical factors emanating from the study has been presented.
- Keywords:** Packaging Scorecard, packaging logistics, logistics, packaging, supply chain, packaging evaluation, method

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1 Introduction

The purpose of this chapter is to provide the reader with a brief background to the area of research. It also describes and explains purpose, problem definition and demarcations of the thesis and gives a short introduction to the case company. The chapter ends with a description of the target group and an outline of the thesis.

1.1 Background

An effect of the increasing globalization is that enterprises have expanded and established themselves on new markets worldwide. As a consequence, new demands have been placed on logistical activities in the Supply Chain and the complexity of the logistical activities has increased.¹ In order to meet this change, it is important to take these logistical aspects into consideration already during the development of product and packaging.²

The role of packaging when creating an efficient and effective distribution is hardly disputable³ and there exists a strong relationship between the design of the packaging and distribution savings.⁴ The largest impact on the costs related to the packaging derives from its interaction with activities in the Supply Chain. The packaging follows the product throughout the Supply Chain, from the supplier to the consumer, and thereby affects the costs for handling, warehousing, transportation and damaged products in a decisive manner.⁵

It is important to try to identify the demands put on the packaging as early as possible in the packaging development process so the packaging will function as efficiently and effectively as possible. The holistic view is crucial and demands deriving from the whole packaging life cycle have to be identified. Some demands are conflictive and have to be weighted against each other, while others coincide.⁶ For packaging designers it is therefore important to know which significant factors that are the most critical to take into consideration along the Supply Chain.

One company that is famous for focusing on packaging and logistics is the Swedish home furnishing company IKEA. From being a small mail-order furniture company, IKEA has grown to become one of the world's largest retailers of home furnishings.⁷ IKEA has chosen to create one packaging solution for every product regardless where in the world that the product is manufactured or where it is supposed to be sold.⁸ The company has about 1,300 suppliers in 53 countries and 228⁹ stores worldwide (December 2005). This situation puts extra emphasis on the distribution flow to be direct, cost-efficient and environmentally

¹ Schary, P.B. & Skjøtt-Larsen, T. (2001) *Managing the Global Supply Chain*. pp 17-19

² Bramklev, C. (2003) *Concurrent Development of Product and Packaging – Towards an Integrated Development Procedure*. p 1.

³ Saghir, M. (2004) *A platform for Packaging Logistics Development – a systems approach*. p 5.

⁴ Robertson, C. (1994) "Package Design yields logistics savings". p 48.

⁵ Dominic, C. et al. (2000) *Förpackningslogistik*. p 38.

⁶ Dominic, C. et al. (2000) *Förpackningslogistik*. p 90.

⁷ Norrman, R. & Ramirez, R. (1993). "From value chain to value constellation: designing interactive strategy". p 2.

⁸ Widén, H. (2003) "Just-in-time out of date? Gamla sanningar skrotades på Förpackningsforum". p 48.

⁹ http://www.ikea-group.ikea.com/about_ikea/ikea_group_stores.html. *IKEA Group Corporate Site*. 2006-02-01.

friendly.¹⁰ IKEA has also come to the conclusion that the construction of the packaging often is more important than its material.¹¹

IKEA controls a large part of their Supply Chain¹² and therefore bears the costs for any packaging related inefficiency occurring along the logistical flow. Hence IKEA holds a big incentive towards optimizing the design of their packaging solutions to support the logistical activities taking place within their Supply Chain.

To be able to achieve this optimization of packaging related activities, the designers at IKEA need to create an understanding for which packaging related factors that have the biggest influence on the Supply Chain efficiency. If they already at an early design stage can recognize areas of improvements or savings, it allows IKEA to take a proactive rather than a reactive part in the packaging design process. In order to support the proactive approach, it is necessary to be able to evaluate the logistical performance of different packaging solutions. This also applies to targeting areas of improvement. In order to make this assessment, a packaging evaluation tool needs to be developed.

The demands placed on the packaging are the demands that actually are placed on a packaged product. The packaged product can be seen as a system that interacts to fulfil the logistical demands presented. It is therefore important to think about both the packaging and the product concurrently in the development process, since a packaging designer cannot make up for a logistically unbeneficial product design.

1.2 Purpose

The purpose of this master thesis is to create a checklist for the product- and packaging designers at IKEA consisting of the most significant logistical demands that are put on a packaging solution from a Supply Chain perspective. A method for evaluating different packaging solutions from a logistical Supply Chain perspective will also be developed.

1.3 Problem definition

To compile the most critical logistical aspects into a checklist that need to be considered within the product and packaging development process at IKEA, the authors have to evaluate which logistical factors that are the most critical for the efficiency and effectiveness of the IKEA Supply Chain. This leads us to the first problem studied:

“Which packaging related logistical factors are significant in the IKEA Supply Chain and should be considered in the product and packaging development process?”

In order to estimate the performance of a packaging solution or comparing different packaging solutions to each other, from a logistical Supply Chain efficiency perspective, some kind of evaluation model has to be created. Therefore, the second problem is defined as:

“How can different packaging solutions be evaluated in terms of their logistical Supply Chain efficiency?”

¹⁰ http://www.ikea-group.ikea.com/PDF/IKEA_FF_0405_GB.pdf. *Facts & Figures – The IKEA Group 2004-2005*. 2006-02-02

¹¹ Widén, H. (2003) “Just-in-time out of date? Gamla sanningar skrotades på Förpackningsforum”. p 48.

¹² Klevås, J. (2005). “Organization of packaging resources at a product developing company”. p 2.

1.4 Focus and demarcations

A packaging system is supposed to fulfil a lot of different demands. These demands can be divided into three aspects; logistical, marketing and environmental aspects.¹³ Within this thesis the focus will be on the logistical aspects of the packaging. Within the logistical field environmental and information aspects will not be considered due to the time limitations of 20 weeks for a master thesis. The focus and demarcations are illustrated in Figure 1.1.

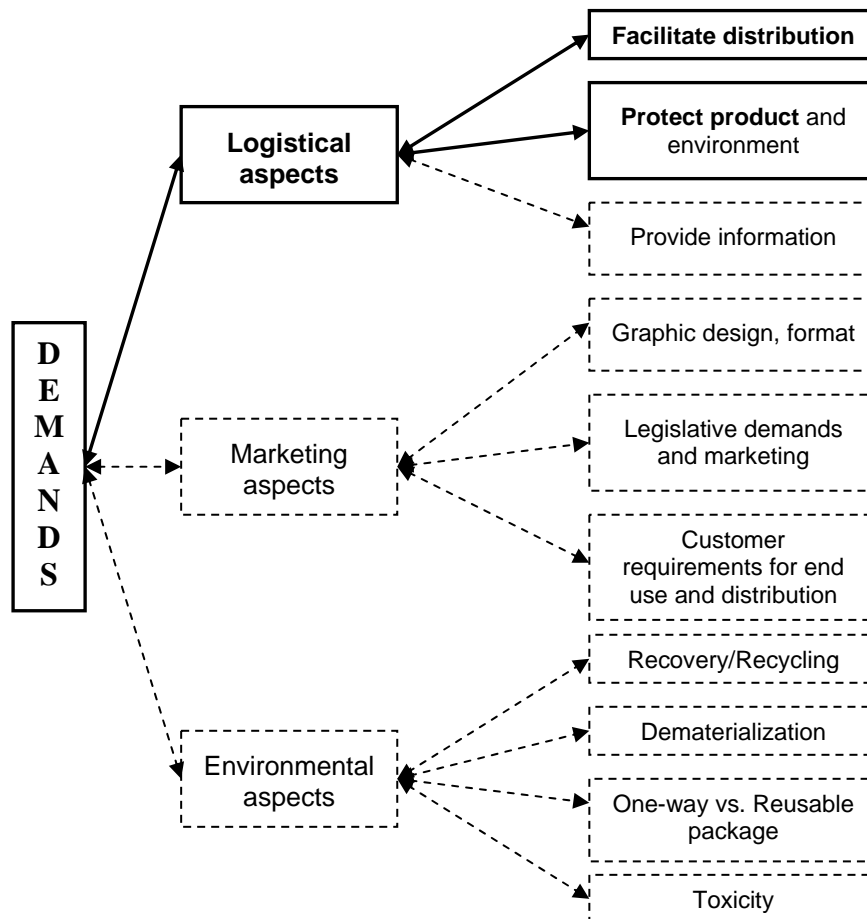


Figure 1.1. Overview of different packaging functions. (Modified from Jönson G. & Johnsson M. (2001) *Packaging Technology for the Logistician*. 3rd Ed. Department of Design Sciences. Division of Packaging Logistics. Lund Institute of Technology. Lund. p 25)

Depending on e.g. type of product, the Supply Chains of IKEA can have different appearances. In the context of this thesis, the IKEA Supply Chain has been demarcated to the distribution flow that occurs according to the Figure 1.2. The thesis will only comprise the logistical factors that affect the packaging, starting with the packing process at the supplier and ending with when the packaged product is displayed in the Retail Outlet.

¹³ Jönson G. & Johnsson M. (2001) *Packaging Technology for the Logistician*. p 25.

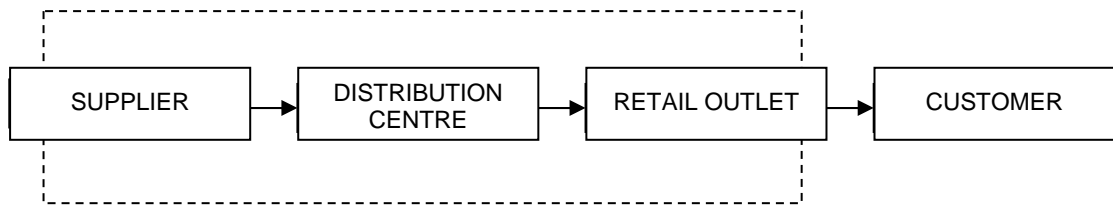


Figure 1.2. The demarcated Supply Chain studied at IKEA.

The analysis at the supplier is done on the basis of purely manual or purely automated packing lines, and no consideration is taken to mixes of both manual and automated packing lines as occurs in industry. The supplier demands are demarcated to only comprise the demands put on the packaging from that the erection of the packaging starts in the packing process until the packaging system is loaded on the mean of transportation. To increase the credibility, the loading and unloading activities have been examined both from a supplier, a Distribution Centre (DC) and a retail outlet perspective. Therefore the transport part of the Supply Chain entails loading, transportation and unloading considerations while at the distribution centre the activities from unloading to loading are taken into account. The store perspective entails the activities from unloading until the packaged product is displayed at the Retail Outlet.

1.5 Target group

The primary target group of this thesis is personnel at IKEA involved in product and packaging development, but academia with an interest in packaging and logistics may also find the report useful and interesting.

Master of Science students at later stages of engineering studies focusing on logistics and/or packaging logistics may also have an interest in taking part of the contents of this report.

1.6 Company introduction

IKEA was founded in 1943 by Ingvar Kamprad and the name **IKEA**[®] is based on the founder's initials (I.K.) and the first letters of Elmtaryd (E) and Agunnaryd (A), the farm and village where he grew up.¹⁴ The IKEA vision is to create a better everyday life for the many people¹⁵ and therefore the company's business idea is formulated as:

“We shall offer a wide range of home furnishing items of good design and function at prices so low that the majority of people can afford to buy them.”¹⁶

IKEA's first home furnishing store was opened 1958 in Älmhult, Sweden, and in December 2005 IKEA had expanded to 228 stores in 33 countries/territories.¹⁷ The IKEA Group employs about 90 000 co-workers that operate in 44 countries¹⁸ and sales were 14.8 billion Euros for the financial year of 2005.¹⁹ IKEA's success can be explained by their unique

¹⁴ http://www.ikea.com/ms/en_GB/about_ikea/timeline/full_story.html. *IKEA Group Corporate Site*. 2006-02-01.

¹⁵ http://www.ikea-group.ikea.com/about_ikea/index.html. *IKEA Group Corporate Site*. 2006-02-01.

¹⁶ Torekull, B. (2003) *Historien om IKEA - Ingvar Kamprad berättar*. p 196.

¹⁷ http://www.ikea-group.ikea.com/about_ikea/ikea_group_stores.html. *IKEA Group Corporate Site*. 2006-02-01.

¹⁸ http://www.ikea-group.ikea.com/PDF/IKEA_FF_0405_GB.pdf. *Facts & Figures – The IKEA Group 2004-2005*. 2006-02-01

¹⁹ http://www.ikea-group.ikea.com/about_ikea/figures.html. *IKEA Group Corporate Site*. 2006-02-01.

concept; flat packaging to lower transportation costs, self-service in the stores keeping handling costs to a minimum and using the customers to assemble the furniture at home.²⁰

IKEA's product range consists of about 9,500 home furnishing articles and already at the designing stage products are analysed to ensure that they fulfil the demands put on function, efficient distribution, quality, the environment and low price.²¹

Significant for IKEA is that it controls its Supply Chain from the supplier to the customer. Most of the product development is done in-house and they do not own the manufacture facilities that produce the products (with a few exceptions).²² IKEA has about 1,300 suppliers in 53 countries. This puts extra emphasis on the distribution flow to be direct, cost-efficient and environmentally friendly.²³

1.7 Outline of the thesis

In order to guide the reader through this report, an outline of it is presented here containing a brief description of the contents of the different chapters.

Chapter 1 – Introduction

The purpose of this chapter is to provide the reader with a brief background to the area of research. It also describes and explains purpose, problem definition and demarcation of the thesis and gives a short introduction to the case company. The chapter ends with a description of the target group and an outline of the thesis.

Chapter 2 – Methodology

The methodology chapter describes and justifies to the readers the chosen research perspectives and approaches made within this thesis. The authors also describe how they have strived to obtain credibility, objectivity and validity towards the end result together with the practical mode of procedure for the study.

Chapter 3 – The Packaging Scorecard method

This section contains a description of the Packaging Scorecard method, criticism of the method as well as a presentation of the applied method together with the authors' modifications.

Chapter 4 – Frame of Reference

The frame of reference chapter describes the theoretical basis used within this thesis and presents relevant literature concerning packaging, logistics and packaging logistics. Adopted definitions are also accounted for.

Chapter 5 – Empirical Studies

Chapter 5 describes different parts of the IKEA Supply Chain, Supplier, Transport, Distribution Centre and Retail, from a packaging perspective. The structure of this chapter is

²⁰ Warnaby, G. (1999). "Strategic consequences of retail acquisition: IKEA and Habitat". p 412.

²¹ http://www.ikea-group.ikea.com/PDF/IKEA_FF_0405_GB.pdf. *Facts & Figures – The IKEA Group 2004-2005*. 2006-02-02

²² Klevås, J. (2005) *On opportunities of integrated packaging, logistics and product development – Experiences from a case study at IKEA*. p 62.

²³ http://www.ikea-group.ikea.com/PDF/IKEA_FF_0405_GB.pdf. *Facts & Figures – The IKEA Group 2004-2005*. 2006-02-02

based on the structure of the Packaging Scorecard method to make it easier to follow for the reader.

Chapter 6 – Results of the Packaging Scorecard Study

This chapter presents the build up of the IKEA Packaging Scorecard for each part of the IKEA Supply Chain together with the weightings collected for the different factors.

Chapter 7 – Analysis

The analysis chapter is based on the frame of reference and the collected empirical data and discusses the findings of this master thesis. The results from the collected Packaging Scorecards are analysed by discussing their subcategories and logistical influence on the IKEA Supply Chain.

Chapter 8 – The IKEA Packaging Scorecard

In this chapter the final Packaging Scorecard adapted to the prerequisites of the IKEA Supply Chain is presented. Motivations for the chosen weights are also accounted for.

Chapter 9 – Packaging and Product Development Process Checklist

This chapter presents the checklist that is proposed to be used by the employees at IKEA of Sweden during the packaging and product development process in order to support the logistical aspects that should be taken into account.

Chapter 10 – Concluding Remarks and Suggested Future Research

In this chapter the authors present their concluding remarks and propose suggestions for future areas of research related to this master thesis, both internally within IKEA and in a more general perspective.

Concluding formalities

These chapters contain the concluding formalities such as references and appendices.

2 Methodology

This chapter aims to describe and justify to the readers the chosen research perspectives and approaches made within this thesis. The authors will also describe how they have strived to obtain credibility, objectivity and validity towards the end result together with the practical mode of procedure for the study.

Research can be defined as a methodical investigation, conducted in a systematic manner to expand someone's knowledge, hopefully also others, by discovering non-trivial facts and achieve non-trivial insights.²⁴ The methodology involves the overall perspective concerning the choices of methods and the interrelationships between them to fulfil the purpose of the research in the best manner.²⁵

The methods are tools that are used to solve problems and create new knowledge. Everything that can contribute to fulfilling these requirements can be called a method, but this does not mean that all methods are as valid or can withstand a critical evaluation as well as others.²⁶ To assure that the research will generate a true and good understanding of the matters studied a well-considered methodical procedure is a necessary prerequisite.²⁷

The aim with this chapter is to make it possible for the reader to, based on the methodology choices made, independently evaluate the results found together with the following argumentation and generalization.

2.1 Research assumptions

Researchers have predetermined assumptions about how the world works, what true knowledge is, how information should be collected and analyzed etc. These fundamental attitudes can have a big effect on how information is gathered, studied and how conclusions are drawn. Therefore it is important that the authors have a clear view of their fundamental assumptions before they decide upon the methodological approach of the study, since this affects the choice of methodology, methods and practical modes of procedure, as illustrated in Figure 2.1.²⁸

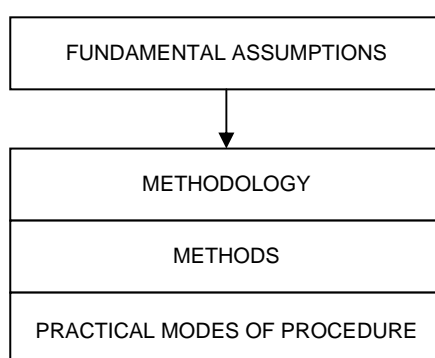


Figure 2.1. The fundamental assumptions of the authors influence the methodology, methods and practical modes of procedure chosen. (Björklund, M. & Paulsson, U. (2003) Seminarieboken – att skriva, presentera och opponera. p 64)

²⁴ Bell, J. (2000) *Introduktion till forskningsmetodik*. p 10.

²⁵ Björklund, M. & Paulsson, U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 57.

²⁶ Holme I.M. & Krohn Solvang B. (1997) *Forskningsmetodik - Om kvalitativa och kvantitativa metoder*. p 13.

²⁷ Holme I.M. & Krohn Solvang B. (1997) *Forskningsmetodik - Om kvalitativa och kvantitativa metoder*. p 11.

²⁸ Björklund, M. & Paulsson, U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 64.

To be able to decide upon a methodological approach it is essential for the authors to contemplate over their predetermined assumptions, paradigms, so that an appropriate approach can be selected. This can be done by determining the authors' conception of knowledge, which is closely related to the paradigms dealing with how research is conducted (epistemology), and reality is viewed (ontology)²⁹.

The authors believe that they, mainly due to their natural science background, view the reality objectively and in an analytical way. They have also adopted the philosophy that the social reality exists independently of the observers and their interpretation of it. This leads to the conclusion that the authors conform to the beliefs of realism. When it comes to the authors view on science, they consider the growth of knowledge as a cumulative process, and knowledge is gained by the verification or falsification of hypotheses, and that the result leads to objective and true knowledge. In this thesis the authors also acted as external observers and did not interact with the observed object. All these assumptions show that the authors lean towards the viewpoints of a positivist.³⁰

2.2 Methodological approach

The methodical approach makes assumptions on how the reality is constituted and guides the researchers so they can study and explain different aspects of it.³¹ The chosen approach considerably affects e.g. the data collection and problem formulation at the same time as it conforms to the researchers' paradigms and philosophical assumptions. This means that the methodological approach acts as a connection point and thereby can provide directions for a more practical mode of procedure.³² There are mainly three different methodological approaches used within research; the analytical-, the systems- and the actor's perspective, which all make different assumptions about the reality it investigates.

2.3 Methodological perspective

In this thesis the authors aimed to investigate how the activities in the supply chain interact with and are influenced by a packaged product in order to identify the logistical key factors that are the most important to consider in the product/packaging development process. This was done to create a foundation to work from when creating the most beneficial product/packaging solution from a supply chain perspective. To enable this, the authors had to study the internal and external processes, and the relationships and correlations between the different parts of the supply chain, in order to identify important synergy effects. All this was done in order to create a holistic view over the supply chain so that sub optimization can be avoided in the development process.

The authors' methodological approach corresponds well to the systems perspective that is often used when the researchers want to explain the reality objectively, but still believes that the whole is separated from, and often more than, the sum of its parts.³³ The perspective also puts emphasis on the interaction between different parts of the system as well as the processes

²⁹ Arlbjørn, J. & Halldorsson, A. (2001) "Logistics knowledge creation: reflections on content, context and processes". p 31.

³⁰ Björklund, M. & Paulsson, U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 65.

³¹ Arbner, I. & Bjerke, B. (1977) *Företagsekonomisk metodlära*. pp 1-3.

³² Arbner, I. & Bjerke, B. (1977) *Företagsekonomisk metodlära*. pp 14-17.

³³ Björklund, M. Paulsson, U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 59.

within and the structure of the whole system³⁴. This is done in order to understand the underlying factors that contribute to different kinds of behavior³⁵.

2.3.1 Design of the study

The amount of the knowledge within the field of research can be of importance when choosing the design of the study. *Explorative* studies are conducted when little knowledge exists about the subject and the researcher is aiming to find fundamental understanding. If there exists fundamental knowledge and understanding within the field of research and the aim is to describe and not to explain the existing relations, a *descriptive* study should be used. An *explanative* study is employed when a deeper understanding and knowledge is desired and the researcher both wants to describe and explain. When the goal is to provide guidance and propose actions and there is some knowledge and understanding within the field, a *normative* study should be used.³⁶

At the beginning of the study, the authors started the thesis work by studying theory existing within the field of packaging and logistics. This was done to examine which demands on packaging that were accounted for within literature. These theoretical studies were followed by general interviews and observations at different parts of the IKEA Supply Chain, in order to create a better understanding concerning what activities that interact with a packaged product along the specified Supply Chain and their significance for the studied logistics flow. After this, the authors started their work towards creating a packaging evaluation method for the prerequisites of the IKEA Supply Chain. This meant a regression back to the theoretical studies where a general method for evaluating packaging solutions called the Packaging Scorecard was found. This method was used as a base for the IKEA evaluation tool. After some modifications of the original method and more empirical studies to examine the significance of different demands, analysis lead to that the Packaging Scorecard method was adapted to the conditions of the IKEA Supply Chain. Based on this method and the empirical studies, the checklist for the packaging and product development process was created. The study process is illustrated in Figure 2.2.

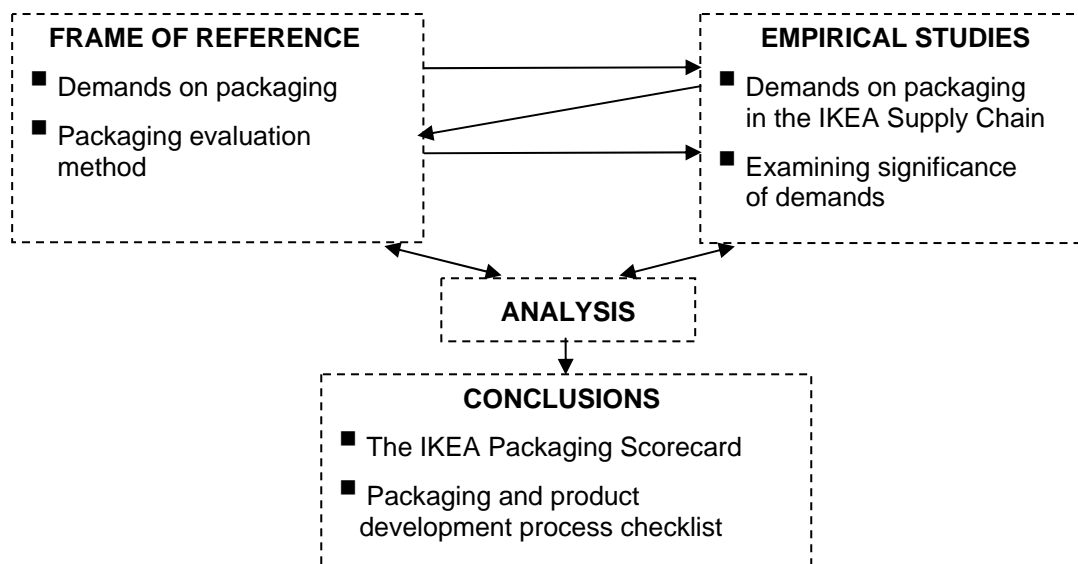


Figure 2.2. The process of the study.

³⁴ Wallén G. (1993) *Vetenskapsteori och forskningsmetodik*. p 29.

³⁵ Björklund, M. Paulsson, U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 59.

³⁶ Björklund M. & Paulsson U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 58.

This means that this master thesis' mode of procedure begins with a descriptive study to create an overall view of the studied Supply Chain and after that continue with a normative study since the aim with this thesis is to provide IKEA with tools to be used as guidance during their packaging and product development process.

2.3.2 Induction, deduction and abduction

There are two main methods of approaching a defined problem or problem formulation. They are the *deductive method* and the *inductive method*.³⁷ In short, induction is based on empirical data whereas deduction is based on logic³⁸. The *inductive method* has its starting point in reality, where one tries to spot patterns that are possible to sum up, thus creating theories or models. Before studying the problem it is not a pre-requisite to study already existing theory – theory is created from the collected empirical data.³⁹ There is put some emphasis on that all data collection is to be unbiased.⁴⁰ Using the *deductive method*, analysing existing theory within the studied area predictions are made about the empirical data. The researcher then tries to verify these assumptions with the help of the collected empirical data, thus making assumptions about different separate events.⁴¹

There is also an additional method of approaching research, which has its origin in both the deductive and the inductive method. It is, simplified, a method where the researcher moves back and forth between the deductive and the inductive method.⁴²

This thesis concerns creating aids on behalf of IKEA to help them assure that packaging logistical concerns are included already in the product and packaging development process and that the packaging solutions can be evaluated. To do this, the authors started with studying literature to achieve understanding of existing theory within concerned areas. After compiling the theoretical data found, the authors received a good insight in the academia's conception of logistical demands on packaging along a typical Supply Chain. The theory was later compared to the collected empirical data, thus a deductive approach was used in the first phase of the study. After this comparison, the authors went back to the theoretical studies trying to find a method that would be suitable for the empirical data collected. The Packaging Scorecard method was found and together with the additional empirical data collected, the method was elaborated in order to fit the prerequisites at IKEA. Since the developed IKEA Packaging Scorecard model is based on the theoretical model, this approach can also be denoted deductive.

2.3.3 Quantitative or qualitative research

Depending on the type of information that needs to be gathered within the study, two different methodological approaches, quantitative or qualitative, can be applied.⁴³ Quantitative studies are conducted when information can be measured and valued in a numerical matter, while qualitative studies are used when a deeper understanding of a situation, event or specific subject is needed.⁴⁴

³⁷ Holme I.M. & Krohn Solvang B. (1997) *Forskningsmetodik - Om kvalitativa och kvantitativa metoder*. p 51.

³⁸ Thurén T. (1991) *Vetenskapsteori för nybörjare*. p 19.

³⁹ Björklund M. & Paulsson U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 62.

⁴⁰ Wallén G. (1993) *Vetenskapsteori och forskningsmetodik*. p 44.

⁴¹ Björklund M. & Paulsson U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 62.

⁴² Björklund M. & Paulsson U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 62.

⁴³ Holme I.M. & Krohn Solvang B. (1997) *Forskningsmetodik - Om kvalitativa och kvantitativa metoder*. p 13.

⁴⁴ Björklund M. & Paulsson U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 63.

One of the main differences between the methodological approaches is how the study is constructed. Qualitative studies are characterized by flexibility, while the quantitative are more structured. The flexibility aspect is important in the qualitative study, since the layout of the study needs to be able to change during the course of the thesis, e.g. due to the authors' experiences during the data collection phase. The authors' open minds towards new knowledge and understanding leads to an ever improving and more fundamental understanding of the research purpose they are working towards. But this can also be a disadvantage since it makes information comparison more difficult between different stages in the research.⁴⁵

The purpose of a qualitative study is to create a deeper knowledge than the fragmented knowledge that is often obtained when using quantitative methods. The ambition is to try to understand and analyze a holistic view of a problem.⁴⁶ The strength of qualitative data and methods is that they provide an overall view, which gives a deeper understanding of processes and different relationships, which coincide with the chosen systems perspective.⁴⁷ According to Björklund et al, a weakness is that it is harder to draw general conclusions from a qualitative study, than from a quantitative.⁴⁸ This is however contradicted by Holme⁴⁹ et al and Kvale⁵⁰, who state that the strength of quantitative research is that the information is gathered in a way that makes a generalization possible. On the other hand, a weakness can be that there is no guarantee that the information gathered is relevant for the studied problem.

To be able to fulfill the purpose of this thesis, the authors had to create a deeper understanding of the processes and relationships that interact within the IKEA Supply Chain in order to create a good holistic view. To do this the authors had to be flexible and by an iterative process, depending on the knowledge collected, continuously create a more and more detailed view of the researched area. Without this view it would have been difficult to correctly determine the essential factors that are most critical from a systems perspective. A quantitative approach without deeper knowledge could lead to that the wrong variables are analyzed and a sub optimization of the process is created. Therefore the authors believe that a qualitative approach is the most suitable for this kind of thesis.

2.4 Case study

One way of conducting research is using a case study method. The case study is "...a way of investigating an empirical topic by following a set of pre-specified procedures"⁵¹. A case study means performing an investigation on a small limited group, which can be an individual or a group of individuals, an organisation or a situation.⁵²

Case studies are in general a good method when answering research questions like "how" and "why" or when the control the researcher has over events is little, although it is a challenging endeavour to embark on.⁵³ It also allows for the researcher to keep a holistic view of events.⁵⁴

⁴⁵ Holme I.M. & Krohn Solvang B. (1997) *Forskningsmetodik - Om kvalitativa och kvantitativa metoder*. p 80.

⁴⁶ Davidsson, B. & Patel R. (1994) *Forskningsmetodikens grunder - Att planera, genomföra och rapportera en undersökning*. p. 99.

⁴⁷ Holme I.M. & Krohn Solvang B. (1997) *Forskningsmetodik - Om kvalitativa och kvantitativa metoder*. p 79.

⁴⁸ Björklund, M. & Paulsson, U. (2003) *Seminarieboken - att skriva, presentera och opponera*. p 63.

⁴⁹ Holme I.M. & Krohn Solvang B. (1997) *Forskningsmetodik - Om kvalitativa och kvantitativa metoder*. p 81.

⁵⁰ Kvale S. (1997) *Den kvalitativa forskningsintervjun*. pp 98-99

⁵¹ Yin R.K. (2003) *Case Study Research - Design and Methods*. p 15.

⁵² Patel R. & Davidsson B. (1994) *Forskningsmetodikens grunder - Att planera, genomföra och rapportera en undersökning*. p. 44.

⁵³ Yin R.K. (2003) *Case Study Research - Design and Methods*. p 1.

The method is to be used when certain questions are placed concerning a certain event and when a certain outcome is desired.⁵⁵

Case studies can be used for exploratory, explanatory as well as descriptive purposes, and has the strength of being able to deal with a majority of evidence (interviews, observations, documents etc.).⁵⁶ The strongest advantage with a case study is that it enables the researcher to focus on a specific event, and try to evaluate which factors that influence the event in question.⁵⁷ Another advantage is that what happens under real circumstances is studied.⁵⁸

A case study is regarded as most appropriate for this thesis for the reasons stated above. In this thesis the subject of study is an organization, IKEA, and the thesis aims to answer *how* different packaging solutions can be evaluated in terms of their logistical Supply Chain efficiency. It also aims to explore *how* a checklist should be designed to best support early packaging logistical involvement. A certain outcome of the thesis is desired, which is a “check list” consisting of the most critical packaging logistical factors to be considered in the product/packaging development process and a method that evaluates a packaging system’s logistical efficiency. Our study also supports the strongest advantage of the case study method, which is evaluating which factors that influence logistical efficiency and effectiveness of the packaged product.

2.5 Case study process

In this chapter the authors describe the way in which the study was carried out. The case study process of this thesis is illustrated in Figure 2.3 below.

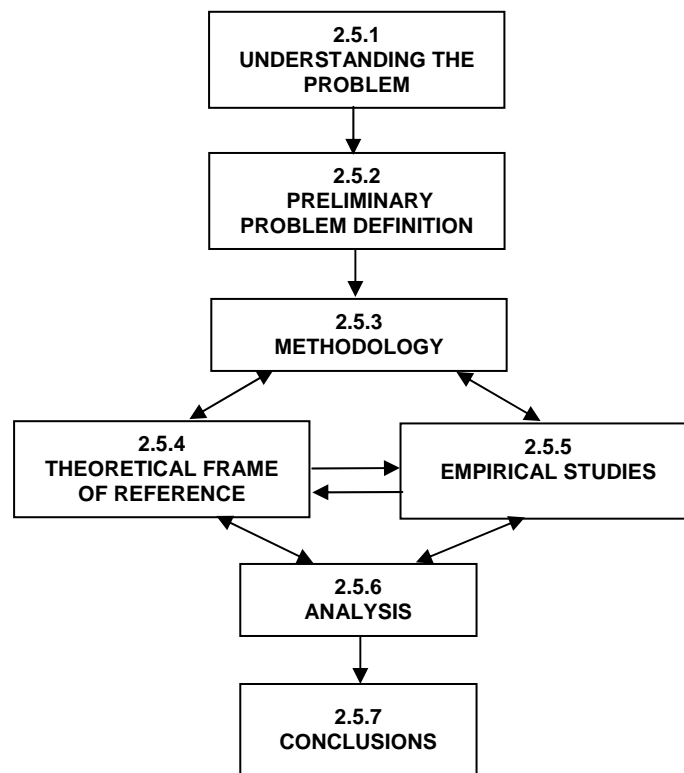


Figure 2.3. The case study process applied in this thesis.

⁵⁴ Yin R.K. (2003) *Case Study Research – Design and Methods*. p 2.

⁵⁵ Merriam S.B. (1994) *Fallstudien som forskningsmetod*. p 50.

⁵⁶ Yin R.K. (2003) *Case Study Research – Design and Methods*. pp 3-8

⁵⁷ Bell J. (2000) *Introduktion till Forskningsmetodik*. p 16.

⁵⁸ Wallén G. (1993) *Vetenskapsteori och forskningsmetodik*. p 105.

The different phases of the case study process are described in detail in the subchapters 2.5.1 to 2.5.7.

2.5.1 Understanding the problem

In order to get a basic comprehension and overview of the area of the study, an introductory visit at IKEA of Sweden in Älmhult was performed. A general discussion with people⁵⁹ working at Packaging Concept department was carried out, whereby a solid basic knowledge of the packaging related issues within IKEA in general was apprehended along with a basic and general understanding of IKEA as a whole. The discussion also led to a better understanding of what IKEA wanted to attain from the study. A contributing factor in this phase was the help available from one of the supervisors⁶⁰ of the authors, who has written her licentiate thesis within the same area and with IKEA as the case study company, thus having good and relevant knowledge to pass on. Furthermore, an introductory visit at one of the IKEA distribution centres in Älmhult was made, where the authors were guided by relevant personnel⁶¹ to whom they could place the questions they had while making general observations. A visit with the same purpose was made at the IKEA store in Malmö. Literature within the area of study was also studied in order to make the overview more complete, along with internal documents given to us by the IKEA employees interviewed. As a result, a general knowledge of IKEA and the studied part of their Supply Chain was achieved, and with this as a base the master thesis could continue.

2.5.2 Preliminary problem definition

With the general understanding attained in the introductory phase, along with the wishes of the Institution of Packaging Logistics, the ones of the supervisor at IKEA of Sweden as well as the authors own, a preliminary purpose and problem definition could be formulated. This has later been altered a little, leaning more towards the wishes of IKEA than the ones of the institution. The supervisors, who have extensive experience of this kind of thesis and of supervising students, have helped the authors to choose a project of suitable size and workload for a master thesis.

2.5.3 Methodology

Methodology means working out a certain “design” or “arrangement” of the study. It determines methods of data collection and data processing used, and the relationship between them.⁶²

To plan and structure this master thesis methodological literature, as well as other relevant literature, was studied. Knowledge of which empirical data that at the time was available to the authors was taken into account. Then, through discussions with the supervisors, the authors concluded which methodological approach and perspective as well as case study approach and design that were suitable and corresponded to their views and the thesis in question.

⁵⁹ Eriksson, Mathias & Ström, Tord. Packaging Technicians. Packaging Concepts at IKEA of Sweden. Interview. 2005-09-19

⁶⁰ Klevås, Jenny. Department of Design Sciences, Division of Packaging Logistics, Lund University. Lund.

⁶¹ Johansson, Jörgen. Range Manager and member of the Q-department at IKEA Distribution Centre in Älmhult. Interview. 2005-09-16

⁶² Björklund M. & Paulsson U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 74.

2.5.4 Theoretical frame of reference

The theoretical frame of reference is developed from literature studies. The data collected from literature studies is called secondary data, which has the significance that the data was originally not compiled for the purpose of the study in question⁶³. Sources of secondary data can be papers, books, periodicals etc.

For the purpose of conducting a study where the conclusions are reliable and good, the authors have strived towards creating a solid theoretical base. Existing publications and theories were extensively studied, of which the ones of importance for this thesis were chosen and presented in this report. Reliable sources have been used and compared to each other in order to secure the use of objective information. The supervisors, who have recommended literature they believed to be of use as well as giving the authors ideas of where to find the information needed, have been a great help in creating the theoretical frame of reference.

The theoretical frame of reference created in the beginning of the study has little by little been completed and revised in order to be short and concise, but yet extensive enough, relevant and contain the information necessary. The first steps involved getting a basic knowledge of models and theories within the area of study, whereby, little by little, while the authors' knowledge deepened, the search for information widened and became more and more accurate.

2.5.5 Empirical studies

There are many different sources of information, out of which *direct observations, interviews and company documentation* are some of the major ones. They all have strengths and weaknesses. *Documentation* can be reviewed repeatedly and contains exact references, names and details. On the other hand retrievability can be low and it can show bias of the author. Access can also be limited. *Interviews* are important when collecting case study information and focuses on the topic studied. They can be very insightful, but questions need to be constructed in a good manner in order to avoid bias. Biased answers may be given by the interviewee, as well as the interviewee can give an answer that the interviewer wants to hear. *Direct observations* reflect real events in real time in the context of the event. However, they are time consuming and many times expensive, and the fact that events may occur differently than they normally do when the actors know they are being observed has to be kept in mind.⁶⁴

The sources of documentation used have mainly been IKEA's internal documents concerning product and packaging specifications etc. This information has been valuable to the authors and is considered exact and unbiased. Access has been somewhat limited though due to company confidentiality, which has had the consequence that the authors have had to collect the desired information in other manners, for example by means of observations. The authors deem this problem of accessing all relevant information to be overcome in this way. The data has been collected during the entire study, where complementary additions have been made when necessary.

In order to achieve good credibility of the information collected during interviews, the interviews have been well thought-through and prepared. The interviewees have relevant positions within the company and a majority have worked at IKEA for many years. Thereby the authors consider them to have a good knowledge and understanding of IKEA in general as

⁶³ Björklund M. & Paulsson U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 70.

⁶⁴ Yin, R. K. (2003) *Case study research – Design and methods*. pp 85-97

well as good knowledge within their specific area. They have been chosen considering their position within the company by the supervisor at IKEA based on the wishes of the authors. Before an interview, a frame of what was to be discussed during the interview was sent to the interviewees. These frames are presented in Appendix A. The interviews have been semi structured, taking the form of discussions. This has made it possible for the authors to further elaborate interesting answers given by the interviewees by asking them more precise questions. The authors aimed to avoid biased answers by preparing both themselves and the interviewees well before every interview. All interviews used were recorded, making it possible to concentrate on the discussion and getting hold of all relevant information as efficiently as possible. It also meant that the authors have had the possibility of listening several times to what has been said during the interviews, thus strengthening the accuracy of the information and making sure that no information has been lost or overseen. The recordings of the interviews have been saved and the interviews typed out, thus creating an empirical database.

Although time consuming, observations have been made. The purpose has been to document what actually happens when and how it happens, and not only to document what is *supposed* to happen. The latter may be the case when studying what activities and procedures that are used. Reality may differ from theory. Sometimes the authors have also seen observations as the only good way to get hold of the necessary data. Notes have been taken during the observations as well as photographs in order to ease the documentation of what has been observed. The authors believe photographs to be a good way for the remembrance of what has been seen during the observations. The observations have many times been made from afar, where the authors have been “unnoticeable”, in order to avoid differences in what normally happens and what actually happened during the observations.

2.5.6 *The analysis*

During the analysis, the collected data is analyzed together with the Frame of Reference. The factors or data that has been found during the studies are discussed and patterns and relationships are explored, e.g. how different factors affect each other. This part of the thesis is mainly built on the thoughts of the authors and therefore it is important that all the stages in the analysis are motivated and described well to facilitate an evaluation of the drawn conclusions.⁶⁵

The first stage of the analysis work was performed after the primary interviews and observations at the different parts of the demarcated Supply Chain. After this stage the authors compiled the most prominent packaging related factors, based on the theoretical and empirical studies together with the authors own experiences, and constructed unique Packaging Scorecards for each part of the Supply Chain. These were completed with an extra document that described the context and meaning of each factor, so that all the people that later made the weighting perceived the contents in the same way. These Packaging Scorecards were later sent out to at least five people at each part in the Supply Chain for weighting. After collecting these weightings, an analysis began with finding patterns in the different weights given, and after discussion, concluding a final weight that should correspond to the factors' importance. The analysis will also result in a brief checklist containing the factors that are the most important to consider all through the Supply Chain when designing new packaging systems.

⁶⁵ Björklund M. & Paulsson U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 47.

2.5.7 Conclusions

In the conclusions the authors present the results from the analysis, what the results are based on together with what consequences the results can have.⁶⁶

The conclusions in this thesis will be presented as the final Packaging Scorecards for IKEA, together with the checklist containing the most important packaging factors to consider while designing packaging systems at IKEA. Also some considerations regarding the employment of the Packaging Scorecard will be discussed.

2.6 Quality of data

It is important to minimize errors and distortions during different stages of the research process in order to present valid and reliable conclusions of the study in question. The quality of the data that is collected needs to be as high as possible, and therefore the entire research process has to be planned with the quality aspect in mind before conducting the study. Quality of data has to be kept in mind during the entire research process.⁶⁷ The manner in which this is done in the context of this thesis is discussed in the chapters below.

2.6.1 Internal validity

Internal validity concerns the question whether or not the results accomplished in the thesis reflects the reality. According to Merriam there exists six fundamental strategies that researchers use to ensure the internal validity of a qualitative study. These are presented below together with the applications in this thesis:⁶⁸

- *Triangulation*, which means that multiple researchers, sources of information and methods are used in order to confirm the results that follows the study.

In this thesis the authors have used both internal documents and observations to confirm the answers provided during the interviews. They have also in the best way possible during the interviews re-asked some critical questions later during the interview, but formulating the question in another way, to ensure that the authors were provided with the correct information and that the interviewee has understood the question correctly.

- *Control of the participants*, which implies that the people that have provided information are given the opportunity to view the descriptions and interpretations made so an evaluation of the credibility of the results can be made.

The authors have sent out an outline of the data collected to the supervisor at IKEA that had the time to revise this, to ensure that the authors perceived the information in the correct way. The authors have also used the knowledge of our supervisors at the institution as a complementary source of inspection.

- Observation for an *extensive time period* of the environment studied or *repeatedly* studying the same phenomenon. This means that the data collection is carried out during an extensive time period in order to increase the validity of the results.

⁶⁶ Björklund M. & Paulsson U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 48.

⁶⁷ Holme I.M. & Solvang B.K. (1997) *Forskningsmetodik – Om kvalitativa och kvantitativa metoder*. p 163.

⁶⁸ Merriam S.B. (1994) *Fallstudien som forskningsmetod*. pp 177-180

Since this thesis is supposed to be completed within twenty weeks, the timeframe doesn't allow an extensive study, but, when it has been possible, multiple visits and complementary interviews have been made to the different areas studied.

- *Horizontal evaluation and critique*, which means that the authors ask their colleagues to comment and criticize the results as they emerge during the study.

The authors have asked their supervisors and other personnel at the institution to comment and criticize the thesis during its construction, and fellow students have acted as opponents at the presentation of the thesis before the final thesis was completed and printed.

- *Participated approach* in the research, which implies that the people studied are involved in the whole research process.

This approach has not been used in this study, due to the limited time and resources of the people involved.

- *Clarifying of distortions* that the researchers are risking to bring to the research, that is that the researchers explicitly account for their initial standpoints, underlying assumptions, view of the world and theoretical perspectives at the beginning of the study.

The viewpoints that might cause distortions have been discussed in the chapters 2.1 Research assumptions and 2.2 Methodological approach, which for example contain the authors' views on epistemology and ontology.

2.6.2 External validity

External validity deals with the problem of knowing if a study's findings are generalizable beyond the immediate case study. This aspect is known as a major barrier when conducting case studies.⁶⁹ Qualitative case studies usually have a high internal validity, but the generalization of case studies is usually more difficult to motivate, since the reason for choosing case studies normally is to study a situation or an event in the depth.⁷⁰ When conducting multiple case studies is not an option, the generalization of the results depends on that a redefinition of the generalization principles is made so they reflect the point of departure or prerequisites that the qualitative research rests upon.⁷¹ To achieve this, researchers have to provide a detailed description of the context in which the study was performed. This description has to specify everything the reader might need to know to be able to understand the results.⁷²

Since this study is a single case study, the authors have put a lot of emphasis on richness of the case description in order to provide the reader, who is interested in transferring the results, with an extensive information base to be used as comparison in other cases.

⁶⁹ Yin, R. K. (2003) *Case study research – Design and methods*. p 37.

⁷⁰ Merriam S.B. (1994) *Fallstudien som forskningsmetod*. p 184.

⁷¹ Merriam S.B. (1994) *Fallstudien som forskningsmetod*. p 185.

⁷² Lincon Y. & Guba E. (1985) *Naturalistic Inquiry*.

2.6.3 Credibility

For the authors, due to the limitations regarding time and funding that are faced when writing a master thesis, it is impossible to validate the credibility of our study by for example conducting the same study once more. Instead the authors have had the aim of securing good credibility beforehand by for example triangulating data. Triangulation means using several different methods for the purpose of investigating the same event⁷³.

Two people have conducted the study, which means that two people have collected the same data when for example conducting interviews. It also means that two people have interpreted the same information. Interviewees have been chosen, to the extent that it has been possible, with their specific knowledge in mind ensuring that the information given by them is correct and relevant. The same questions have been discussed with several different people with different positions within IKEA, and this has in many cases been compared with internal documents and existing publications. All the interviews used have been recorded and observations have been noted and, when allowed considering company confidentiality, photographed. For collecting the information needed for this thesis, several different types of sources have been used, and literature sources used are well acknowledged and respected within the area studied.

⁷³ Björklund M. & Paulsson U. (2003) *Seminarieboken – att skriva, presentera och opponera*. p 76.

3 The Packaging Scorecard method

This section contains a description of the Packaging Scorecard method, criticism of the method as well as a presentation of the applied method together with the authors' modifications.

3.1 The original method

An efficient packaging system is one instrument in fulfilling good supply chain efficiency.⁷⁴ It is therefore important to use some kind of tool that ensures that the packaging system utilized is adapted to the prerequisites of its designated supply chain. The Packaging Scorecard is a systematic analysis method that has been developed in order to evaluate the supply chain contributions of different packaging systems. The aim of the method is to improve packaging systems regarding their supply chain performance.⁷⁵

The method is based on the theories of the Balanced Scorecard method and knowledge regarding packaging and packaging logistics. Packaging functions in each separate step of the supply chain are evaluated to avoid the risk of neglecting needs of any part of the supply chain.⁷⁶ Results from case studies that have been conducted have shown that the method is useful for the actors of the supply chain and that the method merges supply chain needs.⁷⁷

The Packaging Scorecard covers every part of the supply chain from supplier to customer. Table 3.1 below illustrates the factors (criteria) that are considered important for the different actors of the supply chain according to the method.

CRITERIA	SUPPLIER	TRANSPORT	DC	RETAIL	CONSUMER
Machinability	x				
Product protection	x	x	x	x	x
Flow information	x	x	x	x	
Volume & weight efficiency	x	x	x	x	
Right amount and size		x	x	x	x
Handleability		x	x	x	x
Other value-adding properties	x				x
Product information					x
Selling capability				x	x
Safety				x	
Reduced use of resources	x				
Min. use of hazardous substances	x				x
Minimal amount of waste				x	x
Packaging costs	x				

Table 3.1. Criteria for the supply chain actors according to the Packaging Scorecard. (Dominic C. & Olsmats C. (2001) Packaging Scorecard - A method to evaluate packaging contribution in the supply chain. Report no 200. Packforsk. Kista. Table 4-1. p 18)

⁷⁴ Dominic C. & Olsmats C. (2001b) *Packaging Scorecard - A method to evaluate packaging contribution in the supply chain*. p 1.

⁷⁵ Ibid.

⁷⁶ Dominic C. & Olsmats C. (2001a) *Packaging Scorecard - A method to evaluate packaging contribution in the supply chain*. p 17.

⁷⁷ Dominic C. & Olsmats C. (2001b) *Packaging Scorecard - A method to evaluate packaging contribution in the supply chain*. pp 1-2

The criteria marked with x:s under each part of the supply chain are the basis of the creation of Packaging Scorecards. Table 3.2 illustrates an example of a Packaging Scorecard for a supplier and shows the most significant packaging related criteria to consider from a suppliers perspective. The corresponding weightings in the table symbolize the importance of the criteria, with weightings ranging from 0-100% of importance. These weightings are according to the method provided by different contact persons operating at the specific part of the supply chain that the Packaging Scorecard is supposed to represent. After the weightings are provided, the weighted criteria are normalized as follows; the weighted criteria are summed in total and each weighted criterion is then divided by the total. This gives the normalized weight which represents the relative significance of each criterion.⁷⁸

The method is used in the following manner: A packaging solution is evaluated by receiving a score from 0 and 4 (0=criterion not applicable for the packaging, 1=not approved, 2=approved, 3=well approved, 4=requirements fulfilled excellently), depending on how well it fulfils the different criteria. The next step is multiplying each score with the corresponding normalized weight.⁷⁹ An example is shown below in Table 3.2. The weighted average score is calculated as follows: $0,083 \times 2 + 0,083 \times 1 + 0,111 \times 3 + 0,139 \times 3 + 0,194 \times 4 + 0,194 \times 4 + 0,194 \times 2 = 2,94$. This weighted average packaging score gives an indication of how well the packaging is performing in the separate parts of the supply chain. The resulting weighted average scores from the different parts of the supply chain are then added and give together the total packaging score for a packaging solution⁸⁰.

CRITERIA	WEIGHT	NORMALIZED WEIGHT	SCORE
Flow information	30	8,3%	2
Other value-adding properties	30	8,3%	1
Volume and weight efficiency	40	11,1%	3
Right amount and size	50	13,9%	3
Machinability	70	19,4%	4
Product protection	70	19,4%	4
Packaging costs	70	19,4%	2
Weighted average packaging score			2,94

Table 3.2. Example of a Packaging Scorecard for a supplier (Dominic C. & Olsmats C. (2001) Packaging Scorecard - A method to evaluate packaging contribution in the supply chain. Report no 200. Packforsk. Kista. Table 5-1. p 24).

The aim with the packaging scorecard method is to provide a better overview and understanding of the packaging system performance throughout the supply chain. This can be done in two ways. The first way to make use of the results is to identify the most important aspects to consider at a stage in the supply chain, in Table 3.2 the most critical aspects are for example *Machinability*, *Product protection* and *Packaging costs*. The Packaging Scorecard implies that effort should be taken to reduce the *Packaging costs* and that *Other value-adding properties* leaves room for improvement. But since *Other value-adding properties* has a rather low weight this aspect is not as critical to improve as *Packaging costs*.⁸¹ The second way to

⁷⁸ Dominic C. & Olsmats C. (2003) *Packaging Scorecard - A Packaging Performance Evaluation Method*. pp 10-11

⁷⁹ Dominic C. & Olsmats C. (2001) *Packaging Scorecard - A method to evaluate packaging contribution in the supply chain*. pp 13-23

⁸⁰ Ibid.

⁸¹ Dominic C. & Olsmats C. (2003) *Packaging Scorecard - A Packaging Performance Evaluation Method*. pp 10-11

use the results is to use the total supply chain packaging score to compare the performance of different packaging solutions in order to decide the most efficient one from a whole supply chain perspective or to trace and evaluate the consequences of a change in the packaging solution from a whole supply chain perspective. An example of this can be that a product has a certain packaging solution that scores a total weighted average score of 12,34 (2,61 at the supplier, 2,02 during transport, 3,01 at the DC, 2,19 at the retailer and 2,51 by the consumer). A small change in the packaging solution to improve the packaging performance during transport gives raise to other scores at the rest of the parts of the supply chain and the total weighted average score for the packaging shifts to 11,91 (2,09 at the supplier, 3,23 during transport, 2,21 at the DC, 2,06 at the retailer and 2,32 by the consumer). This implies that the change that improves the performance at one stage of the supply chain in the total have a negative effect from a whole supply chain perspective. By using the Packaging Scorecard these negative changes can be discovered and avoided.⁸²

3.2 Critique of the original method

The Packaging Scorecard method has previously been subject of some criticism⁸³. It has been said that the factors (criteria) are broad and are not divided into subcategories. The authors concur to this criticism and have modified the method to include subcategories, making the factors to be weighted more precise. Also, it cannot be told whether or not the scores given to the packaging solutions are affected by subjective views of the respondents. The authors cannot guarantee complete objectivity of the respondents. Even though the respondents work within the same department their tasks may differ, which might give rise to some subjective views whether the respondents are aware of this or not. Another point of criticism is that no explanations are given to why the packaging solutions are provided the scores that they are given.

As mentioned earlier the categories of the original method are very broad and do not contain any subcategories. This makes it hard to pinpoint what exactly is to be considered in each category. It also becomes hard to know what overall score to give a packaging solution when there are so many things to consider in each category. It has not yet been proven that the Packaging Scorecard method is useful, but indications are given in the case studies that have been conducted. Further, more extensive, research has to be conducted in order to prove its usefulness, and the research needs to include different kinds of supply chains and product types, large numbers of respondents etc. Also, there is nothing that says that the packaging solution with the best total score gives the lowest cost to customer, which is something that needs to be taken into account when using the method. The method, however, gives good information about the efficiency of the packaging solution and, if necessary, from which aspects it needs improvement.

3.3 The modified method

The Packaging Scorecard method used in this thesis has been further developed and changed to better suit the needs of this thesis and IKEA, as well as better reflect the views of the authors.

The demarcations used in the original method are somewhat changed and Transport now includes loading activities at the supplier. The reason for this is that handling activities during

⁸² This section expresses the opinion of the authors.

⁸³ Ericsson V. & Towman M. (2004) *Evaluation of secondary packages for Tetra Top on the Italian market – supportive tools for decision-making*. p 28.

loading are not the same as handling activities in a DC, whereby handleability is of different importance during loading and in a DC. The customer is not taken into consideration due to the delimitations of the thesis. The modified method also includes subcategories in order to make the factors easier to assess and give a correct score.

Some factors (criteria) are also removed and some are added. The resulting table, Table 3.3, is shown below.

POS.	CRITERIA	SUPPLIER	TRANSPORT	DC	RETAIL
1	Packing process	x			
2	Product protection	x	x	x	x
4	Volume efficiency	x	x	x	x
5	Right amount and size		x	x	x
6	Handleability	x	x	x	x

Table 3.3. The factors of the modified Packaging Scorecard method.

Factors (criteria) 3 and 7-14 in the original method have been removed. The reason is that they do not have any significance for the studied parts of the supply chain, or that the delimitations of the thesis exclude them.

Factor 1, previously “Machinability”, is renamed and redefined and in the modified method called “Packing process”. Machinability implies that the packing line is automatic, but the modified model considers both manual and automatic packing lines. Factor 4, Volume and weight efficiency, in the original method has been changed to include only the volume aspects in the context of this thesis since the weight of the goods to a very little extent is influenced by the packaging solutions chosen by IKEA. The packagings influence over volume utilization is on the other hand a factor that IKEA can affect. The significance of each factor in the modified Packaging Scorecard method can be found in Appendix B.

4 Frame of Reference

This chapter describes the theoretical basis used within this thesis and will present relevant literature concerning packaging, logistics and packaging logistics. Adopted definitions will also be accounted for.

4.1 Packaging

In this subchapter packaging related definitions, packaging cost trade-offs and factors influencing packaging design will be presented.

4.1.1 Definition

Since the view on packaging has changed from being considered as an isolated part with only a protective function, towards being a part of the logistics chain, there exists some confusion regarding its definition.⁸⁴ Also the meaning of the terms packaging and package is often mixed up both within literature and in daily speech⁸⁵. Therefore it is important to present the authors interpretation of the nomenclature used in this thesis.

While making a literature survey of the definition of packaging, a large number of definitions were found. Paine's three definitions of packaging, presented below, are the most commonly used within the literature studied by the authors. These definitions describe packaging as⁸⁶:

- *“A coordinated system of preparing goods for transport, distribution, storage, retailing and end-use”*
- *“A means of ensuring safe delivery to the ultimate consumer in sound condition at minimum cost”*
- *“A techno-economic function aimed at minimising costs of delivery while maximising sales (and hence profits)”*

Another common definition found, the one that e.g. Dominic et al⁸⁷ and Lumsden⁸⁸ use, is the definition of packaging according to the EU-directives (94/62/EC). There packaging is described as:⁸⁹

“All products made of any materials of any nature to be used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer. “Non-returnable” items used for the same purposes shall also be considered to constitute packaging.”

Within the EU-definition it is also specified that packaging can include a sales/primary packaging, a grouped/secondary packaging and a transport/tertiary packaging.⁹⁰

⁸⁴ Lumsden, K. (1998) *Logistikens grunder, Teknisk Logistik*. p 419.

⁸⁵ Klevås, J. (2005) *On opportunities of integrating packaging, logistics and product development – experiences from a case study at IKEA*. p 33.

⁸⁶ Paine, F A. (1981) *Fundamentals of Packaging*. p 3.

⁸⁷ Dominic, C. et al. (2000) *Förpackningslogistik*. Packforsk. 2nd Ed. Kista. p 24.

⁸⁸ Lumsden, K. (1998) *Logistikens grunder, Teknisk Logistik*. p 420.

⁸⁹ European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste.

⁹⁰ Ibid.

Both the packaging definitions presented can be connected to the view of packaging as an interacting system and this is also the view of the authors. Therefore packaging in this thesis will constitute the term used when applying a system's perspective, while an individual unit with no interaction aspects considered will be denoted a package. In other words, when looking at a packaging a system's approach is used, while a package is just seen as an independent object.

4.1.2 Packaging influence

From a warehousing and materials management perspective, the packaging is closely connected to warehouse efficiency and effectiveness. A perfectly designed packaging increases service, decreases cost, and improves handling, which means that a good packaging can have a positive impact on layout, design and overall warehouse productivity. This can be achieved by letting the packaging interface well with the organisation's materials handling equipment and allow efficient utilization of storage space as well as transportation cube and weight constraints.⁹¹

A good packaging design is mainly dependent on seven factors⁹²:

- Standardization
- Pricing (cost)
- Product or package adaptability
- Protective level
- Handleability
- Product packability
- Reusability and recyclability

Also providing efficient storage space utilization and the ability to convey information are important issues to consider.⁹³

Trade-offs between the factors depend on the importance a firm places on each factor. How the packaging costs can be traded off with other logistic activities is presented in Table 4.1 presented on the next page.⁹⁴

⁹¹ Lambert D. & Stock J. & Ellram L (1998) *Fundamentals of Logistics Management*. p 332

⁹² Ibid.

⁹³ Ibid.

⁹⁴ Ibid.

LOGISTICS ACTIVITIES	TRADE-OFFS
Transportation	
Increased packaging information	Decreases delays of shipments; increased packaging information decreases tracking of lost shipments.
Increased packaging protection	Decreases damage and theft in transit, but increases packaging weight and transportation costs.
Increased standardization	Decreases handling costs, waiting time for the loading and unloading of vehicles; increased standardization; increases modal choices for shipper and decreases need for specialized transport equipment.
Inventory	
Increased product protection	Decreases theft, damage, insurance; increases product availability (sales); increases product value and carrying costs.
Warehousing	
Increased packaging information	Decreases order filling time, labour cost.
Increased product protection	Increases cube utilization (stacking), but decreases cube utilization by increasing the size of the product dimensions
Increased standardization	Decreases material handling equipment costs.
Communications	
Increased packaging information	Decreases other communications about the product such as telephone calls to track down lost shipments.

Table 4.1. Packaging Cost Trade-Offs with other logistics activities. (Lambert D. & Stock J. & Ellram L (1998) *Fundamentals of Logistics Management*. International Edition. McGraw-Hill. p 334)

4.2 Packaging system

Depending on where in the Supply Chain the packaged product is found, different packaging levels (primary-, secondary- and tertiary packaging) are handled. It is important that each level is developed to be functional, but it is interaction between the levels that is critical for an efficient distribution.⁹⁵ Therefore the estimated performance of the packaging solution should include all the levels⁹⁶. The packaging levels can be seen as parts of a system, as illustrated in Figure 4.1.

⁹⁵ Dominic, C. et al. (2000) *Förpackningslogistik*. p. 27.

⁹⁶ Hellström, D. & Saghir, M. (2003) "Framework of Packaging Logistics Activities in Retail Supply Chains". p 123.

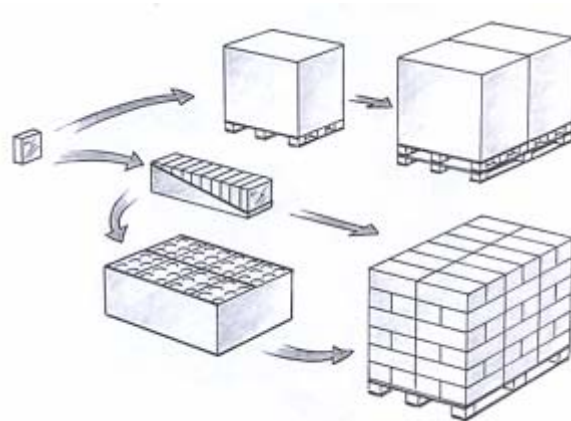


Figure 4.1. Different levels of a packaging system. (Förpackningsguide för dagligvaror – Från producent till konsument (2005) ECR Sverige. Stockholm. p 3)

Naturally the number of levels of the packaging system can differ from the ones given in Figure 4.1.⁹⁷ It is important that the packaging system is adjusted to the load carriers (discussed in chapter 4.2.4 Load carrier) that are used in the distribution chain. Even if the load carrier is not considered a packaging, in some logistical flows it can be regarded as a part of the packaging system.⁹⁸

4.2.1 Primary packaging

The main purpose with the primary packaging is to make the product accessible and attractive to the customer, while it also protects and preserves the properties of the product. The consumer should also be able to easily identify and obtain information about the product. The logistical demands put on the packaging are that they should be easy to stack and adapted to the shelf space. It should also be easy to handle for the consumer when it comes to opening, resealing and recycling.⁹⁹ It has been concluded that primary packaging also should ease production, e.g. by being easy to fill.¹⁰⁰

4.2.2 Secondary packaging

The secondary packaging is a packaging that contains several primary packages and one of its main functions is to make the handling of the products easier at the vending point.¹⁰¹ Another purpose of the secondary packaging is to protect and hold several primary packagings together until they reach the sales area.¹⁰² To minimize labor work, the retailers also prefer the ability to place secondary packaging directly on the shelves in the stores, so that they do not have to unload and place each item separately. Therefore secondary packaging that meet the retail requirements for shelf space are preferred.¹⁰³

4.2.3 Tertiary packaging

The tertiary packaging is usually named the transport packaging. When the tertiary packaging is dimensioned, the designer has to take into consideration, amongst other factors, the products dynamic sensitivity, means of transportation and the recipient country. The tertiary

⁹⁷ Dominic, C. et al. (2000) *Förpackningslogistik*. p 27.

⁹⁸ Ibid.

⁹⁹ Dominic, C. et al. (2000) *Förpackningslogistik*. pp 24-25

¹⁰⁰ Saghir, M. (2004) "The Concept of Packaging Logistics". p 20.

¹⁰¹ Dominic, C. et al. (2000) *Förpackningslogistik*. p 25.

¹⁰² *Förpackningsguide för dagligvaror – Från producent till konsument* (2005) ECR Sverige. p 10.

¹⁰³ Bowersox J.D. & Closs D.J. & Cooper M.B. (2002) *Supply Chain Logistics Management*. p 410.

packaging should also be adapted to the load carrier that is used.¹⁰⁴ Another purpose of tertiary packaging is to ease handling and provide stability.¹⁰⁵

The choice of tertiary packaging is influenced by both the product and the other levels of the packaging system. For example, for rigid and stable products a simple kind of packaging, such as shrink-wrap, might be enough while other less stable products need a transport box in order to enable stacking.¹⁰⁶

4.2.4 Load carrier

Load carriers are a group of means of assistance that are used to facilitate handling and stacking of a larger number of packaging. They come in many different designs, and by using a load carrier a lot of the transportation damages are avoided. Common examples of load carriers are pallets and containers.¹⁰⁷ A load carrier serves many purposes, but among others, it is supposed to protect the goods, hold the goods together as a single unit as well as carry the goods.¹⁰⁸

From a materials handling perspective the tertiary packaging should be standardized and reasonably large in order to minimize the number of units handled in the warehouse. To further facilitate the warehouse handling it is desirable that the retailers order in tertiary packaging quantities.¹⁰⁹

4.3 Logistics

There are many recognized definitions of the term *logistics*, but the one chosen for use in this thesis is the one most commonly used, namely the one of The Council of Supply Chain Management Professionals (CSCMP). They define the term logistics as follows¹¹⁰:

“Logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers’ requirements.”

As the definition above states, logistics is a part of a process and not a function. In order to accomplish customer service objectives, the logistics process strives towards interlinking and coordinating all the activities, from the source of raw material to the end consumer, concerning acquiring, converting and distributing goods. Physical activities such as moving and storing goods, providing the information necessary to support these functions and managing the overall process, are included in this logistics process. All of this is supposed to be done in an efficient and cost effective manner to achieve required levels of customer service. Thereby, by providing customers with the right kind and amount of products as well

¹⁰⁴ Dominic, C. et al. (2000) *Förpackningslogistik*. p 26.

¹⁰⁵ Saghir, M. (2004) “The Concept of Packaging Logistics” pp 20-24

¹⁰⁶ Dominic, C. et al. (2000) *Förpackningslogistik*. p 26.

¹⁰⁷ Dominic, C. et al. (2000) *Förpackningslogistik*. pp 26-27

¹⁰⁸ Lumsden K. (1998) *Logistikens grunder*. p 452.

¹⁰⁹ Bowersox J.D. & Closs D.J. & Cooper M.B. (2002) *Supply Chain Logistics Management*. p 410.

¹¹⁰ http://www.mi-clm.org/cscmp/about_cscmp.htm. *Council of Supply Chain Management Professionals – The Michigan Roundtables*. 2005-09-08

as on the right time and in the required condition, the logistics process contributes to the revenue growth of the company in question.¹¹¹

4.4 Packaging logistics

The concept of *packaging logistics* is a fairly new topic that recently has gained interest, both in the academic world and among practitioners. Even though the topic has been discussed briefly by different organizations, there are few definitions of *packaging logistics* that the authors find satisfactory, but one that is found adequate for use in the context of this thesis is the one by Saghir:¹¹²

“The process of planning, implementing and controlling the coordinated packaging system of preparing goods for safe, efficient and effective handling, transport, distribution, storage, retailing, consumption and recovery, reuse or disposal and related information combined with maximizing consumer value, sales and hence profit.”

The definition above corresponds to the discussion made earlier regarding packaging and the definition of logistics, and is therefore chosen for this thesis.

The concept of *packaging logistics* is to be considered as an integrated approach in which the logistical system and the packaging systems interact, complement as well as adapt to each other, as the definition above implies. A holistic approach is an important aspect, as the aim is to improve the entire integrated system and not only a limited part. For example, making an improvement only regarding the packaging system without considering the logistical system may have a negative effect for the total system.¹¹³

4.5 Storage types

In a storage facility a couple of different storage types usually are found, often depending on the product type stored. Literature describes several different types of storage, but in this thesis only free stacking and deep storing, pallet racking and automated storage will be accounted for, since these storage types are the ones used at the studied Distribution Centre. These are presented in the subchapters below.

4.5.1 Free Stacking and Deep Storing

When pallets are placed in depth (n) directly on the storage floor, the storing type is called deep storing. If it is possible to pile the pallets in multiple levels on top of each other (m), also known as free stacking, the storage volume utilization can reach high values, see Figure 4.2.¹¹⁴

¹¹¹ Byrne P.M. & Markham W.J. (1991) *Improving Quality and Productivity in the Logistics Process – Achieving customer satisfaction breakthroughs*. pp 29-31

¹¹² Saghir M. (2002) *Packaging Logistics Evaluation in the Swedish Retail Supply Chain*. pp 39-45

¹¹³ Saghir M. (2002) *Packaging Logistics Evaluation in the Swedish Retail Supply Chain*. pp 55-56

¹¹⁴ Lumsden, K. (1998) *Logistikens grunder*. p 402.

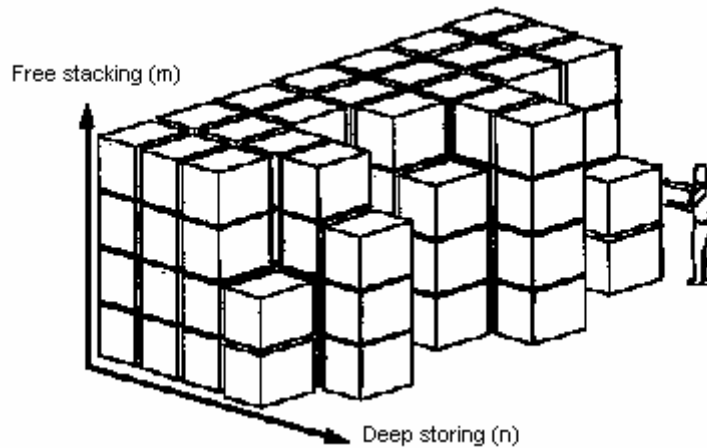


Figure 4.2. Deep storing and free stacking of pallets (Lumsden, K. (1998) *Logistikens grunder*. Studentlitteratur. Lund. p.403).

When using deep storing, the accessibility of the pallets will become somewhat limited, since it is just the pallets at the ends that can be retrieved. A consequence is that the pallets farthest in will become obsolete when only the pallets at the ends are being picked. Therefore this storage type is only attractive for special assortment compositions, and is often used when the storage contains large volumes of the same article. If the storage volume for a single article is 20 m³ or more, you could consider deep storing since it provides good volume utilization compared to other storing types and the costs for storage equipment is eliminated. One disadvantage with this storage type is that the bottom pallet must be able to carry the weight of the pallets stacked on top of it. The pallets should also have a flat top surface to stay stable.¹¹⁵

4.5.2 Pallet Racking

Racking is the most commonly used storage type within industry and the goods are usually stored on pallets. The pallet is placed in a compartment in the pallet rack and all the pallets are directly accessible, se Figure 4.3. Generally the pallet is stored with the short side facing the aisle.¹¹⁶

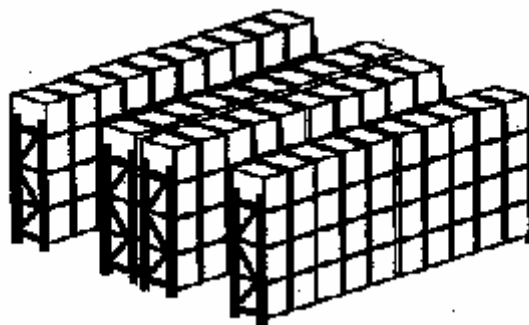


Figure 4.3. An example of a pallet racking system (Lumsden, K. (1998) *Logistikens grunder*. Studentlitteratur. Lund. p.402).

When using racking, a large part of the storage area will be used as transport aisles for the trucks and this will result in a poorer utilization of the storage space compared to free

¹¹⁵ Lumsden, K. (1998) *Logistikens grunder*. pp. 402-404

¹¹⁶ Lumsden, K. (1998) *Logistikens grunder*. p 401.

stacking. Since the volume utilization is lower and that the racking system requires special racks for the pallets, the storage type will generate relatively high costs compared to the volume-stored goods. The big flexibility and the easy access to the pallets are advantages that make the racking system an often-recommended storage type. When the storage volume for each product is between 0,5-20 m³, the racking storing system is especially attractive.¹¹⁷

4.5.3 Automated Storage/Retrieval Systems

An automated unit-load handling storage is a type of storage that, on a signal, delivers a stored unit without human assistance. The advantage with this type of storage is that after the initial investment for the equipment is paid-off, the variable costs are small since the storage type employs few employees. It can also be said to easier cope economically with a large increase of the handling capacity compared to a manual storage. Pallets are usually the unit stored. One example of an automated storage system is illustrated in Figure 4.4 below.¹¹⁸

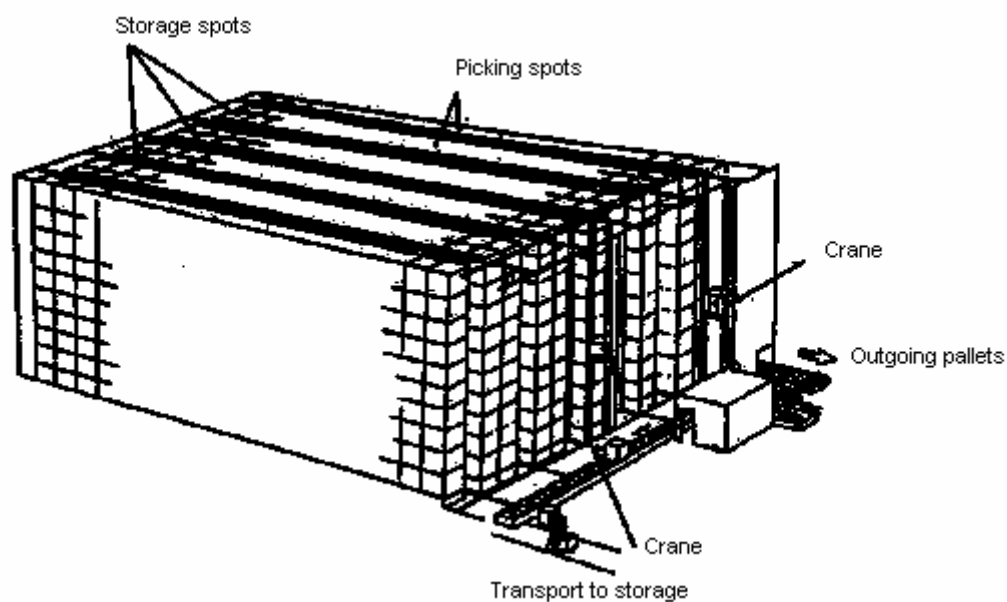


Figure 4.4. An example of an automated storage system (Lumsden, K. (1998) *Logistikens grunder*. Studentlitteratur. Lund. p. 408).

4.6 Demands on packaging

The demands put on the packaging can be divided into three groups; logistical, market or environmental, and derives from the product and the surroundings.¹¹⁹ Each group is then divided into sub-groups, here called categories. In Figure 4.5, the three groups of main demands put on packaging are presented along with related categories of demands. Due to the demarcations made in this thesis, the marketing and environmental aspects are not discussed any further in the theoretical framework.

¹¹⁷ Lumsden, K. (1998) *Logistikens grunder*. pp. 401-402

¹¹⁸ Lumsden, K. (1998) *Logistikens grunder*. pp. 407-408

¹¹⁹ Dominic, C. et al. (2000) *Förpackningslogistik*. p 24.

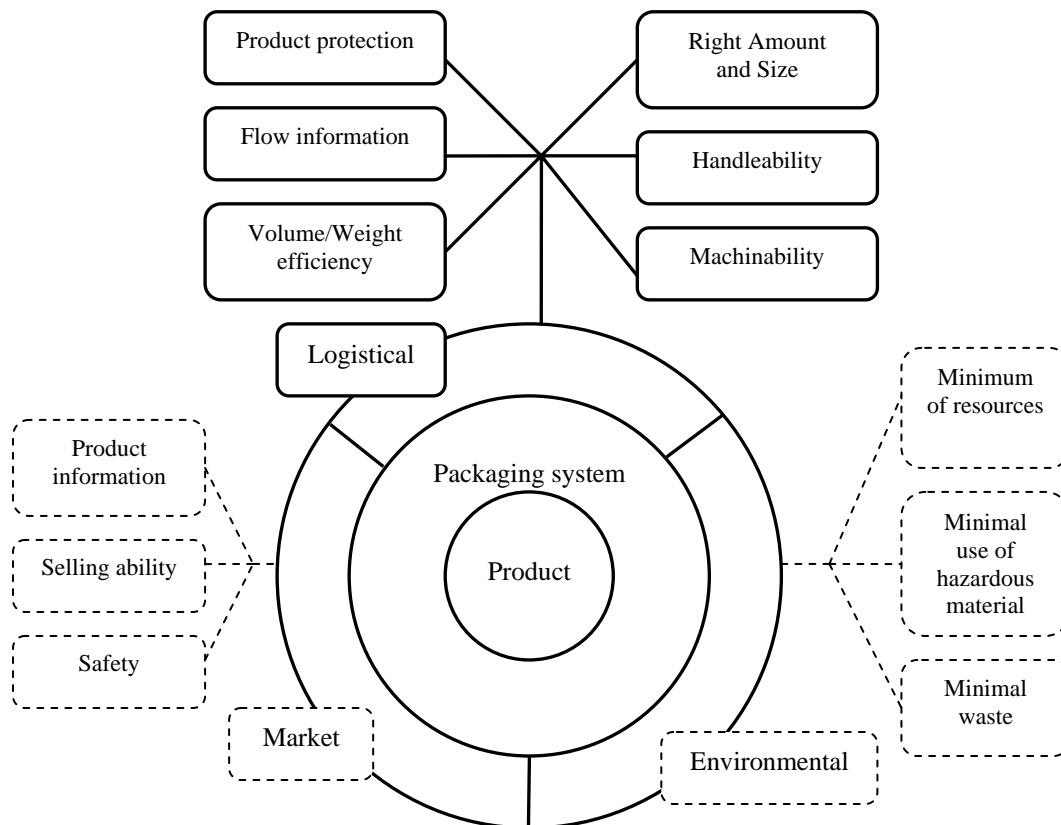


Figure 4.5. Logistical, market and environmental demands on packaging.
 (Modified from Dominic, C. et al. (2000) *Förpackningslogistik. Packforsk.*
 2nd Ed. Kista. p 24)

The logistical demands can be divided into six different categories:

Category 1 - Product protection: Product protection is the packaging logistical demand that handles the connection between the strength of the product, the protective properties of the packaging and the stress caused by the distribution environment.¹²⁰ It is the packaging that ensures that the product reaches its destination in agreed quality.¹²¹ The design of a packaging must, in combination with material, provide the desired level of protection but at the same time not overprotect the product.¹²² The demand comprises the ability to persist stress of different types, e.g.:¹²³

- Mechanical (vibrations, impacts, wear)
- Climatic (humidity, temperature)
- Chemical (air pollution, salt)
- Electro technical (electrostatics, electromagnetic fields)

The most common causes of product damage in a logistical system are from vibration, impact, puncture and compression. Damage can occur whenever a packaging is being transported or

¹²⁰ Dominic, C. et al. (2000) *Förpackningslogistik.* p 52.

¹²¹ Jönson G. & Johnsson M. (2001) *Packaging Technology for the Logician.* p 25.

¹²² Bowersox J.D. & Closs D.J. & Cooper M.B. (2002) *Supply Chain Logistics Management.* p 410.

¹²³ Dominic, C. et al. (2000) *Förpackningslogistik.* pp 52-53

handled.¹²⁴ The packaging should also contribute to the prevention of theft and any kind of manipulation of the products during distribution.¹²⁵

Category 2 - Flow information: Low stock and on-time delivery are features of modern distribution. In this context packaging plays an important role as a carrier of flow information. Information of some kind on the packaging assures that the right products are sent to the right place and handled in the right way.¹²⁶

Category 3 - Volume and weight efficiency: Volume efficiency measures cube capacity utilization throughout the supply chain. The design of the packaging levels can be of utmost importance here. Regarding weight efficiency, packaging does not normally have the same significance, but packaging should of course not be unnecessarily heavy.¹²⁷

Category 4 – Right Amount and Size: One of the functions of the packaging is to enclose and hold together a specific quantity of a product. Different needs from the consumer leads to different sized primary packaging. These are then packed into suitable multiples in secondary and tertiary packaging to allow rational distribution and sales. The term *right amount and size* focuses on that the packaging system solution should be developed to meet the quantity demands that the different actors along the supply chain put on the different packaging levels. This can be accomplished by an interaction between the different packaging levels. The quantity in the primary packaging should correspond to the needs of the consumer, the secondary packaging to the retailers needs and the tertiary packaging to the wholesalers needs. This will lead to a profitable logistics flow by providing rational handling, high rate of turnover, low tied-up capital and minimal obsolescence. An adjustment of the packaging size to the demanded quantity will give a faster rate of turnover in the storage and thereby a lower cost for storing and lower capital tie-up.¹²⁸

Category 5 - Handleability: The handleability concerns how well the packaging is adjusted to the handling aspects – manual or automatic – that the packaging is assumed to encounter along the distribution flow.¹²⁹

Category 6 - Machinability: Machinability refers to the ability of the packaging material to be processed efficiently in production, from packaging material through filling to storage and delivery.¹³⁰

How the packaging is designed to meet these demands highly influence the total effectiveness and efficiency of the supply chain. The demands derive from different actors and different handling situations within the flow, e.g. internal or external transports, opening, unpacking and recycling.¹³¹ “Flow information” and “Other value adding functions” will due to the demarcations of the thesis not be discussed any further.

¹²⁴ Bowersox J.D. & Closs D.J. & Cooper M.B. (2002) *Supply Chain Logistics Management*. p 411.

¹²⁵ Dominic, C. et al. (2000) *Förpackningslogistik*. p 53.

¹²⁶ Johansson K. & Weström P. (2000) *Optimum division of critical properties between primary, secondary and tertiary packaging*. p 11.

¹²⁷ Johansson K. & Weström P. (2000) *Optimum division of critical properties between primary, secondary and tertiary packaging*. p 11.

¹²⁸ Dominic, C. et al. (2000) *Förpackningslogistik*. pp 72-73

¹²⁹ Dominic, C. et al. (2000) *Förpackningslogistik*. p 76.

¹³⁰ Dominic C. & Olsmats C. (2001) *Packaging Scorecard – A Method to Evaluate Packaging Contribution in the Supply Chain*. p 19.

¹³¹ Dominic, C. et al. (2000) *Förpackningslogistik*. p 34.

4.6.1 Supplier

The choice of packaging system influences the probability of an efficient packing process at the supplier. The costs for work supervision and maintenance are also affected by the packaging system design.¹³²

Product protection

The primary, secondary and tertiary packaging has to be adapted to each other to achieve maximal product protection. This interrelationship can both strengthen the protection factor as well as reduce it. The packaging performance when it comes to storing, e.g. at the supplier, is based on the number of stacked pallets, which packaging material that is used, storage time, humidity and temperature conditions. The type of stabilisation method used in the packaging solution influences the stability factor of the packaging together with the stacking pattern used for the secondary packaging.¹³³

Volume efficiency

To keep the logistical costs down to a minimum, it is important to use the available volume and loading capacity to its maximum throughout the whole supply chain. This also affects the efficiency at the suppliers.¹³⁴ The volume efficiency can be divided into two types of efficiencies; inner- and outer volume efficiency. Inner volume efficiency shows the relationship between the outer volume of the packaging and the volume of the product, while the outer volume efficiency describes the relationship between the volume of the existing packaging unit and the available volume provided at different steps in the supply chain.¹³⁵ A typical example of how the volume efficiency can have an effect for a supplier is described in Table 4.2 below. Every step without optimal volume efficiency will result in transportation- and storage costs for empty space.

ACTIVITY	RELATED VOLUME EFFICIENCY
Transportation of primary packaging to the location of the placement into the secondary packaging.	Inner volume efficiency of the primary packaging.
Transportation of secondary packaging to the location where they are palletized.	Inner volume efficiency of the secondary packaging.
Transportation of pallets to their storing location.	Outer volume efficiency of the pallet.
Storing.	Outer volume efficiency of the pallet.
Transportation of pallets to their loading destination.	Outer volume efficiency of the pallet.

Table 4.2. An example of the relationship between activities at the supplier and the corresponding affected volume efficiency. (Modified from Dominic, C. et al. (2000) *Förpackningslogistik. Packforsk. 2nd Ed. Kista. p 67*).

For example, if the volume of a pallet (length, width, height) does not fill the maximum size regarding the storage volume calculated in a pallet rack, the coefficient of fullness is not maximized.¹³⁶ The consequences of insufficiencies of the volume efficiency will cause an

¹³² Dominic, C. et al. (2000) *Förpackningslogistik. p 41.*

¹³³ Saghir M. (2002) *Packaging Logistics Evaluation in the Swedish Retail Supply Chain. pp 94-95.*

¹³⁴ Dominic, C. et al. (2000) *Förpackningslogistik. p 61.*

¹³⁵ Dominic, C. et al. (2000) *Förpackningslogistik. pp 62-67*

¹³⁶ Dominic, C. et al. (2000) *Förpackningslogistik. p 66.*

increase in handling- and storage costs for the supplier. This is caused by an increase of transportation and handling together with an increase of the need for storage space.¹³⁷

Handleability

Handleability concerns how well the packaging solution is adapted to the handling aspects, manual or automatic, that it is assumed to encounter at the supplier. The design of the packaging is a factor that highly affects how it can be handled, e.g. weight, volume and centre of gravity. The handleability is not only dependant on the packaging design, but also by the surrounding system that it is supposed to interact with. Factors that influence the handleability can be transportation- and lifting paths, handling methods, equipment etc.. At the supplier, the packing process can entail both manual and automatic handling and these put different demands on the design of the packaging solution.¹³⁸ The aspects surrounding the packing process will be accounted for in the chapter Packing process below.

Packing process

At the supplier the packing line efficiency, filling efficiency and set up time is related to the performance of the primary packaging, while the performance of the secondary packaging influences packing line efficiency, stability, product protection, handling efficiency and stackability. When it comes to the tertiary packaging its performance is related to aspects like stability, stackability, handling efficiency and weight. Two other factors that also influence the efficiency is the sealing technology and label application. The flexibility of the packing line is usually expressed by the time it takes to set up the packing line for a new product.¹³⁹ All these aspects surrounding the efficiency of the packing line is dependant on the packaging solution design.¹⁴⁰

Experiences regarding automated systems show that packaging solutions that are adapted to mechanical packaging erection and mechanical packing of the products often also are simpler and more ergonomical when handled manually. These packaging solutions usually have a less complicated construction and closer tolerances.¹⁴¹

4.6.2 Transportation

Product protection

Different modes of transportation imply different kinds of stress put on the packaging. Stress during moving of goods consists mainly of stacking pressure, vibration and impacts¹⁴². The modes of transport relevant for this thesis and related stresses are accounted for below:

- *Rail transport:* When shunting train carts, shocks may arise that in turn may damage the goods. Damage caused by shunting shocks depends on the manner in which the goods are loaded and arranged within the cart as well as the nature of the goods. Depending on the travel velocity and the condition of the tracks as well as on which type of cart that is used, vibrations occur. These vibrations may damage the goods that are being transported.¹⁴³

¹³⁷ Dominic, C. et al. (2000) *Förpackningslogistik*. pp 67-68

¹³⁸ Dominic, C. et al. (2000) *Förpackningslogistik*. pp 76-79

¹³⁹ Saghir M. (2002) *Packaging Logistics Evaluation in the Swedish Retail Supply Chain*. pp 93-94.

¹⁴⁰ Dominic, C. et al. (2000) *Förpackningslogistik*. p 77.

¹⁴¹ Ibid.

¹⁴² Lumsden K. (1998) *Logistikens grunder*. p 436.

¹⁴³ Paine, F.A. (1981) *Fundamentals of packaging*. pp 11-12

- *Road transport:* Vibration and bouncing of the goods are the main hazards when transporting by road. The frequency of vibrations is dependent on the condition of the road and the loading and spring characteristics of the vehicle in question. The amplitude of the vibrations depends on the travel velocity and the condition of the road. Bouncing of the goods occur mainly due to larger irregularities in the surface of the road.¹⁴⁴
- *Sea transport:* Here, the hazards depend more on the stowing conditions than on the means of transport. Low-frequency vibrations are caused by engines and propellers and transmitted to the goods. The cargo is also many times stacked in several levels on top of each other, which causes stresses, especially when subjected to pitching and rolling of the ship.¹⁴⁵

Climatic hazards depend on the transport route and destination of the goods in question. They are mainly of three categories:¹⁴⁶

- Exposure to liquid water (rain, sea-spray, condensation)
- Exposure to humidity that may deteriorate the product
- Changes in temperature

These climatic hazards may give rise to physical changes of the goods, corrosion or oxidation of metals or change the dimensions of packaging and/or product etc.¹⁴⁷

It is most often the mechanical stresses from the surrounding distribution environment that are the basis when designing a protective packaging.¹⁴⁸ The material properties and the packaging design have to be combined to achieve the desired level of protection without causing extra cost due to overprotection. To create a satisfactory packaging solution, a degree of allowable damage in terms of expected overall conditions has to be established. When this is made, a combination of design and materials capable of meeting those specifications can be created. There are two key principles when it comes to packaging design; the cost of absolute protection usually is too expensive and packaging construction is suitably a blend of design and material.¹⁴⁹

In order to minimize goods damage, load carrier overhang should be avoided as far as possible.¹⁵⁰ Load carrier overhang is visualized in Figure 4.6 below. The parts of the goods that are outside the load carrier area are unprotected when load carriers are handled and stored, whereby the goods may suffer damage when one load carrier bumps into another etc.¹⁵¹

¹⁴⁴ Paine, F.A. (1981) *Fundamentals of packaging*. p 12.

¹⁴⁵ Paine, F.A. (1981) *Fundamentals of packaging*. pp 12-13

¹⁴⁶ Paine, F.A. (1981) *Fundamentals of packaging*. pp 13-16

¹⁴⁷ Paine, F.A. (1981) *Fundamentals of packaging*. p 39.

¹⁴⁸ Dominic, C. et al. (2000) *Förpackningslogistik*. p 57.

¹⁴⁹ Bowersox J.D. & Closs D.J. & Cooper M.B. (2002) *Supply Chain Logistics Management*. p 410.

¹⁵⁰ *Förpackningsguide för dagligvaror – Från producent till konsument* (2005) ECR Sverige. p 6.

¹⁵¹ <http://www.myfreemanonline.com/fol/mhPackageFreight.jsp>. Freeman Online. 2006-01-18.

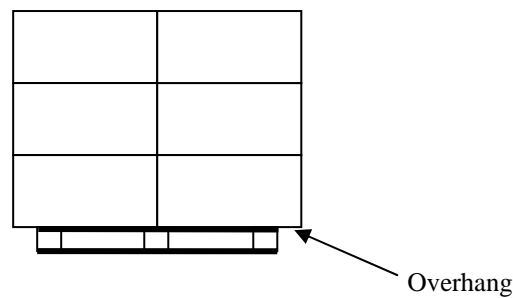


Figure 4.6. Pallet with overhang.

Load carrier overhang should be avoided when stacking pallets as well. One reason for this is that there is an unfortunate stress put on the corners of the pallet that can make the packaging in the corners collapse and in turn make the entire stack collapse.¹⁵²

Volume efficiency

Minimizing the cube is most important for lightweight products that fill up a transport vehicle before weight limits are reached. This can be done by e.g. shipping furniture unassembled. Heavy products that weigh out a transport before the cube is filled, cause the company to pay for shipped air that cannot be filled with products, which will result in reduced transportation efficiency. The weight problem can sometimes be reduced by product or packaging changes, e.g. substituting glass bottles for plastic bottles. For situations where the weight cannot be changed, top loading with lightweight products can take advantage of the empty cube without changing the transportation cost.¹⁵³

In order to maximize volume efficiency, it is important to use modules-thinking when designing packaging of varying size. This means that the modules, i.e. the packaging, are to be adapted to larger packaging. The dimensions of larger packaging should be multiples of smaller ones. At the same time, the modules should be adapted to optimal use in every part of the Supply Chain, e.g. space in the transport vehicle.¹⁵⁴ In Sweden different ISO-standards are used to base a module system on and the most common and widespread one is based on the dimensions 1200x800 mm (the measurements of the EUR-pallet). In exports, however, other dimensions are commonly used as well, which places demands on a thorough analysis when packaging dimensions are selected. The use of modular based packaging is important when mixed loads are transported.¹⁵⁵ Examples of modules based on the measurements of the EUR-pallets are shown in Figure 4.7.

¹⁵² Lumsden K. (1998) *Logistikens grunder*. p 435.

¹⁵³ Bowersox J.D. & Closs D.J. & Cooper M.B. (2002) *Supply Chain Logistics Management*. pp 411-412

¹⁵⁴ Lumsden K. (1998) *Logistikens grunder*. p 452.

¹⁵⁵ Jönson G. & Johnsson M. (2001) *Packaging Technology for the Logistician*. pp 26-27

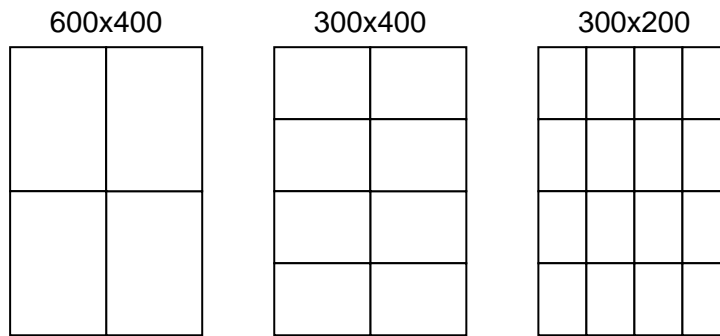


Figure 4.7. Examples of modules based on the EUR-pallet (800x1200)
(Modified from *Förpackningsguide för dagligvaror – Från producent till konsument* (2005) ECR Sverige. Stockholm. p 18)

The amount of packaging material influences volume and weight efficiency, which means that the number of primary and secondary packagings and the number of packaging levels influence volume and weight efficiency.¹⁵⁶

Right amount and size

To meet the demands of transportation, the goods should have dimensions that enable a high load factor.¹⁵⁷ The objective of unitization is to increase handling and transport efficiency. Handling unit loads instead of individual cartons has many benefits, such as minimizing loading and unloading times as well as facilitating materials handling. The factors above reduce logistical costs.¹⁵⁸

Handleability

The handling aspect comprises how well the packaging is adjusted to the handling activities, either manual or automatic, that it encounters along the logistical flow¹⁵⁹, e.g. when being loaded or unloaded. A well designed packaging can both rationalize the work needed and work as an ergonomical means of assistance. The handleability of the packaging is dependent of the surrounding system it is supposed to interact with, e.g. handling methods applied and equipment at disposal.¹⁶⁰

As already mentioned above, handling unit loads is more beneficial than handling individual cartons.¹⁶¹ This leads to a more efficient flow with less handling activities and damages.¹⁶²

4.6.3 Distribution Centre

Product protection

In distribution centres, goods are sometimes reloaded and mixed with other products if the quantity of a product the retailer desires is smaller than what is delivered on one load carrier.¹⁶³ Then it is necessary to be able to place a mix of different products, along with their packaging, on the same load carrier without any product damage occurring¹⁶⁴. Within a warehouse, several things can affect a product in such a way that it is not possible to sell. For

¹⁵⁶ Dominic, C. et al. (2000) *Förpackningslogistik*. p 64.

¹⁵⁷ Lumsden K. (1998) *Logistikens grunder*. p 628.

¹⁵⁸ Bowersox J.D. & Closs D.J. & Cooper M.B. (2002) *Supply Chain Logistics Management*. p 412.

¹⁵⁹ Dominic, C. et al. (2000) *Förpackningslogistik*. p 76.

¹⁶⁰ Dominic, C. et al. (2000) *Förpackningslogistik*. p 77.

¹⁶¹ Ibid.

¹⁶² Coyle J.J. & Bardi E.J. & Langely Jr. J.C. (1992) *The Management of Business Logistics*. pp 410-411.

¹⁶³ Lumsden K. (1998) *Logistikens grunder*. p 422.

¹⁶⁴ *Förpackningsguide för dagligvaror – Från producent till konsument* (2005) ECR Sverige. p 6.

instance, products may deteriorate from careless handling or from a marked change in temperature or humidity.¹⁶⁵ The stress put on a product and its packaging in a distribution centre is mainly stacking pressure. Because of this, it is important to put packaged products of lower weight on top of packaged products of higher weight. When free stacking palletized goods, it is important that there is no pallet overhang. The reason for this is that there is an unfortunate stress put on the corners of the pallet that can make the packaging in the corners collapse and in turn make the entire stack collapse.¹⁶⁶

What is said about goods damage and load carrier overhang during transportation applies in a distribution centre as well, whereby overhang should be avoided if possible.¹⁶⁷ The parts of the goods that are outside the load carrier area are unprotected, which means that goods may suffer damage when one load carrier bumps into another during handling activities etc.¹⁶⁸

Considering storage time, packaging materials become of importance, namely because longer storage times require better packaging solutions.¹⁶⁹

Volume efficiency

In the distribution centre, it is of importance to utilize storage efficiently. This regards both volume and area utilization as well as the allowable height.¹⁷⁰

Right amount and size

To meet the demands of the distribution centre, the goods should be packed in quantities large enough to minimize the number of units handled but yet small enough to be able to handle in an efficient and sound manner.¹⁷¹ Unitization increases handling efficiency. Handling unit loads instead of individual cartons has many benefits, such as minimizing loading and unloading times as well as facilitating materials handling. The factors above reduce logistical costs.¹⁷² Another factor to bear in mind is that manual handling of goods without any handling aids is in most cases not suitable if one unit of goods weighs 25 kg or more¹⁷³.

Handleability

In order to ease and make handling more efficient, outer packaging should be marked clearly making it easy to identify what is in the packaging etc.¹⁷⁴ In a warehouse, secondary packaging should from a materials handling point of view be reasonably large in order to minimize the number of units that need to be handled.¹⁷⁵ This saves both handling and transportation costs, utilizes space better, reduces damage as well as loading and unloading times. It also improves customer service, but may however give rise to other costs throughout the supply chain, e.g. costs when the secondary packaging needs to be split.¹⁷⁶ Different

¹⁶⁵ Bowersox J.D. & Closs D.J. & Cooper M.B. (2002) *Supply Chain Logistics Management*. p 405.

¹⁶⁶ Lumsden K. (1998) *Logistikens grunder*. p 435.

¹⁶⁷ This section expresses opinions of the authors.

¹⁶⁸ <http://www.myfreemanonline.com/fol/mhPackageFreight.jsp>. Freeman Online. 2006-01-18.

¹⁶⁹ Coyle J.J. & Bardi E.J. & Langely Jr. J.C. (1992) *The Management of Business Logistics*. p 410.

¹⁷⁰ Saghir M. (2002) *Packaging Logistics Evaluation in the Swedish Retail Supply Chain*. p 96.

¹⁷¹ This section expresses opinions of the authors.

¹⁷² Bowersox J.D. & Closs D.J. & Cooper M.B. (2002) *Supply Chain Logistics Management*. p 412.

¹⁷³ *Modeller för bedömning av arbetsställningar*. AFS 1998:1. Arbetskyddsstyrelsen.

¹⁷⁴ *Förpackningsguide för dagligvaror – Från producent till konsument* (2005) ECR Sverige. p 6.

¹⁷⁵ Bowersox J.D. & Closs D.J. & Cooper M.B. (2002) *Supply Chain Logistics Management*. p 410.

¹⁷⁶ Coyle J.J. & Bardi E.J. & Langely Jr. J.C. (1992) *The Management of Business Logistics*. pp 410-411

factors influence the handleability of a packaging, e.g. its weight, volume, centre of gravity and placement of handles etc.¹⁷⁷

4.6.4 Retail Outlet

Product protection

Load carrier overhang causes goods damage during transportation and in a distribution centre. This applies also at a retail outlet, since handling of goods and load carriers exist here as well.¹⁷⁸ The parts of the goods that are outside the load carrier area are unprotected, which means that goods may suffer damage when one load carrier bumps into another etc.¹⁷⁹ Sometimes products are “stored” for longer periods of time, and as mentioned earlier this means that packaging materials become of importance since longer storage times require better packaging.¹⁸⁰

When free stacking palletized goods, it is important that there is no pallet overhang. The reason for this is that there is an unfortunate stress put on the corners of the pallet that can make the packaging in the corners collapse and in turn make the entire stack collapse.¹⁸¹

Volume efficiency

Regarding volume efficiency in the retail outlet, packaging should be designed to utilize cube space as well as possible. Adaptation of packaging dimensions to the dimensions of shelves and storage racks is desired.¹⁸²

Right amount and size

It is in most cases not suitable to manually handle goods heavier than 25 kg.¹⁸³ As mentioned earlier, the primary packaging should be adapted to the needs of the customer. The secondary packaging is to be adapted to the needs in the retail outlet regarding handling activities, expected sales volumes and so forth.¹⁸⁴ If the number of units in the secondary packaging that is presented in the retail outlet is smaller than the sales volume, this gives rise to more handling than should be necessary.¹⁸⁵

Handleability

Manual handling is defined as every type of movement of goods where one person or more lifts, puts down, pushes, pulls, carries or rearranges goods that due to their characteristics or bad ergonomical conditions imply risk of personal injury.¹⁸⁶ The packaging can facilitate different handling aspects by being:¹⁸⁷

- Easy to erect and fill
- Easy to grasp – weight, volume, shape
- Easy to open and close
- Easy to empty

¹⁷⁷ Dominic, C. et al. (2000) *Förpackningslogistik*. p 76.

¹⁷⁸ This section expresses opinions of the authors.

¹⁷⁹ <http://www.myfreemanonline.com/fol/mhPackageFreight.jsp>. Freeman Online. 2006-01-18.

¹⁸⁰ Coyle J.J. & Bardi E.J. & Langely Jr. J.C. (1992) *The Management of Business Logistics*. p 410.

¹⁸¹ Lumsden K. (1998) *Logistikens grunder*. p 435.

¹⁸² Saghir M. (2002) *Packaging Logistics Evaluation in the Swedish Retail Supply Chain*. p 97.

¹⁸³ *Modeller för bedömning av arbetsställningar*. AFS 1998:1. Arbetskyddsstyrelsen.

¹⁸⁴ Dominic, C. et al. (2000) *Förpackningslogistik*. pp 24-25

¹⁸⁵ This section expresses opinions of the authors.

¹⁸⁶ *Arbetskyddsstyrelsens föreskrifter om manuell hantering*. AFS 2000:1. Arbetskyddsstyrelsen.

¹⁸⁷ Dominic, C. et al. (2000) *Förpackningslogistik*. p 76.

- Hygienic
- Adjusted to the warehousing system, stackable
- Easy to fold, compress
- Adjusted to recycling/reuse

The factors that affect the handleability are dependent on the design of the packaging, e.g. weight, volume, centre of gravity, handles and their placement.¹⁸⁸ A retail requirement concerning handleability is to minimize handling of secondary packaging by being able to put it directly at the sales area with little or no modification.¹⁸⁹ Unitization has the objective of increasing handling and transport efficiency. Handling unit loads instead of individual cartons has many benefits, such as minimizing loading and unloading times as well as facilitating materials handling. The factors above reduce logistical costs.¹⁹⁰ The handleability is also reliant on the surrounding environment, where transport- and lifting paths, handling methods, equipment, demands on frequency and duration and quality can be crucial factors. There are also factors dependent on human variables, e.g. instructions, training, stress and motivation, which can have an effect on the productivity or strain.¹⁹¹ In addition, unstable packaging or packaging with contents that may shift implies risk of injury when handling them manually. Furthermore, the placement of packaging may give rise to personal injury if it requires handling in ergonomically bad positions.¹⁹²

4.7 Total cost concept

In order to effectively manage logistics processes, a holistic view of the logistical activities, rather than focusing on every activity in isolation, is important. The goal to strive towards is to reduce the total logistical costs, and this is where the total cost concept comes in.¹⁹³ For example, reducing costs in one activity may in turn have effects that raise costs in another activity, whereby the total cost of logistical activities increase.¹⁹⁴

The packaging as a cost influencer

The main influence the packaging has on the cost for a company derives from its interaction with activities along the supply chain. Since the packaging accompanies the product through the whole chain, from production to the end consumer, it crucially determines the cost deriving from handling, storage, transportation and damaged products. A damaged product usually causes costs that by far exceed the product value.¹⁹⁵

When estimating these costs, a division into direct and indirect costs is usually made. Direct costs are caused by a specific cost unit (e.g. a product or service), while indirect costs are costs for resources used by numerous cost units. Generally the most focus is put on the direct material costs for packaging, but the indirect costs are at least as important to consider.¹⁹⁶

For packaging the direct cost involves material, packing/filling up and fees for collection and recycling. The indirect costs are crucial to investigate since it is through them opportunities

¹⁸⁸ Dominic, C. et al. (2000) *Förpackningslogistik*. p 79.

¹⁸⁹ Bowersox J.D. & Closs D.J. & Cooper M.B. (2002) *Supply Chain Logistics Management*. p 410.

¹⁹⁰ Bowersox J.D. & Closs D.J. & Cooper M.B. (2002) *Supply Chain Logistics Management*. p 412.

¹⁹¹ Dominic, C. et al. (2000) *Förpackningslogistik*. p 79.

¹⁹² *Arbetskyddsstyrelsens föreskrifter om manuell hantering*. AFS 2000:1. Arbetskyddsstyrelsen.

¹⁹³ Lambert D. & Stock J. & Ellram L (1998) *Fundamentals of Logistics Management*. p 15.

¹⁹⁴ Ibid.

¹⁹⁵ Dominic, C. et al. (2000) *Förpackningslogistik*. p 38.

¹⁹⁶ Dominic, C. et al. (2000) *Förpackningslogistik*. p 39.

unfold to streamline the flow and lower the costs. The design of the packaging affects for example the pallet adaptation of the packaging and therefore the coefficient of fullness during transportation, which in turn influences the distribution cost. In the same manner the design also influences the costs for packing, transportation, storing, distribution handling and customer handling together with collection and recycling.¹⁹⁷

¹⁹⁷ Dominic, C. et al. (2000) *Förpackningslogistik*. p 40.

5 Empirical Studies

This chapter will describe different parts of the IKEA Supply Chain - Supplier, Transport, Distribution Centre and Retail - from a packaging perspective. The structure of this chapter is based on the structure of the Packaging Scorecard model to make it easier to follow for the reader.

5.1 Supplier

The information below, except when otherwise implied, has been collected during an interview with Per-Olof Palm, a Trading Technician at IKEA. The role as a Trading Technician includes a technical responsibility for a certain group of suppliers and making sure that everything works out in the relationship between the suppliers and IKEA. The matters can for example include quality and technical aspects. Per-Olof Palm has worked for IoS earlier as a Packaging Technician and therefore half his work load involves assisting when designing packaging solutions and other packaging related activities.

5.1.1 Explanation of the process at a Supplier

The packaging related process starts with a filling process of the primary packaging. After that the primary packaging is handled, e.g. transported to the next packing station where it is placed within a secondary packaging with following transportation and handling and placement within the tertiary packaging. Next, the whole packaging system is handled and often stored before it is retrieved for loading and shipping. The packing process can be done entirely manually or automatically, but also as a mixture of both packing line types. The packing system does not always include all three packaging levels either. The storing, loading and shipping procedure can also be different from supplier to supplier. Some handle the whole process themselves and others let the goods go to an external party that takes care of the storing and shipping. There also exist suppliers that instead of sending complete pallets send out mixed pallets since the order is on less products and this causes an extra handling phase.

5.1.2 Packing line

The choice between manual- and automatic packing line depends on the volumes and the product range that a supplier has. Also ergonomical factors and costs are of importance. If the product range is wide it is hard to find a suitable automated packing line that is efficient for all packaging solutions for the different products.

One of the biggest differences between manual and automatic packing lines are that manual is more flexible. With a manual packing line the suppliers are not limited; they can add or subtract how many employees they need for the packing line. With an automated packing system, the packing process is very efficient but at the same time very specialized since it is adjusted to a specific product type. With a manual packing line you can accomplish a lot more in an easier way, e.g. more details within the packaging, but the packing becomes more expensive than with an automatic.

Efficient erection of packaging

Automated packing robots are limited and cannot for example cope with erecting and sealing large packaging. A manual packing line is not limited in the same manner. Some packaging solutions can also be too advanced and complex for automated packing lines regarding e.g. folding patterns. Therefore it is important when designing the packaging systems that they do not complicate the packing process more than necessary.

Efficient filling of packaging

Suppliers with automated packing lines are limited by the number of robots their packing line contains and the skills of the robots. Robots can e.g. not in general pick small details. The number of details, and in which patterns they are placed in packagings, has to be considered during the packaging development process.

An automated packing line must contain enough robots for carrying out all the packing activities, which is a limiting factor.

Efficient sealing of packaging

Automated packing robots are limited and cannot for example cope with sealing and erecting large packaging.

Packaging stability

Stability of pallets is influenced by how packagings are placed on the pallet. Robots place packagings in perfect patterns on the pallet, but the preciseness is lessened when this is done manually, which can affect pallet stability. The differences between manual and automated packing lines when placing packagings on a pallet are in general very small.

Ergonomical demands

When using manual packing lines, the ergonomical aspects become very important. The packaging should not be too large or heavy from a handling perspective and consideration should be taken to folding and sealing procedures. From an ergonomical perspective, packagings should not have dimensions, such as being too low or long, that make the folding and sealing process difficult.

5.1.3 Product protection

Damage to products and packagings seldom take place within the packing line, and the biggest risk of damage at the supplier after the products have been packed in their primary packaging is when they are being manually handled, but in an improper way. Damages mostly happen to the entire unit load.

Protective properties of packaging

IKEA has as a goal to keep storage volumes low, but yet not have any product deficiencies. This means that the products have to be stored somewhere and this usually is at the supplier. To keep costs at a minimum, suppliers must manufacture products in large batches, and therefore products can be stored for long periods of time before being shipped. Static damages can occur if multiple pallets are stacked on top of each other in storage.

Climate effect depends on location of the factory and where the packing takes place as well as the status of the premises. Due to climatical influence, glue or tape might not attach or cardboard can grow mouldy.

No overhang

No empirical data found in this subcategory.

Prevention of theft and manipulation

IKEA considers manipulation or stealing not to be a problem at the supplier. Suppliers do not benefit from manipulating goods.

Minimize empty space in packaging / Fixation of product within packaging
No empirical data found in this subcategory.

Packaging stability
No empirical data found in this subcategory.

5.1.4 Volume efficiency

Storage adaptation

Stackability, as well as that a pallet can carry another pallet of the same weight, is important for good volume utilization. From a volume utilization perspective, pallet overhang should be avoided. Pallets and their size should from an IKEA point of view be adapted to the storing types that they use.

5.1.5 Handleability

Stackability

No empirical data found in this subcategory.

Ergonomical demands

Critical handleability demands concerning ergonomics are size and weight of the packaging, and since many stages in a packing process require much work, the number of stages of a packing line should be kept at a minimum.

Packaging stability

Packaging stability is especially important when picking the finished product and placing it on the pallet, both when doing it manually and when doing it automatically. If the packaging is not stable enough, fixated enough or has the wrong quality cardboard, the packaging can break.

5.2 Transport

The information below that expresses packaging issues from a transportation perspective, except when otherwise implied, has been collected during an interview with Niclas Gemfeldt, a Supply Developer at IKEA. Within his work description he takes part in different business projects where they follow a product along the Supply Chain, and decide upon the most effective order- and distribution methods. He has also worked with transportation- and product range matters.

5.2.1 Explanation of the Transportation process

No general process map will be provided for this part of the Supply Chain since the delimitations regarding Transport is limited to only the three activities; loading, transporting and unloading the goods.

5.2.2 Product protection

Protective properties of packaging

One purpose of the packaging is to keep the product intact during the mechanical movement. Mechanical stresses during transport are vibrations and impacts, but most significant are the stresses that goods are exposed to when not supported by other goods. These stresses must be kept in mind. Most pure transport damages occur due to mechanical reasons. The majority of the individual damages on a pallet are handling related and not transport damages, but a

collapse in a transport compartment means that something has happened during transport due to mechanical reasons.

The mechanical stresses are the largest, and the goods are not exposed to chemical stresses during transportation. Protection against climate is not a question during transport, but more a question of protection when goods are placed outdoors or handled outdoors. The packaging is not determinative when it comes to climatic influence. Goods characteristics are known and thereby whether or not the goods have special requirements during transport. Exposure to moist happens only by concrete faults, such as damaged trailer covers, and concrete faults cannot be taken into account when designing packaging solutions.

No overhang

Pallet overhang means that there can be room for one row less in the transport compartment. This in turn means that stability can be lost, and pallets might begin to skew when stacked. Loading is easy if pallets are uniform, but if they are not uniform loading becomes harder and the mechanical influence during transport has greater effect. If pallets are not uniform in size and shape, transport compartments can be difficult to fill completely whereby goods can move.

All kinds of overhang are unbeneficial but the principle from a transport perspective is not to have overhang on the sides, and longer goods are placed on IKEA-pallets. For the purpose of loading and transporting goods stably, overhang on the sides should be avoided. Stresses are the greatest in the direction of travel, and therefore overhang gives rise to the most serious damages when there is overhang in, and opposite, the direction of travel. When handling by truck, products that hang over on the shorter sides are exposed to increased stresses since the truck can push the pallets slightly. The priorities regarding overhang are as follows: Avoid any overhang if possible. If this is not possible, firstly avoid exceeding the width 800 mm and secondly avoid exceeding the length 1200 mm. Thirdly, avoid overhang on both sides. I.e. that overhang on both sides is the worst-case scenario and no overhang at all is the best.

Prevention of theft and manipulation

Theft and manipulation has never been a problem and is presently not considered to be an important factor at IKEA. IKEA products are of relatively low value and are not that exposed to theft. In order to facilitate handling, holes can be made in the packaging to serve as handles. This makes it possible to put unwanted things into packaging. Trucks and trailers with covers are common and are easy to “break into”, but in the future different kinds of seals and “closed compartments” will be used.

Minimize empty space in packaging / Fixation of product within packaging

If there are loose parts in a packaging, they can during transportation gain kinetic energy and because of this break the packaging if it is not stable enough. Consideration has to be taken to the mechanical influence that goods are exposed to during transport and that it cannot be eliminated. The Transport department cannot solve the problems that arise if the product and packaging designs are bad.

In order to increase handleability, standardized packagings are sometimes used, and a consequence of this is that the product inside has to be fixated. It is important to prevent loose parts from moving. It is not only that the packaging might break when loose parts move around, but loose parts scrape against each other and if there is some dust or similar between the parts the damages would be greater.

Minimize empty space in means of transportation

Due to the height limitations in means of transport, the “3rd layer” needs to be added. The “3rd layer” means that you fill the empty space above the pallets in a transport compartment with goods. If what is loaded on top of the pallets does not go one-to-one with what is underneath, problems arise when loading but especially when unloading since what is placed on the top might have shifted. From a transport point of view, more goods in a transport means an efficiency increase, but mechanically it is unbeneficial to have not fixated products on top of the pallets.

Empty space in a transport compartment is not a problem during a normal transport as long as the pallets are stable and fixated. If the pallets are stable, there is nothing more to be done, and the effects of empty space in the transport compartment cannot be remedied with another packaging solution. Pallets are usually strapped, and if the goods are not uniform it is not possible to secure it as usual. If the pallets have to be fastened with belts to the truck/trailer in order for it not to move, the separate packagings need to be able to take the stresses that are put on it. A belt is strapped across and over the goods to secure it. This is illustrated in Figure 5.1 below.

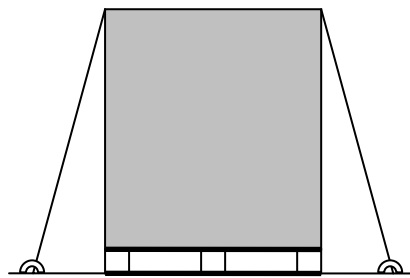


Figure 5.1. Fixation of goods in a transport.

Packaging information

At the present no stacking codes are used and no universal code exists, but there is a need for one in order to make stacking safer. One that has been discussed is marking pallets with different animals, e.g. mouse or elephant, which indicate the weight of the pallet. Today, pallet weight is hard to know and is nothing that can be told when handling it. The design guideline used today is “same on same”, which means that a pallet is supposed to be able to carry a pallet of its own weight.

There are two schools when it comes to information on the packaging or product visibility. Some are of the opinion that packaging information is beneficial and some are not. Arrows indicating orientation are usually not followed, except maybe arrows indicating that the products are to be oriented with the arrow upwards. Arrows indicating downwards or sideways are not always followed since orientation is based on what is the easiest.

Packaging stability

The 27-degree rule tests the stability of a pallet and a unit load, and means that it is supposed to be able to lean an angle of 27 degrees in any direction and still be stable.

When pallets with underhang are stacked on top of each other, the stability can be lost. It is not a disadvantage or problem as long as the pallets are stable from a transport technical point of view, but on the other hand empty space is transported.

If the goods are not stable due to too little friction between the separate packagings they might fall/collapse during transportation. Mechanical influence makes the products slide against each other because of too little friction between them. There are packaging solutions where e.g. particle boards have been placed on top of pallets in order to increase the friction between pallets that are stacked. In Sweden, painted plates are used, and in the paint there is some kind of sand to increase the friction even more. It is also a safety factor that the friction is large enough.

5.2.3 Volume efficiency

Minimize empty space in means of transportation

IKEA's opinion on excess empty space in transports, it is unnecessary funds spent, can be described by the expression "We hate air".¹⁹⁸

Overhang is not good for any kind of transport, and IKEA tradition is to make flat packages that fit the measurements of the EUR-pallet, 800x1200 mm. Today, though, many suppliers are located in Asia where the standard used is the measurements of the oceanic pallet, 760x1140 mm. For this reason the "cross" has been developed, which is a packaging design strategy that is going to be implemented at IKEA. The "cross" strategy has as a goal to design packaging systems either with the measurements 760x1200 mm or 800x1140 mm, and its name comes from the appearance of the combinations. The aim is for products to be designed with the measurements of the "cross" in mind in order for transportation to be volume efficient by truck, boat and railroad.

The pallets are loaded and unloaded from the back of the truck, and the pallets are supposed to be loaded with their shorter side (800 mm) facing the direction of travel. For this reason the width should be kept intact if possible. If overhang makes the length of the pallet exceed 1200 mm by a lot, it has to be kept in mind that the forklift hits the goods that hang over when handling the pallet. Underhang is not unbeneficial from a transport technical point of view as long as the pallets are stable, but on the other hand empty space is transported.

If it is necessary to top load, it is important to have in mind that everything should be able to be loaded and unloaded by truck. The load factor becomes somewhat lower if everything for this reason is loaded on pallets, but this is probably gained in handling efficiency. Under normal circumstances, there are usually not any problems unloading top loaded products by hand when their weight is low. This is however a question of priorities between load factor and unloading efficiency.¹⁹⁹

Minimize empty space in packaging

No empirical data found for this subcategory.

Stackability

If IKEA cannot stack pallets during transport, the possibility of transporting an entire layer of goods is lost, whereby their philosophy of flat packaging becomes useless.

¹⁹⁸ Johnsson, A. Mathiasen B. Consequences of the Loading Ledge implementation – a case study at IKEA. p 2

¹⁹⁹ Olsson, Krister. Operations Area Manager at IKEA Distribution Centre in Älmhult. Interview. 2005-12-19

5.2.4 Right amount and size

Packaging adaptation to means of transportation

Considering measurements, overhang is not good for any kind of transport. The oceanic pallets are smaller than the EUR-pallets, and IKEA has put some effort into this. IKEA tradition is to make flat packages from the measurements of the EUR-pallet, 800x1200 mm, but today many suppliers are located in Asia where the measurements of the EUR-pallet are not the standard. In Asia the standard is the oceanic pallet, 760x1140. For this reason the “cross” has been developed, and this is going to be implemented. The aim is for products to be designed with the measurements of the “cross” in mind in order for transportation to be volume efficient by truck and boat. If it works with trucks and boats, it works with railroad as well.

5.2.5 Handleability

Stackability

No empirical data found for this subcategory.

Packaging stability

Stability of the packaging system depends on the contents. When it comes to for example sofas the packaging is there for protection since nothing is supposed to be stacked on top of it. How stable the packaging needs to be from a handleability point of view is product dependant.

Ergonomical demands

The most important ergonomical factor is the weight of the products. There are many local recommendations in different countries. In Sweden personnel are allowed to transport e.g. heavyweight sofas, and they are allowed to lift these if an agreement has been made up between company and personnel. This agreement specifies how many sofas they can lift each day, compensation for lifting heavy products etc. This is strictly related to deals that have been made and there are no legal restrictions. Heavyweight products that later have to be unloaded manually are not top loaded.

Minimize handling

One purpose of the packaging is to bring the product efficiently through the supply chain to the customer, but packaging has not only a protective purpose - it is supposed to increase handleability as well. The faults and problems that occur during loading are the same as the ones during unloading. Standardized packaging is sometimes used in order to increase handleability, but then the product inside must be fixated in some way.

Everything that can be handled by truck is good, but everything that means that the truck operator has to dismount the truck in order to handle manually is unbeneficial. It could be, however, that it is possible to load another box if it is done manually, and this could be beneficial instead of transporting hundreds of containers (or similar) with some empty space in them.

5.3 Distribution Centre

IKEA has 28 distribution centres in 16 countries that supply goods to IKEA stores.²⁰⁰ The empirical studies performed in this thesis have been concentrated to the IKEA Distribution Centre in Älmhult, Sweden. The information presented in this chapter was, if not otherwise implied, collected during an interview with Krister Olsson²⁰¹, at the time of the interview the Operations Area Manager for loading and unloading at the Distribution Centre in Älmhult, Sweden. His work description included the responsibility of all loading and unloading according to IKEA routines and legal demands, but also the responsibility of improving and streamlining operations. As the Operations Area Manager, his responsibilities also included profitability demands according to presented goals as well as managing 130 IKEA employees. Information gathered during observation at the IKEA Distribution Centre has also been added.

5.3.1 Explanation of the process at a Distribution Centre

When the goods arrive at the Distribution Centre, DC, they first get unloaded by forklift or manually and after that the pallets are placed in a strapping machine where they are strapped in order to keep their stability. After the strapping procedure, the pallets are transported to their assigned storage space, which could either be in an automatic storage, a pallet rack or, at some occasions, free stacking. When an order is received from a retail outlet, the pallets are collected from their storing space and transported to a loading location. Sometimes the stores order less than a whole pallet of goods, and then the goods have to be picked and placed on a mixed pallet. The smallest quantity that can be ordered from a store is called a multi-pack, unless the item ordered is a sofa, a bed or a similar product. When creating the mixed pallets, the pallet that is supposed to be picked from is collected from its storage space and placed in the so-called picking zone. At the picking zone, the mixed pallets are filled by products and multi-packs that are going to the same product range area²⁰² at the retail outlet in order to facilitate the handling process there. These pallets will also be transported to a loading location when finished. After that all the goods are loaded onto a load carrier and transported to a retail outlet.

5.3.2 Product protection

A very important aspect is that the packagings arrive neat and clean at its destination, i.e. the customer. It is supposed to be intact through every step of the supply chain, from supplier to customer.

Protective properties of packaging

When disregarding the pallets that arrive damaged at the DC, the most damages to product and packagings occur because the pallets collapse due to bad packaging. This type of damages account for about 50 percent of all the damages occurring at the DC. In second place comes damages caused by forklift puncture, about 30 percent, followed by compression damages with a damage rate of about 20 percent.

No overhang

Pallet overhang increases the risk of goods damage. Damage of for example an unprotected corner occurs easily since it can be a bit tricky using the pallet racks and handling the pallets

²⁰⁰ http://www.ikea-group.ikea.com/PDF/IKEA_FF_0405_GB.pdf. *Facts & Figures – The IKEA Group 2004-2005*. 2006-02-02

²⁰¹ Olsson, Krister. Operations Area Manager at IKEA Distribution Centre in Älmhult. Interview. 2005-12-19

²⁰² Each range of products is displayed at a separate limited area at the retail outlet that the authors denominate product range area.

in the DC etc. No overhang at all is ideal. If the dimensions of the product make overhang inevitable, a priority is to not exceed the width of 800 mm (for a EUR-pallet). The pallets are loaded and unloaded from the back of the truck, and the pallets are supposed to be loaded with their shorter side (800 mm) facing the direction of travel. For this reason the width should be kept intact if possible.²⁰³

Prevention of theft and manipulation

Prevention of theft and manipulation is a matter of relatively low priority. It may however be different during transportation and in a retail outlet, but in the DC this factor is stated to have a relatively low importance. For the purpose of facilitating handling, holes are sometimes made in packagings to serve as handles. This enables putting unwanted things into the packaging²⁰⁴.

Minimize empty space in packaging / Fixation of product within packaging

If the product can move around inside the packaging, it might brake. If there is empty space inside the packaging it loses stability and might collapse. Because of this, it is important to minimize empty space inside the packagings.

Johansson believes that empty space in the cartons should be avoided if possible since it means a risk for damages occurring. If a void is created it should be filled out with something so that the empty space is minimal in the packaging.²⁰⁵

Packaging information – pallet weight

According to Olsson, information of the pallet weight on the pallet is not very important in the DC since the truck operators already have this information when handling the pallets. Johansson²⁰⁶ points out that they experience more problems due to wrongful stacking at the origin of the pallets, where heavier pallets have been placed on top of lighter pallets. A consequence of this is that at arrival at the DC the heavier pallet might have sunk into the lighter one and therefore cannot be unloaded by a truck. Both these aspects increase handling time and risk of accidents.

Packaging information – pallet orientation

Sometimes, but not very often, pallets arrive in a mess within containers and the packaging systems can have been placed up side down, sideways etc, thus making the unloading process difficult.²⁰⁷

Olsson claims that pallets oriented the wrong way at arrival are unusual. According to Pettersson²⁰⁸, the personnel at the DC tries to follow the orientation specified on the packagings, but usually this is based on that the pallet contains the same article and it does not always work when mixing pallets when they handle about 6000 articles.

²⁰³ Gemfeldt, Niclas. Supply Developer IKEA. Interview. 2006-01-20

²⁰⁴ Gemfeldt, Niclas. Supply Developer IKEA. Interview. 2006-01-20

²⁰⁵ Johansson, Jörgen. Range Manager and member of the Quality department at IKEA Distribution Centre in Älmhult. Interview. 2005-11-08

²⁰⁶ Johansson, Jörgen. Range Manager and member of the Quality department at IKEA Distribution Centre in Älmhult. Interview. 2005-11-08

²⁰⁷ Johansson, Jörgen. Range Manager and member of the Quality department at IKEA Distribution Centre in Älmhult. Interview. 2005-09-16

²⁰⁸ Pettersson, Ronnie. Development out/in-bound at the IKEA Distribution Centre in Älmhult. E-mail. 2006-03-01

Packaging information – pallet contents

Information on the packaging about the contents may be beneficial if cardboard that encloses the pallet is making it impossible to see what the content is. Less packaging material might make people handling the pallet aware of what the content is (glass, porcelain etc.). There is not any other information on not fragile products that could be beneficial.

This reasoning is also supported by Palm that claims that glass products should probably be marked since a brown box gives the impression that it can handle everything and currently IKEA do not have that kind of directives. Sometimes marking is not the best solution since a marking is not always enough to keep people from treating the pallet with glass contents carelessly. The best is of course to create a packaging solution that can bear the load, but when it is not possible the best thing can be to make the packaging look as fragile as possible, e.g. ship mirrors in plastic bags instead of a covered paper box. Many suppliers have experienced problems with one product and added more and more protection, but not until they removed all the protective cover did the damage rate go down since now people treated the pallet more carefully.²⁰⁹

Packaging stability

It is important that the oceanic pallets made of cardboard are stable in order for them not to collapse. Packaging stability is important since it is important that the pallet does not break when it is put down, which sometimes can happen a bit brutally since the personnel work with time limits. It must also be able to be stored during longer periods of time without being impoverished and it must also be stable enough to be able to lift it high up and put it in the pallet racks. Figure 5.2 below shows a pallet that has collapsed.



Figure 5.2. Unstable pallet that has become askew.

The pallets stored in the pallet racks as well as the ones stored in the automatic storage facilities are strapped for sake of pallet stability.

5.3.3 Volume efficiency

Storage adaptation

A pallet requires an entire “pallet spot” in the storage facilities whether the pallet is full or not, and if the pallets are not full a consequence is a low load factor in the storage facilities. This goes hand in hand with minimizing empty space in the storage facilities.

²⁰⁹ Palm, Per-Olof. Trading Technician at IKEA. Interview. 2005-12-19

The cardboard pallets (Oceanic pallets) are put on EUR-pallets when they arrive at the DC, and the measurements between the two pallet types differ slightly. What is lost in load factor in the storage facilities etc. is gained in better load factor during transport. It is important to use as much of the EUR-pallet area (or similar) as possible.

5.3.4 Right amount and size

Module adaptation when mixing pallets

About 19 percent of the goods that are sent out from a DC are mixed pallets. The mixed pallets are sometimes loaded on top of each other, but only when the bottom pallets have flat surfaces.²¹⁰ Module adaptation could be beneficial when mixing pallets since it would give better mixed pallets with better filling rate and it would be possible to achieve pallets with flatter top surfaces. Today the mixed pallets most often have uneven top surfaces, which means that these pallets have to be loaded on the top, since it is not possible to place other pallets on top of them. This could mean that it would be possible to place other pallets on top of mixed pallets as well as gain in cube utilization. Module adaptation can also have beneficial effects on efficiency since it is not necessary to “puzzle” as much when mixing a pallet.

The load factor of the mixed pallets is also dependant of what the Retail Outlet has ordered, and often the pallet height becomes very low. The DC is dependant on what the store orders and cannot force the stores to receive more goods because the coefficient of fullness is not optimal in the transport.²¹¹

Quantity adapted to the needs of retail

When creating a packaging solution one has to have in mind how it is supposed to be delivered to the store, e.g. should it be sent directly to the store or via a DC, and then adjust the packaging to the prerequisites.²¹² Adaptation of the quantity of products to the needs of retail means less picking, and the less picking the better for every part of the IKEA Supply Chain.

The multi-pack is the minimum quantity that the retail outlet can order, except for items like sofas, heavy tables and similar, that prevent them from being packed in units containing more than one product. These should not hold to many products if the turnover is not that high. The multi-packs should not be too big either since then they can become complicated to lift or the packaging can break. The handleability perspective of the multi-pack is important, both from a DC and a retail perspective.²¹³

The advantage with the half pallets is that they are never divided and used for mixed pallets, which minimizes some of the picking process. The handling time per product becomes twice as long compared to a EUR-pallet, but the savings made by eliminating the picking for those products compensate this.²¹⁴

²¹⁰ Petterson, Ronnie. Development out/in-bound at the IKEA Distribution Centre in Älmhult. E-mail. 2006-03-01

²¹¹ Johansson, Jörgen. Range Manager and member of the Quality department at IKEA Distribution Centre in Älmhult. Interview. 2005-11-08

²¹² Ibid.

²¹³ Ibid.

²¹⁴ Ibid.

5.3.5 Handleability

Stackability

According to Olsson, stackability is very important from a DC perspective. They do not stack very many pallets on top of each other in the DC, but when loading it is very important that the pallets can be stacked. According to Johansson²¹⁵, after the unloading process the pallets are sometimes placed free stacked close to the loading area if the pallets are supposed to be sent of in a nearby future. Then it would be a waste of time to place the goods in storage racks etc. This free stacking also occurs sometimes if there exist a capacity deficiency at the DC.

Packaging stability

Packaging stability is also crucial when pallets are mixed. Those packagings should be able to be handled a couple of times manually without breaking. They should not be too heavy or big either.²¹⁶

Ergonomical demands

When it comes to ergonomical demands, the most important aspect is weight. Twisting, turning and lifting heavy boxes can give rise to personal injury. They handle manually only when picking or when top loading. Otherwise trucks are used for handling.

The personnel try to pick the lightest products at the automatic picking station. If picking is manual, as it is at the DC in Älmhult, a “picking truck” is used which makes it possible to come close to the pallet from which the goods are going to be picked. Then it is possible to push the products over to the pallet on the truck instead of gripping and lifting them, which is good when the products are heavy.

Minimize storage handling

The more time that is spent on an activity, the more costs it causes. The bad loading can however be remedied by educating the loading personnel. Johansson²¹⁷ emphasizes that it is important to have an overall view of the Supply Chain and that packaging technicians sometimes focus too much on the coefficient of fullness in the transport. According to him, making the handling activities at a Distribution Centre effective and efficient is the most critical factor from a cost perspective.

Picking ability

Picking in order to create mixed pallets is usually more expensive to do than sending out complete pallets. In the ideal world only whole pallets should be sent, but then all stores would have to be of the same size and have the same turnover.

5.4 Retail Outlet

The information below was collected during an interview with Joakim Strandh, Section Manager of Store Goods Flow (SGF) at the IKEA Retail Outlet in Malmö, Sweden, if not otherwise is implied. He serves under the Logistics Manager of the Retail Outlet and is the supervisor of five Group Managers. His job description includes the operative responsibility

²¹⁵ Johansson, Jörgen. Range Manager and member of the Quality department at IKEA Distribution Centre in Älmhult. Interview. 2005-11-08.

²¹⁶ Ibid.

²¹⁷ Ibid.

of presenting the products at the sales area before the Retail Outlet opens for customers for the day.

5.4.1 Explanation of process at a Retail Outlet

Goods arrive at the Retail Outlet in containers, trailers, but mainly trucks. After being unloaded, which is done by truck, the goods are placed in a transit area from where it is taken by truck to its destination in the Retail Outlet either one pallet at a time, but preferably two at a time when this is possible. If the pallets have the same destination they are transported two at a time if it is possible to stack them. The possible destinations for the goods are the sales area (“self-service-storage” or “shop”), pallet racks in the storage facilities or free stacking in the storage facilities. On the way from the unloading area to its destination, the goods may be handled more than one time and by different types of trucks. The reason for this is that one type of truck cannot perform all activities that are necessary, whereby several types of trucks are used depending on which activity that is performed. Candles and high products, such as sofas, are free stacked.

5.4.2 Product protection

Goods damages that occur in the retail outlet are mainly caused during handling of pallets with trucks. Pallets are very seldom dropped and they seldom collapse.

Protective properties of packaging

There are seldom any problems that affect products or a Retail Outlet due to climatic hazards. Sometimes rugs are wrapped with plastic at the supplier while they are still damp, and when they arrive at their destination they can be mouldy.

No overhang

Most important is not to have overhang on the longer sides, thus exceeding the width of 800 mm (EUR-pallet), since pallets always are stored with their shorter sides towards the aisle. This causes product damage. Pallets with overhang on the shorter sides are normally not a problem and can most often be handled anyway.

Packaging information

Instead of indicating pallet contents by adding this information to the packaging, it can be shown by lessening the amount of packaging material used, thereby leaving the products visible. This way, handling becomes more careful according to the handling requirements of the product. Exposure at the sales area also becomes better, which is beneficial, and it becomes easier to control the contents of the packaging regarding colour etc.²¹⁸

Packaging stability

Pallets are often handled many times from that they arrive at the Retail Outlet until they are displayed at the sales area. For heavyweight pallets that are not handled carefully, the contents might shift a little bit every time the pallet is put on e.g. the floor and eventually it becomes unstable. In turn, this can mean that the contents fall off of the pallet and brakes, causing extra handling, damaged products or even personal injury.

²¹⁸ Johansson, Jörgen. Range Manager and member of the Quality department at IKEA Distribution Centre in Älmhult. Interview. 2005-11-08

5.4.3 Volume efficiency

Storage adaptation

Strandh believes that the storage racks are adapted to the unit module. The height of a pallet is crucial and the Retail Outlets have big problems with pallets that are too high to fit into the pallet racks. When this happens, the pallets have to be stored in the unloading area.

5.4.4 Right amount and size

Quantity adapted to needs of retail

Sometimes, large sales volume products sold in the “self service storage” come in packaging containing relatively few products and sales volumes seem not to have been taken into account during the packaging development. These products could benefit from having another kind of packaging that requires less manual work when opening etc.

Packaging adapted to display mode

IKEA products that are supposed to be displayed on shelves are to a great extent adapted to shelf systems at the Retail Outlet. When placed on shelves, products are most often handled manually.

5.4.5 Handleability

Ergonomical demands

Large size products that give rise to pallet overhang are difficult to handle, as are heavyweight products. Products that come in several boxes where the product is very heavy are hard for the personnel to handle manually, but this is done anyway, which can give rise to personal injury. Products that weigh a lot are not to be stored one level up unless they are lifted up by truck. Heavyweight products constitute a risk of work related injury and risk of injury for the customers that handle the product.

Minimize handling

Handling in the store is considered to be critical from a time and cost perspective. Handling is supposed to be as efficient as possible and because of this the personnel work with time limits. This in turn gives rise to product damage since they have to be fast. Small products are time consuming to handle, and sometimes a product that sells in large quantities have an inappropriate packaging solution that gives rise to a lot of manual opening of packaging etc.

Handling at the sales areas where there is a large number of article numbers and the products are to be presented in small areas is very time consuming. Products that sell in large volumes are usually displayed on a pallet or half-pallet which makes it easy and quick to get the products in place.

6 Results of the Packaging Scorecard Study

This chapter will present the build up of the IKEA related Packaging Scorecard for each part of the IKEA Supply Chain together with the weights and comments collected for the different factors.

6.1 Creating the Packaging Scorecard Study

In order to create the Packaging Scorecards that were supposed to be weighted by different actors along the IKEA Supply Chain, the authors distinguished the factors from the frame of reference and the collected empirical data that they believed to be of the highest importance for the Supply Chain efficiency at IKEA. All the factors originating from the empirical studies have not always been prominent at some parts of the Supply Chain as others, but have still been used during the study to examine their impact on other areas. An example of this is the packaging information factors, whose importance have been examined in not only the originating part of the Supply Chain, the Distribution Centre, but also during Transportation and at the Retail Outlet.

The weightings provided for the different Packaging Scorecards created are presented in the chapters below.

6.2 Results from the Supplier Packaging Scorecard

There are many factors that make it difficult to examine the supplier perspective of the Packaging Scorecard properly. To begin with, the variety among the suppliers is very big. The conditions are very different when it comes to the differences in the products they manufacture and in which manner this is done. Is the product for example a small plastic detail with no moving parts, or is it a larger product such as a closet with hinges etc. Furthermore, another influencing factor is how far the supplier has come regarding manufacturing technology - is it a low technology supplier in Asia or is it a well equipped supplier in Europe. All these factors, and more, affect the role of the packaging at the supplier. To examine all of this in the best possible manner, visits to suppliers who work under different conditions and with every product type would need to be done, as well as interviews carried out with personnel at the different suppliers. Even if this could be done, the variety of conditions and factors influencing packaging and manufacturing at the supplier make it very hard to create one single scorecard that is generally applicable for all types of products but still specific enough to be used by the Packaging Technicians at IKEA.

6.2.1 Weighting

The Supplier Packaging Scorecard has not been weighted by the respondents in the same manner as for the other Packaging Scorecards. The normal procedure for the weighting of the scorecards has been for each respondent to independently give his or her own responses without any influence from the other respondents. The weights in the Supplier Packaging Scorecard have however been arrived at as a co-operation between the five respondents chosen to perform the weighting of the Packaging Scorecard. The authors believe this to be the better way in this case, since it is easier for them with their collected experience to weight the different factors, rather than each respondent giving the weights with reference to his or her limited field of work. If the respondents work with different product categories, this could mean that they separately would give weights connected to the prerequisites of their product category and not products in general. Therefore the authors believe that the weights emanating from the discussion and co-operation of the respondents give a more general view

of the importance of the categories in the Supplier Packaging Scorecard. The resulting Packaging Scorecard from a supplier perspective is presented in Table 6.1.

CRITERIA MANUAL PACKING	WEIGHT	CRITERIA AUTOMATIC PACKING	WEIGHT
Packing process		Packing process	
Efficient erection of packaging	80	Efficient erection of packaging	100
Efficient filling of packaging	75	Efficient filling of packaging	100
Efficient sealing of packaging	75	Efficient sealing of packaging	100
Packaging stability	75	Packaging stability	80
Ergonomical demands	100		
Product protection		Product protection	
Protective properties of packaging	50	Protective properties of packaging	50
No overhang	75	No overhang	75
Prevention of theft and manipulation	20	Prevention of theft and manipulation	20
Minimize empty space in packaging / Fixation of product within packaging	40	Minimize empty space in packaging / Fixation of product within packaging	40
Packaging stability	60	Packaging stability	60
Volume efficiency		Volume efficiency	
Storage adaptation	80	Storage adaptation	80
Handleability		Handleability	
Stackability	80	Stackability	80
Ergonomical demands	100	Ergonomical demands	70
Packaging stability	80	Packaging stability	80
Other factors - please complement		Other factors - please complement	
No factors were added by the participants		No factors were added by the participants	

Table 6.1. The collected values for the Supplier Packaging Scorecard.

All the five persons that have collaborated towards these weightings have worked as Trading Technicians at the IKEA Trading office in Älmhult and been chosen suitable for this survey by the authors' contact person Per-Olof Palm.

6.2.2 Comments

Two comments regarding the weightings were added by the group, one regarding *Prevention of theft and manipulation* and one regarding *Ergonomical demands*. The comment on *Prevention of theft and manipulation* is the same for both manual and automatic packing lines, and says that this subcategory has no large significance at the supplier. The other comment regarding *Ergonomical demands* under the *Handleability* category in the automatic packing line scorecard, is that this is often done mechanically and then the ergonomic aspects do not have a large impact.

Except asking the participants to weigh the different factors, the authors also included three extra questions regarding the packing process. The questions asked together with their answers are presented below.

For a manual packing line:

- Which factors are important in order to achieve an efficient erection of the packaging?
 - The construction and type of packaging
 - The quality of the packaging material
- Which factors are important in order to achieve an efficient filling of the packaging?
 - The packing pattern in which order the details are supposed to be packed
- Which factors are important in order to achieve an efficient sealing of the packaging?
 - The construction and type of packaging
 - The quality of the packaging material

The questions and answers were supposed to be used to strengthen the empirical data regarding the prerequisites of automatic and manual packing lines that were going to be used in the checklist.

6.3 Results from the Transport Packaging Scorecard

This chapter will provide the weightings collected regarding the transportation perspective of the Packaging Scorecard. It will also account for the comments provided by the participants and their areas of responsibility.

6.3.1 Weighting

The weighting of the transportation area has been performed by five participants as intended, and their separate scores are presented in Table 6.2 below.

CRITERIA	1 st	2 nd	3 rd	4 th	5 th
Product protection					
Protective properties of packaging	80	100	80	100	100
No overhang	40	80	20	100	50
Prevention of theft and manipulation	60	60	20	0	20
Minimize empty space in packaging / Fixation of the product	80	100	100	100	80
Minimize empty space in means of transportation	60	60	40	80	100
Packaging information - pallet weight	40	100	80	100	100
Packaging information - pallet orientation	40	40	70	70	50
Packaging information - pallet contents	40	20	70	80	50
Packaging stability	60	100	100	100	90
Volume efficiency					
Minimize empty space in means of transportation	80	100	100	100	100
Minimize empty space in packaging	80	80	100	70	80
Stackability	100	100	100	100	100
Right amount and size					
Packaging adapted to means of transportation	80	100	100	100	100
Handleability					
Stackability	100	60	100	100	100
Packaging stability	60	100	100	100	80
Ergonomical demands	60	80	80	50	50
Minimize handling	40	100	20	10	50
Other factors - please complement					
No factors were added by the participants					

Table 6.2. The collected values for the Transport Packaging Scorecard.

The participants weighting the Transport Packaging Scorecard have been chosen to be suitable by the authors' contact person within the Transport department, Niclas Gemfeldt, at IKEA of Sweden (IoS). Their areas of responsibility, together with their participant number, are presented below.

1st Respondent = Strategic Purchaser, Transport department at IoS

2nd Respondent = Strategic Operational Coordinator, Transport department at IoS

3rd Respondent = Transport HM, Transport department at IoS

4th Respondent = Supply Developer, Transport department at IoS

5th Respondent = Transport Coordinator, Transport department at IoS

6.3.2 Comments

This Packaging Scorecard has been provided with several comments by one of the participants. These will be presented below together with their corresponding subcategories.

The third respondent, the Transport HM, has provided the following comments:

Product protection

Protective properties of packaging

Hard and soft covers, container or load carriers should protect against climate related damages. Oil, dirt etc. are not either supposed to exist. The packaging should “allow” normal handling.

No overhang

“Just as bad, almost worse” if the goods only occupy e.g. 75 % of the pallet, then the filling rate also can become low. All packaging that we handle cannot have the dimensions 120X180?

Prevention of theft and manipulation

We trust our co-workers and the collaboration partners that we are in contact with.

Minimize empty space in means of transportation

See “No overhang”.

Packaging information - pallet weight

This function exists in the computer system that the loading crew uses in their job. The forwarder is not allowed to load!

Packaging information - pallet orientation

Important for certain products, but should be used restrictively.

Packaging information - pallet contents

See “pallet orientation”.

Handleability

Ergonomical demands

Top filling only exists when container loading. Customer packaging can practically weigh limitlessly, while multi-packs are not allowed to weigh more than 15 kg. What is placed on top are therefore most often “lighter” goods.

Minimize handling

We deliver the amount of articles that the retail outlet can sell during a time period of 2-4 weeks. When ordering less than a “full pallet”, the retail outlet is billed for our extra handling costs. Therefore the retails try to avoid “picking handling” as much as possible.

6.4 Results from the Distribution Centre Packaging Scorecard

This chapter will present the weightings collected regarding the distribution centre perspective of the Packaging Scorecard. It will also account for the comments provided by the participants and their areas of responsibility.

6.4.1 Weighting

The weighting of the distribution centre factors has been performed by five participants as intended, and their separate scores are presented in Table 6.3 below.

CRITERIA	1 st	2 nd	3 rd	4 th	5 th
Product protection					
Protective properties of packaging	100	70	50	70	60
No overhang	70	100	80	80	80
Prevention of theft and manipulation	40	0	0	50	0
Minimize empty space in packaging/ Fixation of product within packaging	95	70	100	100	60
Packaging information - pallet weight	30	10	20	75	60
Packaging information - pallet orientation	30	10	40	75	60
Packaging information - pallet contents	60	40	0	60	0
Packaging stability	90	60	100	100	100
Volume efficiency					
Storage adaptation	80	100	50	90	75
Right amount and size					
Module adaptation when mixing pallets	70	70	0	75	0
Quantity adapted to needs of retail	70	50	0	75	0
Handleability					
Stackability	85	100	100	50	100
Packaging stability	100	80	100	100	90
Ergonomical demands	100	70	0	80	80
Minimize storage handling	100	50	100	100	100
Picking ability	90	60	80	60	80
Other factors - please complement					
No factors were added by the participants					

Table 6.3. The collected values for the Distribution Centre Packaging Scorecard.

The participants weighting this Packaging Scorecard have been chosen to be suitable by the authors' two contact persons, Krister Olsson and Jörgen Johansson, at the Distribution Centre in Älmhult. Their areas of responsibility, together with their participant number, are presented below.

1st Respondent = Storage employee, Distribution Centre in Älmhult

2nd Respondent = Quality manager, Distribution Centre in Älmhult

3rd Respondent = Development out/in-bound, Distribution Centre in Älmhult

4th Respondent = Range Manager and member of Quality department, Distribution Centre in Älmhult

5th Respondent = Group manager, Distribution Centre in Älmhult

6.4.2 Comments

The Packaging Scorecard concerning the conditions at the Distribution Centre has been completed with several comments by one of the participants. These will be presented below together with their corresponding subcategories.

The third respondent, developer of out/in-bound flows, has provided the following comments:

Product protection

Protective properties of packaging

Important, but no packaging helps if the handling is careless.

No overhang

On the articles where it is possible to avoid, it of course eases our handling.

Prevention of theft and manipulation

Are done by secured load carriers and seals, together with safety routines at the different IKEA-units.

Minimize empty space in packaging

Air is not exactly bearing and the cause of a lot of cave-ins and damages.

Packaging information - pallet weight

The weight can be misleading. Plates of glass can be very heavy, but still cannot take any direct strain.

Packaging information - pallet orientation

Important, but is often based on the same article. Pillows can usually be placed on top of something else no matter the orientation.

Packaging information - pallet contents

The handling here should always be as carefully done as possible no matter the contents.

Packaging stability

The damages are often caused by that the cardboard quality in the packaging cannot take the stresses.

Volume efficiency

Storage adaptation

If we instead work towards adjusting the goods to the three wood pallet types we will receive this as a bonus.

Right amount and size

Module adaptation when mixing pallets

Sounds nice, but with the filling rate in each carton decreasing, voids are created and cave-ins and less units causes more handling.

Quantity adapted to needs of retail

There are a big variety of the sizes of the retail outlets, hard to find a multi-pack that suits everybody. Egoistic DC-thinking: FULL PALLET!

Handleability

Stackability

The whole supply chain gains by this, not least our storing in House 2 and 3, and during loading and unloading.

Packaging stability

Completely agree.

Ergonomical demands

Ergonomically adjusted packagings should probably mean smaller packagings and therefore more lifts and handling, that in the long run increases the risk of work related injuries.

Minimize storage handling

Priority one for us at the DC!

Pickability

Correct, but it is even better to avoid picking as far as it is possible.

The participant also gave the concluding remark that it is hard to weigh every single factor, since they affect each other the whole time. He also believes that striving towards the golden mean is often the answer.

6.5 Results from the Retail Outlet Packaging Scorecard

This chapter will present the weightings collected from representatives from IKEA retail outlets. Comments provided by the participants will also be accounted for together with their areas of responsibility.

6.5.1 Weighting

The weighting of the Retail Outlet factors has been performed by four participants, not five as intended. The reason is that not all respondents have answered even after several reminders. The scores that did get collected are presented in Table 6.4.

CRITERIA	1 st	2 nd	3 rd	4 th
Product protection				
Protective properties of packaging	25	100	90	60
No overhang	75	100	100	100
Prevention of theft and manipulation	50	0	100	70
Minimize empty space in packaging/ Fixation of product within packaging	50	70	80	70
Packaging information - pallet weight	50	0	30	50
Packaging information - pallet orientation	50	0	80	50
Packaging information - pallet contents	100	50	100	70
Packaging stability	100	100	100	100
Volume efficiency				
Storage adaptation	100	100	100	100
Right amount and size				
Quantity adapted to needs of retail	75	100	100	100
Packaging adapted to display mode	75	50	90	100
Handleability				
Stackability	50	40	100	50
Packaging stability	75	100	100	80
Ergonomical demands	100	100	100	50
Minimize storage handling	100	100	100	100
Minimize sales area handling	100	50	100	100
Minimize waste handling	100	100	100	100
Other factors - please complement				
Packaging information all sides of packaging				100
Adapted solution for sales pack				100
Consideration of sales area at Retail outlet when designing packaging				100

Table 6.4. The collected values for the Retail Outlet Packaging Scorecard.

Two of the weighting participants were chosen by the authors contact person, Joakim Strandh, at the IKEA Retail Outlet and the two other ones were provided by a Packaging Technician at

IKEA of Sweden. Their areas of responsibility, together with their participant number, are presented below.

1st Respondent = Logistics manager, Retail Outlet in Gothenburg

2nd Respondent = Section manager of store goods flow, Retail Outlet in Malmoe

3rd Respondent = Stock controller, Retail Outlet in Malmoe

4th Respondent = Logistics manager, Retail Outlet in Stockholm

6.5.2 Comments

In the Packaging Scorecard regarding the situation at a Retail Outlet, several comments have been provided by two of the participants. These will be presented below together with their corresponding subcategories.

The first respondent, the Logistics manager in Gothenburg, has provided the following comment:

Product protection

Protective properties of packaging

Mechanical, climate related, chemical we have no such influences here.

The third respondent, Stock Controller in Malmoe, has provided the following comments:

Product protection

Protective properties of packaging

Very important considering that some articles are handled many times – especially in our store where there is space/area shortage.

No overhang

One of the primary reasons for 390-write-offs – physical damage, damaged packing etc. It also makes code marking more difficult when the merchandise is given a spot in e.g. self-service-storage or goods pick-up bay.

Prevention of theft and manipulation

It is naturally important to counteract where it is possible. Easiest is perhaps to counteract manipulation of labels by pre-printing article numbers and barcodes on the carton.

Minimize empty space in packaging / Fixation of product within packaging

If empty space exists in packagings it should be filled with styrofoam or something similar in order to avoid 390-write-offs.

Packaging information – pallet weight

Not that important. This is something the truck operators most often feel + that you can see in the article information what it is (textiles, glass, pots, furniture etc.)

Packaging information – pallet orientation

Important for the store when unloading that the pallets are loaded in the correct order.

Packaging information – pallet contents

Extremely important. From this information you know as a truck operator/”goods handler” also how to handle the pallet.

Packaging stability

Extremely important. Partly when stacking, but also at the sales area when the pallet is somewhat sold off so that the remaining articles do not collapse and in this manner cause damages.

Volume efficiency

Storage adaptation

Extremely important, especially when code marking. A product that does not fit into a standard partitioned storage the storage must be modified in order to make room for the product in question – NOT GOOD! There are e.g. some articles (sofas and armchair pallets) that are too high for a normal partitioned shelf. Creates extra work for personnel and hard to handle for customers.

Right amount and size

Quantity adapted to needs of retail

Extremely important. Happens often that incorrect multi-packs cause to large quantities in the store. Gives rise to extra handling and too large stocks – NOT GOOD!

Packaging adapted to display mode

Very important in order to ease direct flows, but also in order to increase safety for return flows. If there is not room for everything at the sales area the remainder have to be put into storage – if the packaging then has lost in stability the risk of collapses in the shelf increases.

Handleability

Stackability

Is very important to us since our store is very small in relation to how much we sell.

Packaging stability

Important in order to minimize risk of collapse in the shelves at a possible return flow.

Ergonomical demands

Concerning this there are no doubts. The health of the personnel is super important.

Minimize storage handling

An enormously big problem for us since our store is undersized relative to our sales volumes.

Minimize sales area handling

Of course very important. The less time that is needed per article, the more articles can be handled.

Minimize waste handling

See above.

The fourth respondent, the Logistics manager in Stockholm, has provided the following comments:

Product protection

Minimize empty space in packaging / Fixation of product within packaging

Important from a pilferage perspective. The customer should not be able to hide other products in the empty space.

Other factors

Packaging information all sides of packaging

The truck driver does not have to think about that just that side has to be in front at sales spot.

Adapted solution for sales pack

The efficiency increases, when handling decreases, i.e. product straight to the sales spot.

Consideration of sales area at Retail Outlet when designing the packaging

Today this end of the chain is overlooked, i.e. IoS focuses more on transport security/damages and do not consider sales spot for customer at the retail outlets.

7 Analysis

This chapter is based on the frame of reference and the collected empirical data and will discuss the findings of this master thesis. The results from the Packaging Scorecards will be analysed by discussing their subcategories and logistical influence on the IKEA Supply Chain.

The weights of each separate subcategory provided by the respondents are presented in a table in respective section along with the mean weight for the purpose of increasing readability, as illustrated in Table 7.1 below.

1 st Respondent	2 nd Respondent	3 rd Respondent	4 th Respondent	5 th Respondent	Mean Value
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Table 7.1. Illustration of how given weights and mean weights are presented throughout the analysis chapter.

The mean has been calculated after disregarding the highest and lowest weights given (which are coloured grey in the tables), since extremes can have a significant effect on the mean value when the respondent group is small, as it is in this case. The Supplier Packaging Scorecard has however not been weighted by the respondents in the same manner as for the other Packaging Scorecards. The normal procedure for the weighting of the scorecards has been for each respondent to independently give his or her own responses without any influence from the other respondents. The weights in the Supplier Packaging Scorecard have been arrived at as a co-operation between the five respondents chosen to perform the weighting of the Packaging Scorecard. Therefore, the weights given are presented in a table in the beginning of the Supplier section. Regarding the Retail Outlet Packaging Scorecard, despite great efforts, the authors have not been able to obtain weights from more than four adequate IKEA employees, and the mean is therefore based on all given values.

7.1 Supplier

The weights of the Supplier Packaging Scorecard, for suppliers with manual as well as automated packing lines, given by the respondent group are presented in Table 7.2. The subcategories are the same for both manual and automated packing lines except for *Ergonomical demands* in the *Packing line* category which only applies at a supplier with a manual packing line. The Packaging Scorecard and respective definitions used for the weighting of the supplier factors are found in Appendix B. The weights given are located in chapter 6 along with comments of the weightings. In this chapter, each of the subcategories is analyzed regarding their weighting.

CRITERIA MANUAL PACKING	WEIGHT	CRITERIA AUTOMATIC PACKING	WEIGHT
Packing process		Packing process	
Efficient erection of packaging	80	Efficient erection of packaging	100
Efficient filling of packaging	75	Efficient filling of packaging	100
Efficient sealing of packaging	75	Efficient sealing of packaging	100
Packaging stability	75	Packaging stability	80
Ergonomical demands	100		
Product protection		Product protection	
Protective properties of packaging	50	Protective properties of packaging	50
No overhang	75	No overhang	75
Prevention of theft and manipulation	20	Prevention of theft and manipulation	20
Minimize empty space in packaging / Fixation of product within packaging	40	Minimize empty space in packaging / Fixation of product within packaging	40
Packaging stability	60	Packaging stability	60
Volume efficiency		Volume efficiency	
Storage adaptation	80	Storage adaptation	80
Handleability		Handleability	
Stackability	80	Stackability	80
Ergonomical demands	100	Ergonomical demands	70
Packaging stability	80	Packaging stability	80

Table 7.2. The weighted Supplier Packaging Scorecard.

7.1.1 Packing process

Efficient erection of packaging

The weight given for manual erection of packaging by the respondents is 80, which indicates that efficient packaging erection is of importance for a manual packaging line. It is however compared to packaging erection for an automated packing line (100) somewhat lower. What influences packaging erection in general is the packaging design, but also the surrounding system with which the packaging interacts. Furthermore, the quality of the packaging material influences the packaging erection process, no matter the characteristics of the erection process. Manual packaging erection is in general more flexible than automated erection, and can handle larger packaging with more complex folding patterns. This could be one of the reasons for that the weighting given for the efficiency of manual packing erection is lower than for the automatic. The manual packing solution could be more complicated with more folding patterns etc. and this makes the process become less efficient and take more time. This possibility to use more complicated packaging solutions is however one of the benefits with a manual packaging erection. Manual work power also gets tired after working a while and is not able to keep the same speed as an automated packing line. It is important to design packaging solutions so that they do not complicate the packing process more than is necessary, but this is extra critical for automatic packaging erection. The packing process most often needs to be as fast as possible, and then it is important for all activities of the process to be just as fast. If one activity falls behind, the entire packing process is slowed down. An efficient packaging erection is therefore important, as is also the filling and sealing of the packaging. These aspects are however not as critical for a manual packing line as they are for an automated

packing line due to the better flexibility of the manual packing line. If the packing erection pace is too slow it is easy for the supplier to add an extra employee at the packing line in order to speed up the process, this is however not an option for an automated supplier.

Efficient filling of packaging

The subcategory *Efficient filling of packaging* follows the same pattern as the previous subcategory. Here the weighting is 75 for the manual and 100 for the automatic packing line. This indicates that the erection of the packaging is more important than the filling of the packaging from a manual perspective. One reason for this could be that the manual erection process is much more straining and could have more complicated phases, than the filling process. From a manual perspective, one important factor that is mentioned in the Packaging Scorecard to achieve an effective filling is the filling pattern in which the details are placed in the packaging. This on the other hand is also important from an automated filling perspective, but in another way, according to the empirical studies. Here the number of activities that each robot performs should be maximized in order to minimize the number of robots needed. This also places demands on the order in which the details are supposed to be placed. Another important filling aspect for automated packing line is packing small details in bigger packagings in advance before the filling process starts, since small details are hard for the robot to grasp. Packing small details in larger packagings makes it possible for the robots to pick them up during the packing process, which is something that perhaps could not be done otherwise.

Efficient sealing of packaging

The weighting provided here is distributed exactly like the previous subcategory, *Efficient filling of packaging*, with a 75 weight for the manual and 100 for the automated packing process. Some factors are especially important for an efficient sealing process, and these are the design and type of packaging and the quality of the packaging material. This applies to both manual and automated packing lines.

The fact that *Efficient erection of packaging*, *Efficient filling of packaging* and *Efficient sealing of packaging* all have received the maximum weight 100 for the automated packing line, probably has to do with the lack of flexibility in the automated packing line. When the packaging line lacks flexibility it is crucial that the packaging system is well designed to fit the prerequisites of that specific supplier. It is also critical that all the automated stages are just as efficient, or a bottleneck will appear somewhere along the packing line.

Changes in the manual packing process are easier to accomplish since the automated line usually is adapted to a specific range of products. Increased efficiency often means a decrease in flexibility, which is supported by the weightings provided.

A factor that influences the sealing efficiency is which sealing technology that is used, for example if the packaging is sealed with tape or glue or if it is self-locking. Glue might take time to dry depending of what kind is used, but a packaging with a self-locking mechanism does not need this extra time. On the other hand self-locking packaging might be more expensive even if no glue is used. Taping takes time but perhaps less time for an automated line than a manual line because the automated does not get tired.

Packaging stability

When it comes to the stability of the packaging from a packing process perspective, the deviation between the given values is very small, 75 for manual and 80 for automatic packing

lines. Packaging stability is important when handling the packaging, manually or automatically. The packaging might e.g. be lifted by hand or perhaps lifted automatically with a suction cup, and needs to be stable enough to take the strains that are put on it during this activity. A robot also lacks the ability to balance unstable packaging, if for example the content shifts, in the same way as a person can. This is a factor motivating the higher value given for packaging stability from an automated perspective than a manual perspective. Packaging stability is from a handleability perspective important especially when placing the finished product and packaging on the pallet.

For heavy products the stability might be more important than it is for lighter products when lifting it. A heavy product needs greater forces to be lifted and the strains put on the packaging are therefore greater. For this reason the stability can be more important for heavy products than for lighter ones. An explanation for why the values given are not even higher is that they are given for a general product of average weight. For heavy products the stability is more important but for lighter products less, which could explain the weightings.

Ergonomical demands

When using a manual packing line the ergonomical demands surrounding this process becomes very important. This is both claimed in the empirical studies and proved by the maximum weight provided in the Packaging Scorecard. This applies of course only for a manual packing line since there is no manual handling in the automated packing process. A consequence is that when using manual packing lines, it is important to create a packaging solution that is adapted to human prerequisites. This in order to both keep the employees healthy and to keep the efficiency of the packing line high. It should be as simple and unforced to erect as possible, the placement pattern of the products and such inside the packaging should be made as easy and effortless as possible and the sealing process as non-demanding as achievable.

Worth noticing is the high general importance of *Ergonomical demands* as shown by the 100 weights of the subcategory in the categories *Packing process* and *Handleability*.

7.1.2 Product protection

Protective properties of packaging

The subcategory *Protective properties* has received the weight 50 from both a manual and an automated packing line perspective. This can be explained by that product- and packaging damages seldom take place within the packing line, and when damages occur the cause is usually manual handling. Another factor that influences the importance of *Protective properties of packaging* is storing at the supplier. Products are sometimes manufactured in large batches, more common when using automated packing lines, for sake of efficiency and cost, but are not always needed by IKEA in that large quantities. Therefore, the packaged products are stored for longer periods of time, perhaps stacked on top of each other in multiple layers of pallets, which places demands on the packaging not to deteriorate from the strains put on it during storing. The stabilization method used in the separate packaging is important here, as well as the packaging material used. When it comes to stability of the pallet, the stacking pattern of the packagings is important. One fact that is important to consider here is that the respondents that have weighted this category works for IKEA and not for the supplier. This could explain the low weighting since if the product is damaged at the supplier, the products probably never will arrive at an IKEA store and this would be a loss for the supplier and not for IKEA. Of course IKEA would not want to overprotect the product due to handling problems or wrongful storing at the supplier.

No overhang

As stated earlier, product or packaging damage seldom occur in the packing line itself. When it occurs it is due to handling errors. The subcategory *No overhang* has been given the weight 75 for both manual and automated packing lines, and that the weights are the same is most probably due to the fact that product damage occurs outside the packing line where the handling of the goods probably is the same no matter if the packing line is manual or automated. Pallet overhang leaves the goods outside the area of the pallet unprotected, and during handling the goods easily gets damaged when bumping into other goods or similar. This motivates the relatively high weight that is given to this subcategory. That the weight given is not even higher might depend on that products damaged at the supplier probably is a problem of the supplier and do not reach an IKEA retail outlet.

Prevention of theft and manipulation

This subcategory has the lowest values of the whole Packaging Scorecard from a supplier perspective, namely 20 for both manual and automated packing lines. The Trading personnel probably think of this from an IKEA perspective when they motivate the values given. From an IKEA perspective, theft at the supplier is a problem of the supplier since it is up to them to deliver the quantity of goods that has been agreed upon. Thus, this is not very important for IKEA. Regarding manipulation, no supplier would benefit from manipulating the goods so this is something that most probably not would be done on purpose. This motivates the weights given by the respondent group.

Minimize empty space in packaging / Fixation of product within packaging

This subcategory has been given the same importance, namely 40, for manual as well as automated packing lines. Empty space in packaging influences the stability of the packaging, as does a fixated or not fixated product inside it. If there exists empty space within the packaging and if the product is not fixated, this can cause damage both to the packaging and the content inside during movement. The strains put on a packaging and its product are perhaps not as large at a supplier as they could be later on in the Supply Chain, which motivates the relatively low weight given to *Minimize empty space in packaging / Fixation of product within packaging*. Stacking multiple pallets on top of each other during longer periods of time can have the effect that the packaging sinks in and damages the products. One explanation to why *Packaging stability* is weighted higher than *Minimize empty space in packaging / Fixation of product within packaging* is that a packaging still can be stable even though there is empty space in it.

Packaging stability

A stable packaging is from a product protection point of view rather important, as indicated by the values given by the respondent group. They have weighted the subcategory a value of 60 for a manual packing line as well as for an automated packing line. From a product protection perspective packaging stability is important in order for the packaging not to collapse either in the packing line or during handling or storing. In order to ensure efficiency and lower costs products are sometimes manufactured in large batches. IKEA may not however have a demand that corresponds to the number of products made, whereby products need to be stored at the supplier. Therefore, the products can be stored for longer periods of time, perhaps stacked on top of each other, which places demands on the packaging not to deteriorate from the strains put on it during storing. The stabilization method used in the separate packaging is important here, as well as the packaging material used. When it comes to stability of the pallet, the packing pattern of the packagings is important. As well as for

Minimize empty space in packaging / Fixation of product within packaging, the strains put on a packaging are perhaps smaller at a supplier than they are later on in the Supply Chain, which motivates the relatively low weight given to *Packaging stability* compared to other parts of the supply chain.

7.1.3 Volume efficiency

Storage adaptation

In order to keep costs at a minimum, it is important to use available volume capacity as efficiently as possible. This applies through the entire supply chain, and at the supplier it is about having a coefficient of fullness as high as possible during storing. The lower the coefficient of fullness, the larger costs for handling and storing the manufactured products for the supplier due to the need of more handling and additional storage space. For this reason it is important for the supplier for the palletized goods to be adapted in size to the storage facilities, which motivates the weight 80 given by the respondent group for the subcategory *Storage adaptation*. Also, when it comes to using space efficiently, pallet stackability and absence of overhang become of importance. This applies not only to the supplier, but to the entire Supply Chain.

7.1.4 Handleability

Stackability

Stackability has been given the weight 80 for both manual and automated packing lines. This implies that there are no differences regarding this subcategory between automated and manual packing lines. However, in the empirical studies it is explained that the pallet can become less stable when the small packagings are stacked on the pallet manually, than when the stacking is automatic. The reason for this is that manual labour cannot perform equally during a whole day's work and the preciseness of the stacking can fluctuate during the day. This is not the case with automated stacking since the robots always carry out their stacking with the same quality and preciseness. But, as also mentioned in the empirical studies, both ways usually work, which probably explains the correspondence in weightings. Stackability is important for, among other reasons, that it enables pallets to be transported on top of each other, which in turn increases handling efficiency.

Ergonomical demands

The packaging should not be too big or heavy from a handling perspective, which is supported by the 100 value for *Ergonomical demands* in the *Handleability* category for a manual packing line and both the empirical studies and the frame of reference. This subcategory has been given a lower weight, 70, for the automated packing line with the motivation that handling often is carried out by machines whereby ergonomics is less important. Since the handling aspects taken into account in the *Handleability* category are not included in the packing line, but are carried out after the product itself has been packaged where the handling is the same no matter if the packing line is manual or automated, the authors are somewhat sceptical to this motivation. The ergonomical aspects should be about the same. The authors are left thinking that the reason for the difference in the values given is a deficiency in the definitions of the subcategories. The values should be about the same for both manual and automated packing lines. What influences ergonomics is for example lifting paths, which equipment that is used as well as handling methods etc. Since ergonomical aspects most probably are essential for the wellbeing of the personnel, as well as beneficial from a cost perspective, this subcategory should be considered during the packaging development process.

Packaging stability

Packaging stability is important from the perspective of a supplier with a manual packing line as well as the perspective of a supplier with an automated packing line. The respondent group gives this subcategory the weight 80 for both manual and automated packing lines, and this concurs with empirical data that states that stable packaging is important from a handleability perspective. The packaging needs to be able to handle the forces it is exposed to during the handling activities. In general, packaging stability is an important factor at the supplier, whether the packing line is manual or automated, with consistently high weights.

7.2 Transport

The Packaging Scorecard and appertaining definitions used for the weighting of the transport related factors are found in Appendix B. The weights given are located in chapter 6 along with comments of the weightings. Below, each of the subcategories is analyzed regarding their weighting.

7.2.1 Product protection

Protective properties of packaging

In this subcategory, respondents have all agreed to that the protective properties of the packaging deserve very high weights, see Table 7.3. That overprotection costs money can explain the lower weights, and therefore a small rate of damaged products may be allowed. To support this reasoning, consideration has to have been taken to the fact that damaged products cost money to e.g. handle, dispose of and replace. So the costs for overprotection and managing damaged goods are to be compared before a decision considering this matter is made. Respondent number three has motivated the 80 weight with that containers etc. should protect the packaging from climate related damages and this is not a function that should be provided by the packaging system. The other 80-respondent has generally placed lower weights (8 of 16 of his subcategories has the lowest weights), than the other participants in the Transport Packaging Scorecard. After removing the highest and lowest values (80 and 100) the mean value for the Protective properties of packaging subcategory is 93,3.

80	100	80	100	100	93,3
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Table 7.3. Presentation of the weights collected for Protective properties of packaging together with the calculated mean value.

According to the theoretical framework the protective properties of packaging should comprise protection against mechanical, climatic, chemical and electro technical stresses. IKEA's transport section however, focuses on that the packaging should withstand the mechanical stresses and thereby keep the product intact. This means that the packaging should be able to withstand vibrations and impacts during mechanical movement and also the stress that occurs when other goods do not support it. Climate protection is not important during transportation since damages deriving from climate factors usually are due to defect containers and such. This also applies to the chemical stresses. This implies that the only protective property of packaging that should be considered during packaging development, from a transportation perspective at IKEA, is the expected mechanical impacts.

No overhang

The *No overhang* category has a wide range of different weightings as illustrated in Table 7.4. Participant number three has motivated his low value (20) with that it is equally bad or almost worse if the goods only occupy 75 percent of the pallet. He also points out that not all packaging systems can have the dimensions 1200x800 mm (in other words, be adopted to

different pallet types). He uses the same motivation at the subcategory *Minimize empty space in means of transportation*, but here he weights it 40. Therefore he probably believes that overhang causes less product damages than underhang and empty space, and that no overhang is not that important from a product protection perspective.

40	80	20	100	50	56,7
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Table 7.4. Presentation of the weights collected for *No overhang* together with the calculated mean value.

The motivation for the 100 weight is that different types of overhang cause different types of damages. From a transportation perspective it is important to avoid overhang on the sides (by exceeding 800 mm for a EUR-pallet) since that can cause that there is not room for another pallet and a void is created, which in turn means that the stability that pallets provide to each other is lost. As a consequence the pallets can start to move, and if the pallets are stacked they might start to skew, with product and packaging damages as an outcome. If the overhang on the other hand is on the 800 mm side (by exceeding 1200 mm for a EUR-pallet) damages can happen during the loading or unloading of the pallets since the truck slightly can push the pallet and then the back- and front side of the packaging system is unprotected and can be crushed. The mechanical stresses during transportation are the greatest in the direction of travel and therefore overhang in, and opposite, the direction of travel causes the most serious damages. The disadvantages of overhang from a product protection perspective are also supported by the literature, e.g. overhang causes an unfortunate stress of the corners of the pallets when double stacked, which can cause the packaging to collapse. Since the arguments are strong against overhang, both from an empirical and theoretical perspective, the mean value of the weights is surprisingly low.

Prevention of theft and manipulation

The values provided for the *Prevention of theft and manipulation* subcategory are generally low, as seen in Table 7.5. Respondent three has motivated his 20-weight with that IKEA trusts their employees and their collaborating partners. The participant providing the weight 0 has motivated his choice by explaining that theft and manipulation never has been a problem for IKEA, probably because they transport low value products.

60	60	20	0	20	33,3
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Table 7.5. Presentation of the weights collected for *Prevention of theft and manipulation* together with the calculated mean value.

Both manipulation and theft will be even harder to accomplish in the future since IKEA will start using different kinds of seals and “closed compartments” during transportation. This will probably have as a consequence that the importance of this subcategory will become even lower in the future.

Minimize empty space in packaging / Fixation of the product within the packaging

This subcategory seems to have a big importance for IKEA, see Table 7.6. An explanation can be that loose parts move around in the packaging if there is empty space in it, which during transportation can cause damages both to the product, the packaging and its surroundings. When using standardised packaging this can be a problem since filling materials have to be used in order to stabilize the product. Not all packaging solutions can be custom made to fit the specific product and still be effective and efficient both from a cost- and a Supply Chain perspective. If all packaging are developed specifically for each of IKEA’s products this will

be a time consuming and therefore costly development process. Furthermore, for low volume goods, the time and money packaging development consumes can exceed what is saved due to the benefits custom made packaging entail. Also, a packaging development process is time consuming, which could lead to delays in product launches that could be critical for the IKEA business. The 80 weights can be explained by that the cost for fixating products in standardized packagings might be higher than the costs deriving from product and packaging damage that the filling counteracts.

80	100	100	100	80	93,3
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Table 7.6. Presentation of the weights collected for Minimize empty space in packaging / Fixation of the product within the packaging together with the calculated mean value.

The importance that IKEA places on the subcategory *Minimize empty space in packaging / Fixation of the product within the packaging* is surprisingly high since this is a factor that hardly has been mentioned in the literature used in the frame of reference.

Minimize empty space in means of transportation

The values provided to the *Minimize empty space in means of transportation* subcategory diverges, as seen in Table 7.7. The given values range from 40 to 100, which is a large diversion and adds uncertainty to the mean value. This subcategory can be connected to *No overhang* since overhang affects the possibility to minimize the empty space in the means of transportation. Overhang can have the effect that the transport cannot be filled up properly, leaving space between the pallets, which could cause damages. Underhang causes a risk for movement or collapse of the packaging. The lowest value 40 can be explained by that underhang e.g. causes empty space when transported, but according to IKEA as long as the packaging system is stable from a transport technical point of view this should not lead to product damages. Another explanation is that top filling with a 3rd layer that minimizes the empty space on top of the double stacked pallets, is not always beneficial from a product protection point of view. If the goods placed on top do not go one-to-one in size with the goods below, the 3rd layer might shift during transportation and both cause damages during transportation and make the unloading aspect so difficult that damages occur for that reason.

60	60	40	80	100	66,7
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Table 7.7. Presentation of the weights collected for Minimize empty space in means of transportation together with the calculated mean value.

The person that provided this subcategory with the value of 80, claimed that the worst stress that a packaging is exposed to during transport is when it is not supported by other goods, e.g. when the transport compartment is not completely full or when the design of pallets transported causes empty space. This person also stated that if there is empty space in the transport compartment, nothing would happen during a normal transport as long as the pallets are stable and fixated properly. It is the carrier’s responsibility to take measures to fixate the load and this is nothing that can be remedied with packaging.

When comparing the values provided to the subcategory *Minimize empty space in means of transportation* from a product protection and volume efficiency perspective, the respondents have generally placed lower weights on the product protection perspective. This indicates that empty space during transportation has less significance from a product protection than from a volume efficiency perspective.

Packaging information - pallet weight

This subcategory shows a strong trend towards a high relevance of placing information regarding pallet weight on the packaging, as illustrated in Table 7.8. All the participants have placed the highest weighting on pallet weight of all the packaging information subcategories, except participant number one who placed the same weighting on all three. The overall high weighting shows that information on the packaging regarding pallet weight is of great relevance from a transportation perspective.

40	100	80	100	100	93,3
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Table 7.8. Presentation of the weights collected for Packaging information – pallet weight together with the calculated mean value.

The rule used today at IKEA is “same on same”, which means that a pallet is supposed to be able to carry its own weight, but there is a need for some kind of stacking code, e.g. when mixing different types of pallets during transport. If a heavy pallet is placed on top of a lighter one, the lighter one is usually compressed, and the pallet weights can be difficult to estimate during loading. What they might have considered is that at some consolidation points, e.g. in Asia, the loading of mixed goods can be done manually and under a tight time schedule. The loading personnel might not even know how to read, and therefore a universal coding system would make it possible to avoid these kinds of damages. This reasoning is also supported by the high mean value provided.

Packaging information - pallet orientation

The weighting provided regarding *Packaging information – pallet orientation* shows a quite small diversity and the mean value is calculated to 53,3, as shown in Table 7.9. Participant number three, who weighted the factor to 70, commented that this information is important for some specific products, but should be used restrictively. Respondent number four, also with a 70 weight, thinks that the arrows indicating direction that are provided for specific products today are not always followed, with product damages as a consequence. This is a handling problem and has to be solved with information to the parties involved.

40	40	70	70	50	53,3
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Table 7.9. Presentation of the weights collected for Packaging information – pallet orientation together with the calculated mean value.

Pallet orientation information in general for packaging does not seem to be of great importance from a transportation perspective, both due to the mean value and the motivations, but should be concentrated to specific critical products and packaging solutions. Packaging solutions with specific critical orientation should probably be avoided as far as possible, since these can cause extra handling time and a greater risk of damage.

Packaging information - pallet contents

The subcategory *Packaging information – pallet contents* shows a variety of different weightings, as illustrated in Table 7.10. This can be explained by that some participants might have weighted the subcategory generally for all types of products, without reading the specified definitions, and some after products of glass and mirrors as emphasized in the definitions enclosed. This argument is supported by a comment provided with participant number three (70), who claims that the information is important for specific products and should be used in a restrictive manner. Respondent number two, with just a 20 weight, might for example have the opinion that it is unnecessary to mark all packaging with the contents, or

that the people that handle the packaging should be careful whatever contents they are loading or unloading.

40	20	70	80	50	53,3
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Table 7.10. Presentation of the weights collected for Packaging information – pallet contents together with the calculated mean value.

Since there exists a risk of misinterpretation of this subcategory, the weighted mean value of 53,3 might not be justified.

Packaging stability

This subcategory seems to have a big impact for IKEA, se Table 7.11. The participant that has placed the generally lowest weights in the whole Transportation Packaging Scorecard provides the only strongly deviating value (60). If the packaging is not stable, it will collapse during transportation where the mechanical influences are very strong. Therefore packaging stability should be essential from a transportation perspective and deserves a much higher value than 60, which is supported by the other very high values provided. Something that also contradicts the 60 weight is that the same participant has placed his only 100 weight for *Stackability*, and if the packaging is not stable it will not be stackable without causing product and packaging damages.

60	100	100	100	90	96,7
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Table 7.11. Presentation of the weights collected for Packaging stability together with the calculated mean value.

One explanation to the weight 60, and some other differentiating weights provided by the first respondent compared to other participants can be explained by different job descriptions and therefore different priorities and insight of the examined areas. The mean value 96,7, which was calculated after removing two of the extreme values, seems to be a justified weight. Especially since the goods usually are transported for an extensive period of time. It can be discussed whether or not it is necessary to design a 100 percent stable packaging if some stability can be provided by aids, e.g. painted boards that maximize the friction between two stacked pallets and thereby providing stability to the transported load. This depends on the view of the packaging system, if the aids are included or excluded in the definition of a packaging system. If there is no underhang or empty space in a transport, some stability can also be provided to a pallet by other pallets that are in contact with it.

7.2.2 Volume efficiency

Minimize empty space in means of transportation

The very high weights provided for this subcategory, as seen in Table 7.12, can be explained by the IKEA philosophy “We hate air”, which represents IKEA’s opinion on empty space in transports. This is one of the fundamental values that the IKEA logistics is built upon. They believe that unnecessary empty space in transports entails more costs for transportation and should be eliminated. The four participants that have provided the 100 weights are probably motivated by that IKEA has suppliers spread all over the world that supplies IKEA retail outlets world wide with their products. To minimize these huge global transportation costs it is essential to minimize empty space in the means of transportation.

80	100	100	100	100	100
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Table 7.12. Presentation of the weights collected for Minimize empty space in means of transportation together with the calculated mean value.

The same person that has provided the lowest weights in the majority of the subcategories provides the only deviating value, 80. What he could motivate his value with is that minimizing the empty space in means of transportation should not be strived towards at any price. E.g. adding extra products in transports by top loading means a volume efficiency increase, but mechanically it is not always beneficial to have loose goods on top since this could cause unnecessary product damages, and thereby costs that exceeds the benefits with optimizing the transport volume. The extra top loaded goods might also give rise to an increase in handling costs for loading and unloading that exceed the transportation costs saved, which would not be beneficial from a whole Supply Chain perspective. For the reason of utilizing space more efficiently in means of transportation, IKEA has developed the “cross” (800x1140 or 760x1200), which is a packaging design strategy that is going to be implemented at IKEA. The aim is for products to be designed with the measurements of the “cross” in mind in order for transportation to be efficient by truck, boat and railroad.

Minimize empty space in packaging

This subcategory does not have as high weights as the previous subcategory *Minimize empty space in means of transportation*, as illustrated in Table 7.13. Three people have weighted it with 80 and the deviations are not large, which implies that they all share quite the same view on this subject. Since the category is *Volume efficiency*, the lower values can be explained by that even if the empty space within the packaging is eliminated, this does not always lead to that more products can be transported. Therefore it could be an unnecessary measure to take from a volume efficiency perspective and this action could e.g. lead to that an uncalled for underhang is created that requires a more stable packaging solution, to be stackable, which also is a necessity from a volume efficiency perspective.

80	80	100	70	80	80
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Table 7.13. Presentation of the weights collected for *Minimize empty space in packaging* together with the calculated mean value.

The higher values are most likely based on the philosophy that every unnecessary empty space transported generates unmotivated costs, which should be avoided. But at certain circumstances, as the one described above, this might not always result in better volume utilization.

Stackability

Within this subcategory all participants agree that stacking ability is essential from a volume utilization perspective, se Table 7.14. Everybody has weighted it with the highest possible weight, which probably is motivated by that if IKEA are not able to stack pallets, they loose the possibility of transporting an additional entire layer of pallets. The volume of the transport compartment is fixed and they will pay for the same volume, whether it is filled or not.

100	100	100	100	100	100
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Table 7.14. Presentation of the weights collected for *Packaging stability* together with the calculated mean value.

Also, if the height in the means of transportation cannot be utilized the whole concept with flat packages becomes useless. All this supports the validity of the mean value of 100 for this subcategory.

7.2.3 Right amount and size

Packaging adapted to means of transportation

Packaging adapted to means of transportation is closely connected to the subcategory *Minimize empty space within means of transportation* for natural reasons, which also can be seen when comparing Table 7.15 below with Table 7.12. Both of the Tables have the same weighting and a lot of the reasoning used in *Minimize empty space within means of transportation* can also be applied here.

80	100	100	100	100	100
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Table 7.15. Presentation of the weights collected for *Packaging adapted to means of transport* together with the calculated mean value.

According to the theoretical framework, the packaging modules should be adapted to optimal use in every part of the Supply Chain. In Sweden the module used is the based on the dimensions of the EUR-pallet, while in some other countries other module systems are used. It is impossible to design packaging solutions that will optimize the space used in all means of transportation, e.g. train, truck or boat, but IKEA has as an aim to design according to the “cross” described in the Empirical Studies chapter. When these measurements can be reached, transportation will be efficient by truck, boat and railroad as well. Maybe the weight 80 is placed here because it is impossible for one packaging solution to totally be optimized to all means of transportation used, while the people with the 100 weights want to put an emphasis on that this is to be strived towards as much as possible, e.g. by using the “cross” principle. To totally adapt a packaging solution to a mean of transportation is sometimes impossible depending on the product, and for example overhangs, which is not good for any kind of transportation, cannot always be avoided. When applying an overall perspective, striving towards the “cross” when designing packaging systems is likely the best strategy for IKEA and due to this aspiration this subcategory should have the mean value 100.

7.2.4 Handleability

Stackability

The respondents of this subcategory seem to find stacking ability from a handling perspective to be very important, as seen in Table 7.16. To facilitate loading and unloading activities stacking ability can for example allow two pallets to be handled at the same time. If the pallets can be handled two at the time, the handling time per pallet can be reduced with a great deal. This applies both from a loading and an unloading perspective.

100	60	100	100	100	100
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Table 7.16. Presentation of the weights collected for *Stacking ability* together with the calculated mean value.

Since this whole category is focused on the handling aspects of the packaging, it is surprising that the values provided in this category are so different from the subcategory *Minimize handling*, which generally has low values, see Table 7.19. The person providing the 60 weight in this category does not find stackability to be of such a great importance from a handling perspective, but has weighted *Minimize handling* with the top weight 100. This can be explained by that some of the participants might not have read the enclosed definitions closely and just thought that stackability is important from a transport perspective. If this is the case, the high mean value in this subcategory might not be totally valid, but two of the participants with 100 weights, number three and four, have proven to have read the definitions and has weighted accordingly.

Packaging stability

This subcategory has received high weights, with the exception of the value 60 as seen in Table 7.17. The first respondent has placed a low weight, which has been a trend through the whole Packaging Scorecard for transportation. The same person also weighted packaging stability from a product protection perspective with the weight 60, which shows that packaging stability in general does not have a great significance in his opinion. This view could be connected to his professional position or work assignments.

60	100	100	100	80	93,3
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Table 7.17. Presentation of the weights collected for Packaging stability together with the calculated mean value.

The other participants seem to agree with the statement that packaging stability is of great importance from a handling perspective when loading and unloading, so the mean value 93,3 is most likely relevant in this subcategory.

Ergonomical demands

The *Ergonomical demands* subcategory shows a quite uniform cluster of weightings as seen in Table 7.18. One comment, provided by participant number four is when it comes to top loading products from an ergonomical perspective, there exists many local recommendations in different countries. Also specific deals can be agreed upon with the employees with e.g. different lifting weight limitations, which could motivate his low weight 50. If ergonomical demands can be evaded by specific agreements, this could explain the low mean value of this subcategory from a loading and unloading perspective. Another explanation to why the values are not higher is that generally there is little manual handling and most of the loading and unloading activities are performed by forklift.

60	80	80	50	60	63,3
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Table 7.18. Presentation of the weights collected for Ergonomical demands together with the calculated mean value.

Respondent number three has weighted this subcategory with a weight of 80. He has also commented his weight with that when it comes to loading and unloading top loaded products, usually light products are placed on top. Also according to him, top filling only occurs when transporting goods in containers. The importance of the weight of top loaded products lessens when they are palletized, because this makes it possible to handle the products by forklift. When it comes to transport, the primary ergonomical factor is the weight of the products.

Minimize handling

This subcategory shows the largest diversion of weights of all subcategories that has been used for the transport version of the Packaging Scorecard, as illustrated in Table 7.19. The weighting also lacks any relevant motivations for the different weights. One explanation for the low weights could be that they have not considered the extra costs that are generated from a Supply Chain perspective when extra handling is needed, which participant number two might have realized with his 100 weight. Another justification to the low weightings can be that handling is seen as a modest part of the transportation field that there is not much to earn by minimizing it.

40	100	20	10	50	36,7
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Table 7.19. Presentation of the weights collected for Minimize handling together with the calculated mean value.

The big diversity of weighting makes it hard to draw any well-based conclusions, and therefore there exists a big risk that the mean value is not justifiable. Palletizing top loaded goods is a good way to minimize manual handling and increase handling efficiency. A consequence is however a lower load factor during transport, but what is lost in volume efficiency is possibly gained in better handling efficiency.

7.3 Distribution Centre

The Packaging Scorecard and respective definitions used for the weighting of the distribution centre factors can be found in Appendix B and the weights given are located in chapter 6 along with comments of the weightings. Below, each of the subcategories is analyzed regarding their weighting.

7.3.1 Product protection

Protective properties of packaging

As can be seen in Table 7.20 below, the mean value (after removing the highest and lowest ones) is 66,7. There are no large deviant weights given by the respondents when the highest and lowest values have been removed. When including all weights, only one value deviates from the rest, and this is the value 100. A respondent who gives the weight 100 for *Protective properties of packaging* might reason that a product in a broken packaging, or a broken product for that matter, cannot be sold. This in turn gives rise to cost not only for a lost product, but additional costs in other parts of the supply chain. A motive given to the lowest value, 50, is that the *Protective properties of packaging* are important but cannot remedy careless handling etc. Thus, the protective properties are not considered to be crucial by the group of respondents.

100	70	50	70	60	66,7
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Table 7.20. Presentation of the weights collected for Protective properties of packaging together with the calculated mean value.

Regarding the protective properties of packaging, literature states that durability against mechanical influence is of greatest importance. This should also apply for the packaging at a DC, since here impacts occur when the pallets are handled, puncture damages due to reckless unloading sometimes happen and compression damages are sometimes caused by long storage times. In a distribution environment the mechanical stresses are the largest ones. However, according to literature, products or packaging may also deteriorate from changes in temperature or humidity.

No overhang

The factor *No overhang* is very even and after removing the extremes, the weights left are all 80. This leaves us with a mean value of 80 as can be seen in Table 7.21. The respondents are all of the opinion that this particular factor is of relatively high importance, and this can be explained by the fact that products outside the area of the load carrier (pallet etc.) are very exposed to mechanical impact and other stresses during handling. In a DC, goods are handled frequently by truck during loading and unloading, during racking etc, and are therefore at high risk of bumping into other goods which could give rise to goods damage.

70	100	80	80	80	80
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Table 7.21. Presentation of the weights collected for No overhang together with the calculated mean value.

Both literature and the empirical data concur concerning pallet overhang as a factor that contributes to an increase in product damage. In a distribution environment it is the fact that pallet overhang leaves parts of the goods unprotected against mechanical impact that increase goods damage. Overhang should if possible be avoided completely. If this is not possible, a priority for IKEA is to keep the width intact since pallet racks and the manner in which loading is done are adapted to an intact pallet width.

Prevention of theft and manipulation

Three out of five weights given indicate no importance of prevention of the subcategory *Prevention of theft and manipulation*. The two deviant ones are 40 and 50 and can be explained by the possibility of manipulating products, e.g. by putting foreign objects into packaging with holes in it. The weights indicating no importance for this particular factor can be explained by a comment given by one of the respondents, who says that theft and manipulation is prevented by safety routines at different IKEA instances along with better safety seals etc. The mean is 13,3 and can be seen in Table 7.22 below. One of the higher values, namely 40, is given by a respondent who has given high values to a great extent, and especially in the category *Product protection*. For 6 out of the total 8 in this category, this respondent has given the highest values.

40	0	0	50	0	13,3
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Table 7.22. Presentation of the weights collected for Prevention of theft and manipulation together with the calculated mean value.

Literature states that theft and manipulation is a factor to take into account when designing packaging, but IKEA does not consider theft and manipulation in the DC:s to be a problem, and gives this a low priority. This is supported by the values in the Table above as well as empirical data. The reason is most probably that IKEA product are of relatively low value and not particularly attractive to steal. Many products are also of the kind that probably is hard to manipulate or there is no reason for doing it. It is however possible to put foreign objects for smuggling into packaging through holes in the packaging made for facilitating handling.

Minimize empty space in packaging / Fixation of product within packaging

The weights given by the respondents indicate importance of the subcategory *Minimize empty space in packaging/Fixation of product within packaging*. Possible consequences of empty space in the packaging can be of a kind that influences product and packaging safety. Three of the values indicate maximum or almost maximum importance, while the other two indicate a somewhat lower importance. Excluding the extremes, the resulting mean value, as shown in Table 7.23, is 88,3 which corresponds well to the overall pictures of given values. Empty space in packaging does not necessarily lead to product or packaging damage since there are ways of remedying it. For example, stability and fixation can be achieved with filling material. Maximum importance is therefore a too high value.

95	70	100	100	60	88,3
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Table 7.23. Presentation of the weights collected for Minimize empty space in packaging together with the calculated mean value.

Empty space inside a packaging can make the packaging lose its stability and in the long run it might collapse. If a single packaging collapses, the entire pallet can become unstable, and eventually collapse during handling. Sometimes products are stored for a considerable amount of time in a DC, and with stability lost due to empty space in the packagings, the unit load might collapse with product damage as a consequence. This is an important factor when free stacking, which sometimes occurs in a DC. If there are not fixated products inside the packaging, these might, if set in motion, destroy or damage the packaging.

Packaging information – pallet weight

There are two apparent groupings of values, as is evident in Table 7.24 below. Three are grouped at the lower end of the scale, while two are on the middle upper part. The highest weight is given by a respondent who values product protection high in general. Since the weights are spread over large parts of the scale, the mean value of 36,7 (extremes not used) is of relatively low value. The results of the weighting shown below support the findings from different parts of the supply chain; that there are two schools regarding packaging information. There are those who are in favour of it and believe that it is useful, and those who are of the opinion that it is unnecessary. Packaging weight is important when loading and unloading, or whenever it is beneficial to stack pallets on top of each other. Employees at IKEA DC:s in general know the characteristics of IKEA products and therefore know how to handle them and load them etc., which is a fact that somewhat lessens the importance of this particular factor.

30	10	20	75	60	36,7
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Table 7.24. Presentation of the weights collected for Packaging information – pallet weight together with the calculated mean value.

A comment, given by the respondent who weighted the factor 20, about pallet weight is that it is tricky. A heavy weight pallet does not necessarily mean a stable pallet that can carry a lot, e.g. shelves made of glass. When constructing a packaging solution, a design guide line that says that any pallet is supposed to be able to carry its own weight is used. The essence of this is that information about pallet weight alone does not tell the whole truth.

Packaging information – pallet orientation

Information about pallet orientation shows similarities with information about pallet weight. The only difference between the values given by the respondents is an increase from 20 to 40 for one of the respondents. Otherwise values are the same. Here as well, the mean value of 43,3 (extremes not used), see Table 7.25, is of little value since the weights are spread over large parts of the scale. The findings here also support that there are two schools regarding packaging information. It is also the same respondents that have given the lowest weights regarding pallet orientation as have given the lowest regarding pallet weight.

30	10	40	75	60	43,3
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Table 7.25. Presentation of the weights collected for Packaging information – pallet orientation together with the calculated mean value.

The deviations of the weights can be explained by that information regarding pallet orientation is only important for specific products and therefore is unnecessary to have on all packaging solutions.

Packaging information – pallet contents

Here, the scenario is somewhat different compared to other packaging information. Three of the respondents have given *Packaging information about pallet contents* around the centre point of the scale, while two have said that it has no importance. The mean after the extremes have been removed is, as can be seen in Table 7.26 below, 33,3 but says relatively little here as well. One of the respondents that have given a weight of 0 importance here has previously given values that are higher. The respondent has given 0 with the motivation that handling should be careful no matter what the contents are. What handling should be like is not of importance if it does not correspond to reality, so this argument is of low value. This factor applies mainly to fragile products, such as glass and porcelain, but this fact is perhaps not satisfactorily emphasized in the definitions sent along with the scorecard to be weighted. The ones who have given the factor a weight of 0 have perhaps done this with the motivation that it is unnecessary to put information about pallet contents on every pallet, while the others have only had fragile products in mind.

60	40	0	60	0	33,3
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Table 7.26. Presentation of the weights collected for *Packaging information – pallet contents* together with the calculated mean value.

For product safety it could be beneficial for the personnel handling the goods in the DC to know what type of goods it is since e.g. glass has different handling requirements than wood. Less packaging material, making the products visible, could possibly have the same effect. *Packaging information about pallet contents* may also be beneficial from a handleability point of view.

Packaging stability

The weighting shows great importance for *Packaging stability*. All respondents except for one have given weights of 100 or close to 100 as is shown in Table 7.27 below. The resulting mean value after the extremes have been removed is close to 100, namely 96,7.

90	60	100	100	100	96,7
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Table 7.27. Presentation of the weights collected for *Packaging stability* together with the calculated mean value.

Packaging stability is a factor that has not come across as as important in literature as it has during interviews with personnel at IKEA DC:s. The weighting also supports the importance of *Packaging stability*. *Packaging stability* is closely connected to stability of the entire unit load since unstable packagings cannot form a stable unit load. Stability of the oceanic cardboard pallets is of great importance in order for them not to collapse, and stability of the wooden pallets (EUR-, IKEA-, half-pallets) is important in order for the pallets not to collapse or break when lifted high above the ground or put down on the floor, or for not being impoverished when stored for longer periods of time. Considering storage time, literature states that the longer time in storage the more important are the properties of the packaging material, since it must not become too weak during storing. At an IKEA DC all goods must be strapped before being placed in pallet racks etc, which should be beneficial for unit load stability.

7.3.2 Volume efficiency

Storage adaptation

The weighting concerning *Storage adaptation* shows a clear pattern and is considered important by the respondents. The one who has given this factor a weight of 50 is of the opinion that if one instead aims at adapting the goods to the three kinds of wooden pallets storage adaptation comes as a bonus. This explains the relatively low value of 50. Disregarding the extreme values, the resulting mean is 81,7 which is shown in Table 7.28.

80	100	50	90	75	81,7
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Table 7.28. Presentation of the weights collected for *Storage adaptation* together with the calculated mean value.

Literature and empirical data state that storage facilities are to be used in an efficient manner, and this includes area and volume utilization as well as using the allowable height. Many factors influence volume utilization in a DC; pallet overhang, if pallets are full or not, module adaptation etc. Pallet overhang, as well as other factors with a negative influence on volume efficiency, should of course be avoided, but this is not always possible since there are aspects that are static and cannot be changed. Adapting unit loads to storage facilities is a manner in which it is possible to achieve goods volume utilization at a DC. Underhang decreases volume utilization, but is not critical for the volume utilization of the storage facilities since it does not affect the number of pallets that fit into the storage spots or where the pallets can be stored as overhang pallets do.

7.3.3 Right amount and size

Both factors of this category have been given similar weightings from every respondent. The results show two groupings; one that considers the category to be of importance and one that is of the opposite opinion.

Module adaptation when mixing pallets

The weights given by the respondents show two groupings; those who give *Module adaptation when mixing pallets* 0 importance and those who consider it to be important and give a weight around 70 (see Table 7.29). When removing the extremes, the resulting mean value is 46,7. The mean, however, does not reflect the weights given well at all; it does not show support for either group. These two groupings can be explained by that the respondents have different job descriptions and thereby prioritize differently. Some have more formal influence than others and some work more operatively etc. However, there are some patterns to the answers. One respondent who has given the weight 0 has given a corresponding weight of a 100 when it comes to *Minimizing empty space in packaging* as well as *Packaging stability (Product protection)* and *Minimize storage handling* which are factors that can suffer damage when module adapting. The second respondent that has given a weight of 0 shows a similar pattern, with the difference of a somewhat lower weight of *Minimize empty space in packaging*. The opposite does not apply for the respondents that have weighted this factor higher. They have also given high values for the corresponding factors, but to a lower extent.

70	70	0	75	0	46,7
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Table 7.29. Presentation of the weights collected for *Module adaptation when mixing pallets* together with the calculated mean value.

Module adaptation when mixing pallets makes it possible to get flatter top surfaces of pallets when creating mixed pallets. Carefulness is however important when module adapting. It

should be kept in mind that the load factor in the separate packagings might decrease and thereby empty space increase. Empty space can influence packaging stability if measures are not taken to prevent it and the amount of collapses might increase. On the other hand module adaptation can make it easier to create stable unit loads. An effect of module adaptation could, if the quantity in the separate packagings becomes smaller, be an increase of the number of handling activities. There are both positive and negative effects of module adaptation, and a suitable compromise must be sought. Better unit loads that are easier to stack against lower load factor and a possible decrease in stability etc. Module adaptation can also eliminate empty space in transports, e.g. by eliminating underhang, which could be beneficial from a product protection point of view, and picking might become more efficient since it is not necessary to “puzzle” as much when creating the pallet.

Quantity adapted to the needs of retail

The weights given for this factor shows the same groupings as for the one above, *Module adaptation when mixing pallets*. After removing the extreme values, the resulting mean is 40. The weights given by the respondents are presented along with the resulting mean value in Table 7.30 below.

70	50	0	75	0	40
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Table 7.30. Presentation of the weights collected for Quantity adapted to the needs of retail together with the calculated mean value.

The 0 weights can have the explanation that the needs of every different retail outlet world wide of different sizes are hard, if not impossible, to meet with a single solution. On the other hand, *Quantity adapted to the needs of retail* means that less picking in the DC:s is needed, which in turn has beneficial consequences for the IKEA supply chain. The 0 weights in both the subcategories under *Right amount and size* can also be explained by that at a DC they do not want to have any picking handling at all and therefore wish to have only pallet solutions that they can send off. This is also partly supported by a participant that has motivated his 0 weight with that it is hard to find a multi-pack that is suitable for all retail outlets and therefore it would be best if they could send complete pallets instead.

7.3.4 Handleability

Stackability

Stackability has been given weights showing its importance. Three of the values are 100 and one is close to 100. See Table 7.31 for the results of the weighting. The only deviant value is 50, which still indicates importance of this factor. The mean after removing the extremes is 95, which is very high. In the DC, the majority of pallets are not stacked on top of each other, but when loading this feature becomes very important as stated by a respondent who gave the factor maximum importance. If the pallets are not stackable, only one layer can be loaded into a container or similar, which has great effects on cube utilization and efficiency during transport. The entire IKEA supply chain gains from good stackability. Another respondent who gave Stackability maximum importance comments that loading and unloading activities benefit from good *Stackability*.

85	100	100	50	100	95
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Table 7.31. Presentation of the weights collected for Stackability together with the calculated mean value.

Stackable pallets should be possible to load already stacked, that is, the pallets are loaded two at a time, which has a great influence on loading efficiency. *Module adaptation* is related to *Stackability*, since a flat surface is of essence when it comes to stacking pallets. No correspondence between the weights given for these two factors can be found though. A probable reason for this is that the possibility of achieving flatter surfaces only is a part of the effects of *Module adaptation*.

Packaging stability

All respondents are of the opinion that *Packaging stability* is of utmost importance, even though there are some fluctuations of the weights they have given. One has given 80 and one 90, and the remainder have given 100 as can be seen in Table 7.32. The resulting mean value after removing the extremes is 96,7. Without *Packaging stability*, handling becomes hard since so many other factors are connected to the stability as well. For example product protection is influenced and means that handling needs to be adapted to the weaker packagings.

100	80	100	100	90	96,7
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Table 7.32. Presentation of the weights collected for *Packaging stability* together with the calculated mean value.

Stability of the separate packaging is strongly connected to stability of the entire unit load. If one packaging is unstable and perhaps breaks, the unit load becomes unstable as well. Consequences are that product damage increase and that handling becomes harder and more dangerous for the personnel etc. A comparison between weights given for *Packaging stability* from a product protection perspective and a handleability perspective shows that the mean value is the same, 96,7, but the deviation is higher for *Packaging stability* from a product safety perspective. There are not any clear patterns to find, but the same respondent has given the lowest weights for both factors and values *Packaging stability* lower than the others, who have given both factors a weight of 90 or higher (two of them 100 for both factors).

Ergonomical demands

A trend among the given weights is evident. There is however one deviant value, which is 0. When disregarding the extremes, the resulting mean is 76,7 from which the majority of the values deviate little. This is shown in Table 7.33 below. The deviant weight, namely 0, has its explanation in a comment given by the respondent that says that ergonomically sound packagings would mean that the packagings are smaller. In turn, this means that more lifts need to be done and thereby the risk of work related injury increases in the long run.

100	70	0	80	80	76,7
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Table 7.33. Presentation of the weights collected for *Ergonomical demands* together with the calculated mean value.

The authors are however sceptical to this motive. Naturally, heavier packagings are harder to handle and imply greater strains on the human body than lighter packagings. Ergonomics are about work related injury and sound working positions etc. There are, however, other aspects that influence work related injury than just weight as the respondent says. Packagings that are easy to handle, for example packagings with dimensions or handles that enable easy gripping, influence as well. Packagings that enable sound working positions are important as well. Handling a packaging of five kg in a bad ergonomical position might damage the human body more than handling a ten kg packaging in a sound working position. This reasoning is also

supported by the results of the weighting. One of the most important factors when it comes to ergonomics is still weight, which is stated in literature. IKEA, however, ranks weight from a DC perspective as the single most influential ergonomical factor.

Minimize storage handling

All respondents have given the factor *Minimize storage handling* maximum importance (see Table 7.34), the weight 100, except for one who has given the weight 50. This is a convincing trend that shows the significance of the factor. A comment from a respondent is that minimizing handling is priority number one for a DC. The respondent who has given the deviant weight generally prioritizes the category *Handleability* relatively low. The resulting mean after the extremes have been removed is 100.

100	50	100	100	100	100
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Table 7.34. Presentation of the weights collected for Minimize storage handling together with the calculated mean value.

Minimizing storage handling is important and especially minimizing manual handling. As far as the DC is concerned, everything that can be handled by truck is good. They therefore strive towards minimizing manual handling; top loading and unloading etc. If top loading is inevitable they try to only top load palletized goods which can be done by truck, even if the pallet it self occupies space that otherwise could have been used for transporting products. They are of the opinion that what is lost in cube utilization is gained in handling efficiency. Handling is an activity that requires a lot of personnel and for a company like IKEA costs for personnel is large. For this reason, cutting cost by *Minimizing handling*, thereby minimizing the amount of personnel, is a good move. Also, handling requires time which slows the flow of goods down, and lowering the amount of handling could improve goods damage statistics since a lot of goods damage occur during handling.

Pickability

The weights given by the respondents range from 60 to 90, as is shown in Table 7.35 below, and show a clear importance for *Pickability*. The resulting mean after removing the extreme values is 73,3 and deviates relatively little from the given weights. For a DC, picking should of course be avoided completely since it only implies costs and does not add any value to the customer. Picking is however very hard, if not impossible, to avoid. Therefore picking should be enabled by the packaging solution. This is a probable explanation for the weights given by the respondents. A respondent weighting the factor 80 says that it is important that packagings are easy to handle and stack in order to facilitate picking activities, but picking should be avoided as far as possible.

90	60	80	60	80	73,3
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Table 7.35. Presentation of the weights collected for Pickability together with the calculated mean value.

Picking can be either manual or automatic but still needs to be enabled by the packaging solution. A DC is a location where pallets often are split and mixed with other goods before sent to the retail outlets. It is for this reason important that picking and forming new pallets is easy and efficient. From a handling perspective, pickability is considered important.

7.4 Retail Outlet

The Packaging Scorecard and respective definitions used for the weighting of the retail outlet factors are found in Appendix B. The weights given are located in chapter 6 along with comments of the weightings. Below, each of the subcategories is analyzed regarding their weighting.

7.4.1 Product protection

Protective properties of packaging

Protective properties of packaging has been given weights that vary over rather wide range, namely from 25 to 100, as presented in Table 7.36 below. The same respondent as has given the factor a weight of 90 has said that articles are often handled many times in a Retail Outlet where the space is limited, whereby this factor is of great importance. This is supported by empirical data, which states that handling induces risk of product damage. Goods damage in a Retail Outlet is mainly caused when handling pallets by tuck. Since this type of damages could be caused by handling errors, it is maybe not as crucial to consider during packaging development, which could explain the low value. If the damages on the other hand are caused by e.g. poorly protective packaging etc, the weightings should be very high. Pallets are seldom dropped and seldom collapse. If pallets with overhang are stacked on top of each other, extra stress is put on the corners of the pallet, which in turn increases the risk of damage or even collapse of the pallet.

25	100	90	60	68,75
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Table 7.36. Presentation of the weights collected for *Protective properties of packaging* together with the calculated mean value.

Any damage to a product or its packaging should be avoided if possible since a damaged packaged product cannot be sold. If a product cannot be sold, it only costs money – both cost for the product itself, but also indirect costs for extra transport etc. This is a fact motivating the higher weights given by the respondents. The protective properties of packaging should primarily be protection against mechanical influence since other influence seldom occur in a Retail Outlet, as supported by comments given to the weights as well as literature and empirical data. An explanation for the lower weights (60 and 25) is that the respondents have taken electro technical as well as chemical and climatic stresses into account, which very seldom, if ever, occur in a Retail Outlet and therefore lessens the importance of the *Protective properties of packaging* in general.

No overhang

No overhang has in general been given maximum importance, with the exception of one deviating value, 75. This is shown in Table 7.37 below. From a product protection perspective this factor is very important since pallet overhang can cause goods damage during handling due to the fact that goods on the pallet is less protected if it is outside the pallet area. This supports the weights given by the respondents and is supported by literature as well as empirical data. An explanation for the lower weight, 75, is that if handling is carried out with caution and not in a hurry, *No overhang* becomes less important. Personnel in Retail Outlets work many times under time pressure, which makes it hard to use the caution needed. One respondent that gives this subcategory a 100 weight commented that overhang is one of the primary reasons for physical damage to products or packaging in a Retail Outlet, and adds that overhang makes it hard to dimension the sales area of the product in question since this depends on, among other things, packaging size. Since goods are placed in pallet racks with their shorter side towards the aisle, it is tricky to place pallets with a small overhang on the

longer side (exceeding the width of 800 mm) into the rack and still be able to put the number of pallets in the rack that it is dimensioned for. With some effort it can sometimes be done, even if it requires handling and relocation of all pallets. The margins are then very small, and if the person who lifts pallets down from the racks is not as careful, the goods might be damaged.

75	100	100	100	93,75
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Table 7.37. Presentation of the weights collected for No overhang together with the calculated mean value.

The same reasoning as in *Protective properties of packaging* regarding damaged products and packaging and that they cannot be sold applies here as well. Damages that occur during handling make it necessary to scrap products, which means both direct and indirect costs for IKEA. Overhang should for the reasons above be minimized as far as possible.

Prevention of theft and manipulation

The weights presented in Table 7.38 vary quite a lot, but there are explanations for this. The 100 weight is motivated by that it is important to prevent theft and manipulation where it is possible, and that the perhaps easiest way to prevent label manipulation is to print information such as article number and bar codes on the packaging. The respondent giving this factor a weight of 70 has motivated his weighting of *Minimize empty space in packaging* with that it from a theft perspective is important to minimize empty space in packagings since it otherwise is easy to steal by putting smaller products in the empty space. This motivates his weighting of the subcategory *Prevention of theft and manipulation* as well.

50	0	100	70	55
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Table 7.38. Presentation of the weights collected for Prevention of theft and manipulation together with the calculated mean value.

A motivation for the lower weights given is that IKEA products are often low value products that are not that attractive to steal. However, theft and manipulation most probably occur and should therefore be prevented if possible.

Minimize empty space in packaging / Fixation of product within packaging

The weights of this subcategory are grouped in a rather narrow range, see Table 7.39 below. Comments given by the respondents motivate the relatively high weights with empty space in packaging as a contributing factor to product damage and that it needs to be filled either with styrofoam or other filling material. Empty space also makes it possible to steal products by putting other products into packaging containing empty space.

50	70	80	70	67,5
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Table 7.39. Presentation of the weights collected for Minimize empty space in packaging together with the calculated mean value.

Packaging stability is affected by empty space in packaging which in turn affects the resistance against mechanical influence both during handling and storing, thereby lowering product protection. Packagings with empty space in them where the products, or parts of a product, are not fixated are exposed to a somewhat greater risk of damage if during handling the products/parts are set in motion relative to packaging. The products/parts or packagings can then break. This motivates a high importance of this subcategory.

Packaging information – pallet weight

As can be seen in Table 7.40 below, the importance of *Packaging information about pallet weight* is according to the respondents relatively low. A factor motivating this, as commented by the respondent giving the 30 weight, is that truck operators often “feel” the pallet weight and that it can be seen in the article information what type of product (glass, furniture etc.) that is being handled, thereby making it possible to assess the weight of the pallet.

50	0	30	50	32,5
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Table 7.40. Presentation of the weights collected for *Packaging information – pallet weight* together with the calculated mean value.

In a Retail Outlet pallets are seldom stacked on top of each other, but it happens when taking pallets to their destination if it is possible to double stack. Goods are only unloaded in a Retail Outlet and not loaded, which lessens the importance of knowing pallet weight since knowing pallet weight is important when loading but not when unloading. Personnel at a Retail Outlet also know the IKEA assortment, which includes which products that are heavy and which are not etc. The discussion above indicates that *Packaging information about pallet weight* is of little importance at a Retail Outlet.

Packaging information – pallet orientation

Packaging information about pallet orientation shows the same pattern as *Packaging information about pallet weight*, but with the difference that one weight has been changed from 30 to 80 (see Table 7.41). The 80 weight is motivated by the importance of correct pallet orientation for sake of good unloading efficiency.

50	0	80	50	45
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Table 7.41. Presentation of the weights collected for *Packaging information – pallet orientation* together with the calculated mean value.

If pallets are oriented the wrong way during transport to the Retail Outlet, it also has to be unloaded the wrong way. This is something that is unbeneficial for the unloading efficiency at the Retail Outlet and causes extra handling activities. It is mostly during handling that product damages occur, and therefore extra handling due to errors in pallet orientation is bad from a product protection perspective. Thus, information on the packaging about its orientation can be beneficial. This is also a factor motivating the higher weights given by the respondents. Orientation errors could put stresses on the product and packaging that they are not designed to withstand and therefore increase the damage risk. Goods that come to a Retail Outlet most often come from an IKEA DC, and at a DC the personnel know the products that are transported and thereby know how to handle and load it. For this reason the majority of goods are loaded oriented the right way, which motivates the 0 weight given that indicates that there is no need for *Packaging information about pallet orientation* from a Retail Outlet perspective.

Packaging information – pallet contents

Packaging information about pallet contents show a much higher importance than other packaging information according to the weights given by the respondents, see Table 7.42 below. One of the respondents placing a 100 weight comments that this information is very important since personnel handling the products by knowing the pallet contents also know how to handle the pallet/products. This is a factor motivating all values given, but there is however a difference in placed weights. An explanation for the difference is that handling

personnel are supposed to know which goods they are handling, but that they not always do. The 100 weights could have been placed since the personnel not always know the contents and that it therefore should be made more evident, and the lower weights due to the fact that the personnel are supposed to know the pallet contents.

100	50	100	70	80
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Table 7.42. Presentation of the weights collected for Packaging information – pallet contents together with the calculated mean value.

Handling is a crucial factor when it comes to minimizing product and packaging damage, and handling requirements are product specific. For this reason, knowing which type of product that is being handled could be of relatively high importance. Placing information about contents on a packaging can help making personnel aware of handling requirements, thus minimizing product and packaging damage. Pallet contents can also be shown by minimizing the amount of packaging material, thus making the products visible. This can make the personnel handling the goods aware of that they are handling e.g. fragile goods and thereby adapt handling to the product requirements. Less packaging material can also improve product exposure at the sales area as well as make people aware of e.g. the colour of the contents, thereby minimizing the risk of product/packaging damage when customers open the packaging to verify the specifications of the contents. Minimizing the amount of packaging material can thus be beneficial from a product protection point of view.

Packaging stability

All respondents agree and give the subcategory *Packaging stability* maximum importance as shown in Table 7.43. A comment given is that *Packaging stability* is extremely important for among other reasons stackability, but it is also important that the remaining products on a pallet, or similar, when some of the products have been sold at the sales area do not collapse and therefore give rise to damages.

100	100	100	100	100
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Table 7.43. Presentation of the weights collected for Packaging stability together with the calculated mean value.

Storage time influences the need of *Packaging stability*, and a Retail Outlet is generally not used to store goods for longer periods of time, which somewhat lessens the importance of *Packaging stability*. *Packaging stability* is as mentioned above important when stacking. If the packagings on a pallet cannot take the stresses that are put on them during stacking they might collapse, and a consequence of collapsed packagings can be that the entire pallet collapses. Handling exposes the pallet to mechanical stresses, which the packaged product needs to be able to take without breaking due to lack of stability. *Packaging stability* is for the reasons above very important.

7.4.2 Volume efficiency

Storage adaptation

All respondents have given *Storage adaptation* weights of 100, which are shown below in Table 7.44. A probable explanation for this is that space is limited at the Retail Outlets and space also costs money whether it is used or not, and for this reason it is important from a cost perspective to use space as efficiently as possible. For using space as efficiently as possible adaptation of products and packaging to storage facilities is important. Also, as mentioned before, Retail Outlets sometimes are limited regarding space and need to use space very

efficiently in order to make room for all products. One of the respondents says that *Storage adaptation* is very important, and if products do not fit into standard racks the racks need to be modified which is bad. Empirical data states that IKEA products to a great extent are adapted to shelf systems when it comes to products that are supposed to be presented on shelves. According to Joakim Strandh (Section Manager of Store Goods Flow, IKEA Retail Outlet in Malmö, Sweden), storage racks etc. are also adapted to the unit module. Literature supports that volume space is to be used as efficiently as possible and that products and packagings should be adapted to shelf and storage space.

100	100	100	100	100
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Table 7.44. Presentation of the weights collected for *Storage adaptation* together with the calculated mean value.

At the Retail Outlets goods are in general not stored for longer periods of time. If pallet overhang makes it impossible to fit the number of pallets in a pallet rack that the pallet rack is adapted to, volume utilization suffers. Volume space that is not used efficiently costs money, but does not add any value to customer, whereby unused space should be eliminated if possible.

7.4.3 Right amount and size

Quantity adapted to needs of retail

The respondents have in general placed high weights for this subcategory. All of them have given *Quantity adapted to needs of retail* 100 weights except for one who has given it a weight of 75, see Table 7.45. This indicates a high importance for adapting the quantity of the packaging solution to the needs of IKEA Retail Outlets. This is also supported by empirical data that says that if high sales volume products come in too small packagings, handling increases due to the fact that many packagings need to be opened and an increased amount of waste material needs to be disposed of. This extra handling takes time, which costs money. The extra handling probably also means that personnel need to take the time needed from other activities that should be done. Literature also supports that packaging at a Retail Outlet should be adapted to the needs regarding handling and to expected sales volumes etc. A comment given by a respondent giving a 100 weight is that *Quantity adapted to needs of retail* is very important since secondary packaging containing unsuitable quantities cause extra handling and sometimes unnecessary storing, which is bad.

75	100	100	100	93,75
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Table 7.45. Presentation of the weights collected for *Quantity adapted to the needs of retail* together with the calculated mean value.

In order for the Retail Outlets to keep inventory high enough to cover demands, but still low enough to minimize inventory and storage costs, an adaptation of the quantities delivered to Retail Outlets is important. Since every IKEA Retail Outlet of different size has different quantity demands, the question is whether or not this adaptation is possible to do in a cost efficient and profitable way. Probably it is not possible to find one solution that suits all Retail Outlets.

Packaging adapted to display mode

The weights provided by the respondents for *Packaging adapted to display mode* are somewhat diverse, as can be seen in Table 7.46 below. The respondent giving the 90 weight comments that this is important in order to ease direct flows to the sales area, but also in order

to increase safety for return flows. If there is not room for the entire contents of a pallet at the sales area, the remainder has to be pallet racked, and if the packagings then have lost stability the risk of collapses in the pallet racks increases. This shows that *Packaging adaptation to display mode* has significance for both safety and handling efficiency.

75	50	90	100	78,75
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Table 7.47. Presentation of the weights collected for *Packging adapted to display mode* together with the calculated mean value.

Packagings that are adapted to display mode can be beneficial in many ways. For example it can lessen handling since personnel do not have to unpack as much and perhaps can place an entire secondary packaging in the shelf and not the primary packagings separately. *Packaging adapted to display mode* can also have significance for volume and area utilization. Products that are sold in large quantities can gain from being presented on a pallet where the packaging material that needs to be removed to expose the products take little effort to remove and where the pallet easily can be placed at its sales area. This can also have the effect that the product does not need to be refilled as often as if the quantity in the packaging was smaller.

7.4.4 Handleability

Stackability

There is a cluster in the weights given by the respondents in the middle of the scale and one deviating value of a 100, see Table 7.48 below. The respondent giving the deviating value motivates it with the importance of *Stackability* for his particular Retail Outlet which has large sales volumes compared to its size. A motivation of the 100 weight can be that they sell large volumes and stacking pallets on top of each other when handling them is beneficial for handling efficiency. It is however more probable that the respondent has misinterpreted this subcategory and reasons that it is important to be able to keep large volumes of products stored in order to cover the demands, and to make room for all products/pallets they need to be stacked on top of each other. The respondent refers to his particular Retail Outlet, whereby his reasoning most probably is not applicable to all IKEA Retail Outlets and the importance of this particular weight should therefore be lessened.

50	40	100	50	60
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Table 7.48. Presentation of the weights collected for *Stackability* together with the calculated mean value.

Empirical data supports the other values by saying that *Stackability* is important when handling pallets in a Retail Outlet. After unloading, pallets are stacked if it is possible and if the pallets have the same destination within the Retail Outlet whereby they are taken stacked on top of each other to the destination. This procedure saves time since each pallet does not have to be handled separately, and time saved is also money saved. For the reason of minimizing handling in a Retail Outlet *Stackability* is important but not crucial, which motivates the weights given. Literature supports the importance of *Stackability* from a handleability perspective.

Packaging stability

The respondents have given this subcategory relatively high weights. The values are presented below in Table 7.49 and are on the upper part of the scale. Two respondents have given *Packaging Stability* a weight of 100. A comment given by one of the respondents giving it a weight of 100 is that *Packaging Stability* is important in order to prevent collapse in racks when there is a return flow of goods that are not displayed in the Retail Outlet and therefore

need to be put in the storage until it can be displayed. Literature supports the weights given by stating that unstable packagings can cause product damage and personal injury when handling it manually.

75	100	100	80	88,75
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Table 7.49. Presentation of the weights collected for Packaging stability together with the calculated mean value.

Handling puts increased stresses on packaging due to the mechanical movement that the packaging needs to be able to persist without breaking or collapsing, and for this reason Packaging Stability is important. Unstable packagings are furthermore time consuming to handle since it takes more effort to handle them safely because of the fact that they often need to be balanced by the handling personnel. If they are really unstable they might not even be able to handle manually without handling aids. *Packaging Stability* is for the reasons above very important from a handling perspective in a Retail Outlet.

Ergonomical demands

Ergonomical demands are important to take into account from a handleability perspective. Literature and empirical data as well as the respondents agree to this. As can be seen in Table 7.50 below there is only one value (50) that deviates from the others (100). One of the respondents who gave this subcategory the weight 100 comments that *Ergonomical demands* are very important since the health of the personnel is important, and this is most probably also the opinion of the other respondents weighting 100 since a lot of handling is done at a Retail Outlet. According to empirical data, the main ergonomical aspect in a Retail Outlet is the weight of the products. Literature also states that packaging design is important from an ergonomical perspective, and what influences ergonomics is e.g. packaging weight, volume, centre of gravity, placement of handles etc. Also, the number of handling activities is of importance as well as the surrounding environment when it comes to *Ergonomical demands*. Weight is the primary ergonomical aspect to consider, as mentioned above, but the weight of products is very hard to influence since glass and wood usually are heavy while pillows are lighter. This can motivate the lower weight (50) given by one of the respondents.

100	100	100	50	87,5
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Table 7.50. Presentation of the weights collected for Ergonomical demands together with the calculated mean value.

Facilitating handling is something that influences costs and how much time that is consumed by handling activities. Handling can be facilitated by making packagings more ergonomical to handle regarding e.g. ease of opening and closing them, stackability, unitization, how easy they are to grasp etc. More ergonomical packagings also contribute to the wellbeing of personnel, since handling ought to be one of the most common activities that are carried out at the Retail Outlet, and if handling can be minimized and eased less work related injuries ought to be an effect. The wellbeing of the personnel also has cost benefits. A lot of activities are carried out manually at a Retail Outlet, whereby ergonomical packaging aspects should be emphasized. Therefore *Ergonomical demands* deserves a high weight.

Minimize storage handling

The respondents have all weighted this subcategory with maximum importance, as can be seen in Table 7.51. The most probable explanation for this is that handling requires resources and takes time but does not add any value to the customer, and that it for this reason should be

minimized. Time used for handling could possibly be used for other activities that are of value for the customer or lead to a smaller need of personnel. Any larger downsides of *Minimizing storage handling* except for a possible increase of packaging related cost have not been found by the authors.

100	100	100	100	100
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Table 7.51. Presentation of the weights collected for *Minimize storage handling* together with the calculated mean value.

Minimize sales area handling

As presented in Table 7.52 below, the majority of the respondents have given *Minimize sales area handling* maximum importance while one has given it a weight if 50. One respondent who gave a 100 weight states that this factor is very important since the less handling time needed per product, the more products can be handled. Many articles at IKEA are sold in large quantities, which also should mean that these particular products require a large total amount of handling. A retail requirement is, as stated in literature, minimizing handling at the sales area by not handling the primary packagings but only secondary packagings. The secondary packagings should also require little modification before they are displayed at the sales area. The respondent giving the weight 50 points out that especially small products that do not sell in quantities large enough to be presented on a pallet or half-pallet are very time consuming to handle and that these packaging solutions could be improved from a handling perspective. Products that sell in large quantities however are usually presented on a pallet solution. The respondent might therefore reason that not all packaging solutions need improvement, which motivates the lower weight.

100	50	100	100	87,5
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Table 7.52. Presentation of the weights collected for *Minimize sales area handling* together with the calculated mean value.

As mentioned above in the subcategory *Minimize storage handling*, handling requires resources and time adds no value to the IKEA customers, and that it because of this should be minimized.

Minimize waste handling

Minimize waste handling shows the same pattern as the other two handling subcategories, which is a very high importance. All respondents have as can be seen in Table 7.53 below given this subcategories a value of 100. One of them reasons that the less waste handling time needed per article when unpacking an article, the more articles can be handled in total. This is also most probably the reasoning of all the respondents.

100	100	100	100	100
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Table 7.53. Presentation of the weights collected for *Minimize waste handling* together with the calculated mean value.

The time needed to handle waste material should be in proportion to the amount of packaging material that is used for the products. If the packaging material then is minimized, the handling of waste material should also become less. However, other aspects can influence the time needed for handling waste. As stated by literature, waste material should e.g. also be easy to fold and compress. Other factors that could be of importance are the weight of the packaging material, if it is easy to grasp and carry as well as the number of pieces of

packaging material. As for all handling, waste handling does not add any value to the customer and should if possible be minimized.

7.4.5 Additional factors

The following subcategories have been added by the respondents according to their view of what is important at a Retail Outlet and thereby should be included in the Packaging Scorecard.

Packaging information on all sides of packaging

One participant has added *Packaging information on all sides of packaging*, e.g. product name, as an additional factor that he believes should be included in the Packaging Scorecard. He has also given this subcategory maximum importance (100). The truck operator does thereby not need to think about which side that is to be oriented towards the aisle. This could be beneficial from a customer perspective also, but due to the demarcations in this thesis, the customer perspective will not be considered. The proposed subcategory has the purpose of easing handling, but in the Packaging Scorecard these aspects are already taken into account in the subcategories concerning minimizing handling, and are because of this not discussed any further.

Adapted sales pack solution

This subcategory has been added and also given the weight 100 with the motivation that handling can be minimized when the sales pack solution is adapted to the needs of retail, thus increasing efficiency. It could enable direct transport of the product to the sales area. The motivation given signifies what the authors already have included as a subcategory, namely *Quantity adapted to needs of retail*, in the Packaging Scorecard, and will therefore not be discussed further in this master thesis.

Consideration of sales area at Retail Outlet

Also this subcategory has been added by one of the respondents. It has been weighted with the maximum importance, namely 100, and is motivated by the importance of increasing consideration of the sales areas at the Retail Outlets. These aspects are however included in the *Quantity adapted to needs of retail* subcategory in the Packaging Scorecard and will for this reason not be discussed any further.

8 The IKEA Packaging Scorecard

In this chapter the final Packaging Scorecard adapted to the prerequisites of the IKEA Supply Chain will be presented. Motivations for the chosen weights are also accounted for.

When the authors have placed the following weights of the IKEA Packaging Scorecard, the point of view has been how the packaging system can influence the final prices of a product to the customer. The question that has been asked is how IKEA can design a packaging system that in the best possible way contributes to a distribution cost as low as possible.

To view the complete IKEA Packaging Scorecard that is provided to IKEA, see Appendix D.

8.1 The IKEA Supplier Packaging Scorecard

The final IKEA Supplier Packaging Scorecard is presented below in Table 8.1 for suppliers with manual packing lines and in Table 8.2 for suppliers with automated packing lines, thereafter motivations for the chosen weights will be accounted for.

CRITERIA MANUAL PACKING LINE	WEIGHT	NORMALIZED WEIGHT	SCORE
Packing process			
Efficient erection of packaging	85		
Efficient filling of packaging	75		
Efficient sealing of packaging	75		
Packaging stability	80		
Ergonomical demands	100		
Product protection			
Protective properties of packaging	60		
No overhang	75		
Minimize empty space in packaging / Fixation of product within packaging	50		
Packaging stability	70		
Volume efficiency			
Storage adaptation	60		
Handleability			
Stackability	60		
Ergonomical demands	-	Weight depends on supplier	
Packaging stability	80		
WEIGHTED AVERAGE PACKAGING SCORE			

Table 8.1. The IKEA Supplier Packaging Scorecard for a supplier with a manual packing line.

CRITERIA AUTOMATIC PACKING LINE	WEIGHT	NORMALIZED WEIGHT	SCORE
Packing process			
Efficient erection of packaging	100		
Efficient filling of packaging	100		
Efficient sealing of packaging	100		
Packaging stability	85		
Product protection			
Protective properties of packaging	60		
No overhang	75		
Minimize empty space in packaging / Fixation of product within packaging	50		
Packaging stability	70		
Volume efficiency			
Storage adaptation	60		
Handleability			
Stackability	60		
Ergonomical demands	-	Weight depends on supplier	
Packaging stability	80		
WEIGHTED AVERAGE PACKAGING SCORE			

Table 8.2. The IKEA Supplier Packaging Scorecard for a supplier with an automatic packing line.

The only aspects that differ between the two Supplier Packaging Scorecards are the prerequisites of the packing lines. A consequence of this is that the weightings only differ for the Packing process category, and not for the other categories, since the handling that products are subjected to after they have left the packing line is the same whether they are manually or automatically packed.

8.1.1 Packing process

Efficient erection of packaging

Complicated and demanding packaging solutions are sometimes necessary in order to create efficient and effective distribution later in the Supply Chain. Due to the flexibility of the manual packing line, it can better handle these complex packaging solutions than an automated packing line. The drawback is that what the manual packing line gains in flexibility it loses in efficiency. Since the manual packing line gains in flexibility compared to an automated packing line it is not as important for a manual packing line as for an automated one to have an efficient packaging erection.

For an automated packing line it is crucial that the packaging solution is adapted to the prerequisites of the specific packing line. It is an expensive solution to rebuild an existing packing line in order to enable good packing line efficiency rather than designing a packaging solution according to the existing conditions. It is important that the packaging enables a packaging erection that is as efficient as possible, whereby *Efficient erection of packaging* for an automated packing line is given the weight 100 and for manual packaging line the weight

85 due to its higher flexibility and ability to handle more demanding packaging solutions. This is an area where IKEA has the possibility of lowering costs at the supplier by making the packing process more efficient. This would lead to lower costs per article and thereby either lower sales price or higher revenue.

Efficient filling of packaging

The reasoning of this subcategory is the same as for *Efficient erection of packaging* above. Generally, the filling is also a less demanding activity from a manual perspective than packaging erection. This motivates a somewhat lower weight for manual packaging filling than manual packaging erection. Filling is still very important for the efficiency of the entire manual packing line. What the manual packing line sometimes lacks in efficiency it makes up for with the ability of handling more complex packing patterns and smaller objects. An efficient filling process is also important for the automatic packing line, but here the inflexibility involves a higher demand on the packaging design to facilitate and streamline the filling procedure. Therefore the authors award the manual filling process with a weight of 75 and the automatic filling process with 100.

Efficient sealing of packaging

The flexibility factor is also decisive when it comes to the efficiency of the sealing process. Manual packing lines have different prerequisites than an automatic, and the efficiency demands on the sealing process in an automatic packing line is much more critical than for the manual packing line. This since the efficiency of the whole automatic packing line is more important than the efficiency of the manual packing line because of the flexibility factor. The weightings provided by the authors will therefore be 75 for the manual packing line and 100 for the automatic packing line. One aspect that needs to be taken into consideration during packaging development for a manual packing line is that the sealing procedure can be straining for the personnel, e.g. when taping is used. This can indirectly affect the efficiency of the sealing process.

Packaging stability

The authors agree to the relative importance of the weights given by the respondent group, but rank this factor somewhat higher, and weigh packaging stability 80 for a manual packing line and 85 for an automated packing line. In order to keep a good efficiency of the packing process, no matter if it is automated or manual, stable packagings are crucial, which motivates a high weight for *Packaging stability*. The difference in importance is motivated by the more dynamic balancing abilities of the manual packing line compared to the automated one.

Ergonomical demands

The respondent group has given *Ergonomical demands* the maximum weight, 100, and the authors concur. In order to keep the manual packing line efficient, the health of the employees is essential. Packing line efficiency is also dependent on ergonomical packaging since they require less effort to handle. Ergonomical packagings also enable the personnel to maintain an even pace since they do not become strained to the same extent.

8.1.2 Product protection

Protective properties of packaging

IKEA may benefit from small changes in product or packaging design if they have the effect that the supplier can give them a lower price per packaged product due to less product and packaging damage. Implementation of the changes depends on how much they cost and whether or not they give rise to benefits later on in the Supply Chain as well. IKEA does not

however want to pay a higher price for the product due to damages caused by handling or storing errors at the supplier. Therefore the authors are of the opinion that *Protective properties of packaging* deserves a higher weight, namely 60, than the respondent group has given it.

No overhang

Since overhang affects the packaging after the packing process, where the handling is the same both after a manual and automatic packing line, the weight given should be the same for both. This subcategory might not earn the maximum weight since at the supplier they are accustomed to handling their own products and therefore know how the packaging system should be treated in order to avoid damages. From a storing perspective, however, overhang can cause damages when pallets are stored on top of each other since the pressure is distributed unevenly on the underlying pallets. IKEA should however not design the packaging to withstand the strains that occur due to wrongful storing and handling at the supplier. A lot of product and packaging damages occur due to pallet overhang, whereby overhang should be kept at a minimum. The weighting provided by the respondent group, 75, therefore corresponds to the weighting of the authors.

Prevention of theft and manipulation

IKEA pays for a certain amount of packaged products to be delivered and it is up to the supplier to meet this agreement regardless if theft is occurring within his operation. If manipulation occurs it is only the supplier that loses and therefore the risk for manipulation should be minimal. To prevent theft and manipulation is the responsibility of the supplier and therefore should not be included in price negotiation. It has to do with the supplier company control, and therefore it lies outside the interest of IKEA to consider during the packaging development. The authors have for the reasons stated above weighted this subcategory with a 0 and removed it from the final Supplier Packaging Scorecard.

Minimize empty space in packaging / Fixation of product within packaging

Keeping empty space in packaging at a minimum is important from a product protection perspective. The reason for this is that packaging stability can be lessened. Also, fixation of products within the packaging is important for product protection since loose products or parts of products can be set in motion during handling, thereby causing damage to packaging or product. Empty space does not, however, necessarily mean that product protection is lessened as long as the packaging still is stable. Handling at a supplier is usually relatively limited after the packaging has left the packing line, and since it is during handling activities that product protection is most important, this somewhat lessens the importance of this particular subcategory. Storage conditions expose the packaging to stresses of different magnitudes and influences the need of stable packaging and thereby the need of minimizing empty space within packaging and fixating the product in the packaging. Product protection is very important, but handling is relatively limited at the supplier and after the packaging has left the packing line, handling activities are the same no matter which type of packing line that is used. For this reason, the authors award this subcategory with a weight of 50 for both manual and automated packing lines.

Packaging stability

According to the empirical studies very few damages occur during the packing process, regardless if the process is performed manually or automatically. Therefore, the differences between the packing line processes are disregarded from a product protection perspective. After the packing process, the packaging will be exposed to exactly the same activities and

therefore the same strains, which motivates that this subcategory should have the same weight for both the manual and the automatic packing process categories. Since the packing line is disregarded, the two single most influencing factors, when it comes to packaging stability from a product protection perspective, are handling and storing. Handling is usually limited at a supplier, but storing sometimes occurs for longer periods of time. Exposure to stresses that occur during handling are therefore limited, whereas the ones that occur during storing are more common and could thereby be important from a cost reduction perspective. Because of this, the authors give the Packaging stability subcategory a weight of 70.

8.1.3 Volume efficiency

Storage adaptation

In order to keep costs as low as possible, it is important not to waste resources. Therefore it is important to have a volume utilization that is as high as possible and e.g. avoid pallet overhang, which can decrease the number of pallets that fit in a pallet rack. If it is possible for IKEA to get lower prices, effort should for this reason be put into adapting packaging solutions to storage facilities at the supplier as long as the solutions do not compromise the total efficiency of the Supply Chain. This subcategory is therefore awarded a weight of 60.

8.1.4 Handleability

Stackability

From a handling perspective, stackability is beneficial for increasing handling efficiency. Good stackability enables for example the possibility of handling two or more pallets at once and thereby saving both time and resources. Since only a limited part of the goods flow at a supplier benefits from stackability from a handleability perspective, the authors weigh this subcategory with 60, which is somewhat lower than the weight of the respondent group.

Ergonomical demands

The weighting of this subcategory depends on to what extent manual handling occurs at the supplier. If manual handling is common, ergonomical demands are very important, but if manual handling on the other hand seldom occurs, the weight should be low. For this reason, no weight will be given to the ergonomical demands subcategory, but is instead to be added during the development process when conditions of the supplier/suppliers in question are known.

Packaging stability

Handling efficiency is very much dependent on stable packagings, for example when stacking, placing pallets in racks, loading etc. Since these activities take place at a typical supplier, the packaging stability subcategory should have a high weight regardless if a manual or automated packing line precedes the handling activities. The authors agree with the weights given by the respondent group, and give this subcategory a weight of 80 for suppliers with a manual packing line as well as suppliers with an automated packing line.

8.2 The IKEA Transport Packaging Scorecard

The final IKEA Transport Packaging Scorecard is presented in Table 8.3, and thereafter motivations for the chosen weights will be accounted for.

CRITERIA	WEIGHT	NORMALIZED WEIGHT	SCORE
Product protection			
Protective properties of packaging	100		
No overhang	80		
Minimize empty space in packaging / Fixation of the product within packaging	100		
Minimize empty space in means of transportation	50		
Packaging stability	100		
Volume efficiency			
Minimize empty space in means of transportation	100		
Minimize empty space in packaging	80		
Stackability	100		
Right amount and size			
Packaging adapted to means of transportation	100		
Handleability			
Stackability	90		
Packaging stability	100		
Ergonomical demands	60		
Minimize handling	60		
WEIGHTED AVERAGE PACKAGING SCORE			

Table 8.3. The IKEA Transport Packaging Scorecard.

8.2.1 Product protection

Protective properties of packaging

Damaged products only generate costs and are not of any value for IKEA. The costs are not only related to the cost of the damaged packaged product, but also indirect costs for handling, transportation, disposal etc. Therefore the weight for this subcategory should be 100. This value applies only to mechanical stresses since other influences, like wrongful handling or faulty means of transportation, are exceptions and should not be taken into account. The 100 value does not mean that the product should be 100 percent protected at any cost, but that the relative importance of this subcategory is 100. That is, the costs surrounding a damaged product should be compared to the costs for overprotection.

No overhang

Overhang can cause damages both during loading and unloading. It will also cause extra stress on the goods during transportation if the overhang is in or opposite the direction of travel, since the mechanical stresses are the biggest in these directions. Overhang perpendicular to the direction of travel can also cause product damages, since a consequence can be that the transport compartment cannot be filled properly and thereby leaving empty space for the pallets to move around in. If the pallets then are not secured, product damages might occur. For the reasons stated above, the authors agree with the higher weightings provided by the respondents, and therefore weigh this subcategory with an 80 value.

Prevention of theft and manipulation

Since IKEA transports low value products, and in the future will secure their loads with different kinds of seals and closed compartments, this subcategory should not have a high importance during the packaging development. The authors therefore agree with the majority of the respondents and give this subcategory a weight of 0. This subcategory will for this reason be excluded from this Packaging Scorecard.

Minimize empty space in packaging / Fixation of the product within the packaging

Within this subcategory, the authors concur with the high values provided by the participants. Empty space in packaging can have the effect that some stability is lost. If the stability is lost, the packaging will be more sensitive to mechanical stresses. Not fixated parts can be set in motion during transport and cause damages to the product within the packaging, the packaging itself, but also to the surrounding environment if the packaging is broken. This subcategory is therefore given the weight 100.

Minimize empty space in means of transportation

As long as the pallets are fixated in the transport compartment and the pallets themselves are stable, empty space in the transport compartment is not according the empirical findings a significant problem from a product protection perspective. Deficiencies in fixation of pallets during transport cannot be remedied with a different packaging solution since it is the responsibility of the carrier to fixate his load. For the reasons stated above, the authors give this subcategory a 50 weight.

Packaging information – pallet weight

Packaging information about pallet weight is a matter that cannot be evaluated and given a grade based on how well the packaging complies with the requirements since packaging information either exists or not. The authors believe that information about pallet weight should be marked on every pallet according to a universal stacking code especially since it seems to have a great significance from a transport perspective. In order to make loading safe and efficient, easy access to information about pallet weight that people of every nationality and origin can understand is very beneficial. This subcategory is due to the discussion above excluded from the IKEA Packaging Scorecard.

Packaging information – pallet orientation

Packaging information regarding pallet orientation, the authors believe to be a matter to decide for each specific product since demands on orientation are product specific. A matter like this is something that cannot be evaluated and given a grade based on how well the packaging complies with the requirements since packaging information either exists or not. Therefore, this subcategory is not included in the IKEA Packaging Scorecard.

Packaging information – pallet contents

The case with packaging information regarding pallet contents is the same as the case with packaging information about pallet orientation discussed above. The authors believe that marking pallets with their contents is not necessary for all products, but that fragile products should either be marked with its contents or that the packaging system should be designed to make the fragile contents visible, thus making the personnel aware of what kind of goods they are handling. Therefore, this subcategory is not included in the IKEA Packaging Scorecard.

Packaging stability

The entire packaging system, including stabilizing aids, should be stable enough to handle the strains put on it during transport. Stability is however not only important because of transport induced strains, but also from a stackability point of view. If these demands are not met, pallets might collapse with product and packaging damage as a consequence. Therefore the authors give this subcategory a weight of 100.

8.2.2 Volume efficiency

Minimize empty space in means of transportation

IKEA transports enormous amounts of products very large distances and minimizing logistics costs is therefore important. Transported empty space should for this reason be minimized since it only generates costs and does not add any value to the customer. An assessment has to be made to ensure that what is saved due to better volume utilization is not lost due to costs for extra handling etc. The authors weight this subcategory with a 100 value, which is also supported by a majority of the respondents.

Minimize empty space in packaging

When it comes to achieving good volume efficiency during transport, minimizing the empty space in packagings can have a large impact. The more unnecessary empty space that is transported, the more unmotivated costs are generated. But minimizing empty space in packaging might not always result in better volume utilization, e.g. it can lead to that unnecessary underhang is created without allowing more products to be transported. Therefore the authors believe that the weight of 80 is suitable for this subcategory and this value also concurs with the mean value calculated for the weightings of the participants.

Stackability

This subcategory is essential from a volume efficiency perspective. If it is not possible to stack pallets on top of each other, IKEA will lose the possibility to transport an additional layer of pallets within their means of transportation. This will lead to both more generated costs per item and lower volume efficiency. Therefore subcategory deserves a 100 weight, both according to the authors and to the participating respondents.

8.2.3 Right amount and size

Packaging adapted to means of transportation

Packaging systems should be adapted to optimal use in every part of the Supply Chain. From a transportation perspective, it is important that the goods have measurements that allow the coefficient of fullness in the means of transportation to be as good as possible. The dimensions of the packaging solution should also enable efficient loading and unloading, e.g. by unitization. It is not always possible to adapt packaging solutions to means of transportation, but this should always be strived towards, and the authors therefore place a weight of 100 for this subcategory.

8.2.4 Handleability

Stackability

From a handleability perspective, the participants have provided *Stackability* with high weightings, and the mean value was calculated to a 100. From a handling perspective the time aspect is vital and since the stackability of the pallets greatly influence this, both during the loading and unloading process, the authors agree with the participants to place a high weight, but 90 seems to be a more justified weight. The reason for this is that the stackability property cannot always be utilized, e.g. due to the fact that two pallets of the same weight and size are

not always situated close enough to make double stacking beneficial from an efficiency perspective.

Packaging stability

This subcategory also is significant from a handleability point of view. The mean value calculated was 93,3, but the authors believe that *Packaging stability* is critical from a handling perspective and deserves a 100 weight. If the packaging stability is poor, the handling becomes more complicated, which causes time losses. It also increases the risk for damages occurring, both to the product and the personnel. Both these aspects will involve costs for IKEA, which motivates the weighting provided.

Ergonomical demands

The weightings provided in this subcategory were comparatively low, with a resulting mean value of 63,3. Forklifts perform loading and unloading in general, since it is the most efficient way of executing these activities. Manual handling does not occur that often during these activities, and when it happens, the specific packaging system should be designed to meet this prerequisite, but generally this is not an important aspect to consider during loading and unloading. Concerning manual handling of top layers, which only occurs in containers, it can be avoided by palletizing the goods and thereby both reduce the need for manual handling and the loading and unloading related costs. Therefore the weight for this category will be 60.

Minimize handling

From a cost and time perspective, minimizing handling during loading and unloading seems to be of important nature. The handling might not be as large-scaled within the transportation area, but it exists and should therefore be minimized if possible. The weights provided by the participants show a big diversity with values ranging from 10 to 100, with 100 as the most deviating value. The possible reasoning for the low weights, that handling is such a little part of the transport perspective, the authors do not find to be totally valid and therefore place the weight 60 for this subcategory.

Handling adds no value to the customer, but is associated with large costs. Especially manual handling is time consuming, and because of this top loading should preferably be done on pallets in order to enable handling by forklift. A little is lost in lower coefficient of fullness, but this is most probably gained in increased handling efficiency. This should be strived towards if it minimizes the costs generated per packaged product along the Supply Chain. Of course the costs are supposed to be balanced, between the costs for optimal filling of the transports and the handling costs that this generates, in order to find the best solution.

8.3 The IKEA Distribution Centre Packaging Scorecard

The final IKEA Distribution Centre Packaging Scorecard is presented in Table 8.4, and thereafter motivations for the chosen weights will be accounted for.

CRITERIA	WEIGHT	NORMALIZED WEIGHT	SCORE
Product protection			
Protective properties of packaging	90		
No overhang	80		
Minimize empty space in packaging/Fixation of product within packaging	90		
Packaging stability	100		
Volume efficiency			
Storage adaptation	80		
Right amount and size			
Module adaptation when mixing pallets	20		
Quantity adapted to needs of retail	70		
Handleability			
Stackability	95		
Packaging stability	100		
Ergonomical demands	80		
Minimize storage handling	100		
Pickability	80		
WEIGHTED AVERAGE PACKAGING SCORE			

Table 8.4. The IKEA Distribution Centre Packaging Scorecard.

8.3.1 Product protection

Protective properties of packaging

A damaged product or packaging cannot be sold, and is only a disadvantage for any company. At IKEA distribution centres 50 % of all damages are caused by bad packaging systems that collapse. Handling is a considerable cause of damage, and at a DC handling is a common activity as well as storing. For this reason the protective properties of packaging should from a DC perspective be taken into account during the packaging development process. However, handling errors should not be considered, but what is to be considered is the stresses put on products and packagings during handling and storing. For this reason, the authors award this subcategory with a 90 weight.

No overhang

Handling represents a large part of the activities that take place within a DC. During handling, packaging with overhang increases the risk of damages for several reasons and makes the handling aspect much more complicated. Damages e.g. occur due to overhang when picking up and putting down the pallet, when placing the pallet in storage and during movement, i.e. practically all activities within a DC. The authors therefore agree with the majority of the respondents and also weight this category with a value of 80.

Prevention of theft and manipulation

A DC is a fairly restricted area with safety routines and low value products, which probably explains the low values provided by the participants. Since theft and manipulation do not seem to be a problem for a DC, the authors agree with the low significance of this factor and give it a weight of 0. This subcategory will therefore be excluded from this Packaging Scorecard.

Minimize empty space in packaging / Fixation of product within packaging

Empty space in packaging can cause damages to the product and packaging, both during handling and storing. If the packaging is not filled up properly, or the product not fixated, it becomes unstable and could make the whole packaging system shift its centre of gravity during handling and thereby collapse. Also during storing, the void within the packaging can make the packaging system cave in, especially if there are pallets stacked on top of each other. Both handling and storing are major activities at a DC, which explains the high weighting provided by the participants. The authors also believe that *Minimize empty space in packaging* is significant from a DC perspective and therefore provide this subcategory with the weight of 90.

Packaging information – pallet weight

Packaging information about pallet weight is a matter that cannot be evaluated and given a grade based on how well the packaging complies with the requirements since packaging information either exists or not. The authors believe that information about pallet weight should be marked on every pallet according to a universal stacking code even if it does not seem to have a great significance from a DC perspective. This subcategory is due to the discussion above excluded from the IKEA Packaging Scorecard.

Packaging information – pallet orientation

Packaging information regarding pallet orientation, the authors believe to be a matter to decide for each specific product since demands on orientation are product specific. A matter like this is something that cannot be evaluated and given a grade based on how well the packaging complies with the requirements since packaging information either exists or not. Therefore, this subcategory is not included in the IKEA Packaging Scorecard.

Packaging information – pallet contents

The case with packaging information regarding pallet contents is the same as the case with packaging information about pallet orientation discussed above. The authors believe that marking pallets with their contents is not necessary for all products, but that fragile products should either be marked with its contents or that the packaging system should be designed to make the fragile contents visible. Therefore, this subcategory is not included in the IKEA Packaging Scorecard.

Packaging stability

As mentioned before, storing and handling of the packaging systems constitute the majority of the activities within a DC. To avoid damages occurring during both of these types of activities, the packaging stability is essential. The authors therefore believe that the weighting 100 is suitable for this subcategory, which is supported by the majority of the weightings provided.

8.3.2 Volume efficiency

Storage adaptation

To adapt the packaging system to the conditions of the storing facility is important from a volume efficiency perspective. At the DC, the storing facilities are adjusted to the format of the different types of pallets used, which leads to that if the packaging is adjusted to the size of the pallet, the volume efficiency will become good. But sometimes this adjustment is not possible, and if for example a packaging system has underhang, the volume efficiency does not become optimal in the technical sense, but there would not be possible to store any more products in the void created anyway. This is the reason for why the authors concur with the mean value provided by the participants and weigh this subcategory with 80.

8.3.3 Right amount and size

Module adaptation when mixing pallets

This subcategory is complicated since module adaptation can have such impact on other Supply Chain actors as well, e.g. if the multi-packs are adapted to the display shelves in the store. This is also shown by the contradicting weightings provided. From a DC perspective, however, there are benefits and drawbacks with module adaptation. It can e.g. create better volume efficiency on the pallet, making the stacking less a puzzle and increase the pallet stability when mixing pallets. The disadvantage is that when the products do not fill up the module-adapted packaging, filling materials that cost money have to be used to stabilize the packaging. If this is not done, the packaging can both be less stable to handle and therefore need more effort, and be more inclined to break. Without stabilizing material one of the drawbacks, the stability of the mixed pallet, will also be at least partly lost. Although mixed pallets leaving a DC is about a fifth of the total outbound goods, the mixed pallets usually have a relatively low coefficient of fullness since retail outlets normally do not order quantities for each separate product range area large enough to fill an entire pallet. This implies that the benefits associated with module adapted packagings when mixing pallets do not exceed the possible disadvantages. Also, to benefit from module adaptation when mixing pallets, the majority of packagings on the pallet also need to be module adapted as well. Considering the drawbacks accounted for, this is probably not beneficial for a majority of products. The authors therefore award this subcategory a weight of 20.

Quantity adapted to the needs of retail

The packaging system should be designed to fit the supposed delivery quantity to the store. For a product that is supposed to be delivered in big quantities, a half pallet solution could be beneficial. If only a few products are needed at each order point, a suitable multi-pack with a quantity that reflects the need of the store would be more useful. Both of these solutions can be considered to match the quantity needs of retail, and facilitates and minimizes the handling at the DC, since picking the product in smaller quantities, or one by one, would take much more time and cost more money. Therefore the weighting here should be quite high. Of course a multi-pack cannot be custom made to fit every different sized store's need, but the packaging designers should try to reach a good quantity balance during the packaging development process. The 0 weighting in this subcategory is unreasonable because it is not possible to send complete pallets to the retails and the authors therefore support the majority of the participants and place the weight 70 for this subcategory.

8.3.4 Handleability

Stackability

The high values given by the participants are also supported by the authors. Stackability surely plays a significant role from an efficient handling and storing perspective at a DC.

Unloading double stacked, taking two pallets at the same time to the storage location saves an extra trip, storing pallets free stacked when there is a volume deficiency in the storage facilities etc. are examples on the aspects that are affected by the pallet's stackability. The score for this subcategory therefore will be the same as the mean value, 95.

Packaging stability

Packaging stability is crucial for all packaging related handling activities, no matter if it is the whole pallet system or the primary or secondary packaging that is handled. This because there are so many other handling factors that are connected to the stability as well, e.g. stackability and pickability. To be able to carry out all these activities in an efficient manner, the packaging stability deserves a very high value, 100, according to the authors.

Ergonomical demands

A DC strives towards minimizing handling to an extent as great as possible, and this applies especially to manual handling. Manual handling occurs however, but to a limited degree. When handling is manual, ergonomical aspects are very important for the wellbeing of the personnel as well as important from a handling efficiency perspective. Since manual handling is limited, this subcategory is not given maximum importance, but because of the importance of personnel health, the authors give the ergonomics subcategory a high weight, namely 80, which almost corresponds to the mean value of 76,7.

Minimize storage handling

All handling requires resources in the form of money and personnel etc., but adds no value to the customer. The personnel that is required to handle goods could, if unnecessary handling is eliminated, be used elsewhere, where their value to IKEA is greater. Handling at a DC also takes time, which slows the logistical flow of goods down. What is stated above motivates according to the authors a weight of 100 for *Minimizing storage handling* and concurs with the opinions of the respondents.

Pickability

Picking can be both manual and automatic, but requires resources and takes time in any case, and should for these reasons be avoided to an extent as large as possible. Mixed pallets constitute 19 % of all outbound goods and cannot be avoided. The picking process should therefore be facilitated by the packaging design, thereby making picking as efficient as possible. Therefore, this subcategory is given a weight of 80.

8.4 The IKEA Retail Outlet Packaging Scorecard

The final IKEA Retail Outlet Packaging Scorecard is presented in Table 8.5, and thereafter motivations for the chosen weights will be accounted for.

CRITERIA	WEIGHT	NORMALIZED WEIGHT	SCORE
Product protection			
Protective properties of packaging	80		
No overhang	100		
Prevention of theft and manipulation	60		
Minimize empty space in packaging/Fixation of product within packaging	75		
Packaging stability	100		
Volume efficiency			
Storage adaptation	100		
Right amount and size			
Quantity adapted to needs of retail	100		
Packaging adapted to display mode	85		
Handleability			
Stackability	50		
Packaging stability	75		
Ergonomical demands	100		
Minimize storage handling	100		
Minimize sales area handling	100		
Minimize waste handling	100		
WEIGHTED AVERAGE PACKAGING SCORE			

Table 8.5. The IKEA Retail Outlet Packaging Scorecard.

8.4.1 Product protection

Protective properties of packaging

In a Retail Outlet, handling activities are frequent and imply risk of damages occurring due to mechanical reasons, but other influence occur only in rare occasions and should therefore not be taken into account when designing packaging. Damages caused by handling errors should not either be taken into consideration during the packaging development process, since this is a problem that should be remedied by other means than overprotecting the product. Overprotection costs more than it saves, and is because of this not beneficial. Due to the importance of keeping products and packaging intact the weight of this subcategory should be high. It is not beneficial to protect products and packaging against damages that are exceptions, which lowers the weight. The authors therefore give *Protective properties of packaging* a weight of 80.

No overhang

Handling of pallets is frequent in a Retail Outlet, and since products outside the area of the pallet are relatively unprotected, overhang is bad from a product protection perspective. Pallet overhang is one of the primary reasons for product and packaging damages in a Retail Outlet.

Pallet overhang also lessens handleability, which in turn can give rise to more damages. For these reasons the *No overhang* subcategory is given a weight of 100, which also is the opinion of a majority of the respondents.

Prevention of theft and manipulation

IKEA products are of relatively low value and are therefore not very attractive to steal or manipulate with. Theft and manipulation occurs however at a Retail Outlet, mostly at the sales area, and should for this reason be taken into account during the product and packaging development process. Based on the reasoning above the authors give this subcategory a weight of 60.

Minimize empty space in packaging / Fixation of product within packaging

Empty space has an effect on product damages since some packaging stability can be lost due to the lack of support from the product itself. The effects of mechanical influence can then be larger. In order to prevent this, filling material or other stabilizing material needs to be added, which costs money. Also, if parts of the product or the product itself are loose inside the packaging, these may be set in motion during handling and thereby damage the packaging. However, empty space in a packaging does not necessarily mean that product damage increases as long as the packaging is stable and the product is fixated. For the reasons above a weight of 75 is given to this subcategory by the authors. This also reflects the weightings of the respondents.

Packaging information – pallet weight

Packaging information about pallet weight is a matter that cannot be evaluated and given a grade based on how well the packaging complies with the requirements since packaging information either exists or not. The authors believe that information about pallet weight should be marked on every pallet according to a universal stacking code even if it does not seem to have a great significance from a retail perspective. This subcategory is due to the discussion above excluded from the IKEA Packaging Scorecard.

Packaging information – pallet orientation

Packaging information regarding pallet orientation, the authors believe to be a matter to decide for each specific product since demands on orientation are product specific. A matter like this is something that cannot be evaluated and given a grade based on how well the packaging complies with the requirements since packaging information either exists or not. Therefore, this subcategory is not included in the IKEA Packaging Scorecard.

Packaging information – pallet contents

The case with packaging information regarding pallet contents is the same as the case with packaging information about pallet orientation discussed above. The authors believe that marking pallets with their contents is not necessary for all products, but that fragile products should either be marked with its contents or that the packaging system should be designed to make the fragile contents visible. Therefore, this subcategory is not included in the IKEA Packaging Scorecard.

Packaging stability

From a product protection perspective, packaging stability is necessary in order for products and pallets to be stacked on top of each other, and to take the mechanical stresses that are put on them, without breaking or even collapsing. Also, the remainder of the pallet contents that cannot be displayed at the sales area, and therefore needs to be taken back to storage, must be

stable and not collapse during storage. The amount of time that products are stored adds other demands on the packaging concerning stability and requirements on packaging material. However, in a Retail Outlet, products are not in general stored for any longer periods of time, which somewhat lessens the need of packaging stability. During handling in a Retail Outlet, products are exposed to mechanical stresses that they need to be able to handle without being damaged. With the reasoning above the authors have motivated the weight of 100 of the packaging stability subcategory, which also is in line with the opinions of the respondents.

8.4.2 Volume efficiency

Storage adaptation

Storage space at a Retail Outlet is often limited and costs money whether it is used or not, thus, using space efficiently is very important. Also, since space often is limited, using storage space as efficiently as possible is necessary in order to make room for all products that need to be stored. In order for this to be possible, as well as minimizing empty space, adaptation of product and packaging to the storage facilities is important. Low volume utilization due to badly designed products and packaging means unnecessary costs and should therefore be avoided, which can be done by adapting products and packaging to the storage facilities. Thus, the authors award this subcategory a weight of 100 in accordance to the opinions of the respondents.

8.4.3 Right amount and size

Quantity adapted to needs of retail

If the number of units in a secondary packaging is too small compared to sales volumes, this gives rise to an increased number of handling activities, which in turn requires resources. In the event that the quantity is larger than the demand is, this might lead to an unnecessary number of products in stock, and this increases inventory and storage costs. Therefore, it is important to adapt the quantity of packagings in the multi-pack to the needs of retail regarding handling activities, expected sales volumes etc. This is also important in order to avoid unnecessary capital tie-up. This motivates a weight for the *Quantity adapted to needs of retail* subcategory of 100, which also is the opinion of a majority of the respondents.

Packaging adapted to display mode

It is desirable to minimize handling at the sales area, and this can be done by adapting the packaging to the manner in which the product is supposed to be displayed, e.g. by making it possible to place an entire secondary packaging at the shelf in only one handling activity. This is beneficial from a handling and cost perspective. Adaptation of the packaging can also have beneficial effects on volume and area utilization. Packagings that are not purposely adapted to the mode of display do not necessarily have unbeneficial effects on space utilization, handling etc., which lowers the importance for this subcategory. For the reasons above, the authors give this a weight of 85.

8.4.4 Handleability

Stackability

It is beneficial from a handling efficiency perspective to be able to stack pallets on top of each other when handling them by truck, since this can save both time and money. At a Retail Outlet, stacking occurs for the reason above, but not to any larger extent. Therefore, the authors give the stackability subcategory a weight of 50.

Packaging stability

During handling, products and packagings are exposed to increased mechanical stresses, which the packaging needs to be able to persist without suffering damage. Stability of the packaging is for this reason important. Also, unstable packagings can cause personal injury when handling them manually. Unstable packagings are time consuming to handle, and really unstable packagings might not even be possible to handle without handling aids. The view of the authors corresponds to the view of the respondents giving the lower values, whereby this subcategory is given a weight of 75.

Ergonomical demands

A lot of manual handling is carried out at a Retail Outlet, and by easing handling by making packaging more ergonomical, less work related injuries is possible to achieve. Sound ergonomical conditions contribute to the wellbeing of the personnel, which is very important for IKEA. The primary ergonomical factor at a Retail Outlet is the weight of the product and its packaging, but also size, volume and placement of handles etc. influences as well as the number of handling activities that need to be carried out. Ergonomics can be improved by making packaging e.g. easier to open, stackable and unitized. Due to the importance of personnel health and sound working conditions, the authors award the ergonomical demands subcategory a weight of 100 in accordance with the opinion of the respondents.

Minimize storage handling

This subcategory has received 100 weights from all participants, emphasizing the significance minimizing storage handling has for the IKEA Retail Outlets. Storage handling, as well as other forms of handling, requires time and resources and should for that reason be minimized as much as possible. If the design of the packaging system can influence the storage handling efficiency, e.g. by being easy to place and collect in the “self-service”-storage, this should be considered during the design process. This subcategory therefore is assigned the weight 100.

Minimize sales area handling

The sales area handling is one, if not the most, time and personnel consuming activity at a Retail Outlet. Therefore one of the primary functions that the packaging system should have is to facilitate the unpacking and displaying activities. This is also supported by the high weightings provided by the respondents, and the authors therefore weigh this subcategory with a 100 weight.

Minimize waste handling

Packaging systems that give rise to excess packaging waste when unpacked should be avoided to the largest possible extent. This due to, not only the extra handling removing it that is required, but also the fact that the waste needs to be collected, carried and disposed of. The more waste, the more resources will be required to execute these handling activities. Packaging waste can in most cases not be avoided, but it is important to consider this aspect already during the design process to facilitate the work for the personnel at the Retail Outlet. The authors therefore agree with the weightings given by all the participants, and place the weighting 100 for this subcategory.

9 Packaging and Product Development Process Checklist

This chapter will present the checklist that is proposed to be used by the employees at IKEA of Sweden during the packaging and product development process in order to support the logistical aspects that should be taken into account.

When developing a packaged product, what the customer desires must be kept in mind. Other aspects besides the product specifications themselves influence how attractive the product is to potential customers, and it is essential to consider these aspects. The packaging can be one mean of achieving what the customer values except for what the product itself can provide.

The packaging related matters presented in the checklist below are essential to consider during the product and packaging development process in order to achieve the goals of efficiency throughout the Supply Chain and low cost to the customer. In the Packaging Scorecard presented earlier in this thesis, consequences of the factors in each separate part of the Supply Chain have been considered, but in the checklist what is considered is their effect on the entire Supply Chain as a whole.

The ideal case, and also what is to be strived towards during the product and packaging development process, is for the packaging system to earn a positive answer to every question. If any factor is not fulfilled and thereby receives a negative answer, an evaluation should be made as to whether or not a redesign is necessary and possible.

If all factors in the checklist cannot be fulfilled, they have to be weighed against each other from case to case in order to achieve the best possible overall solution. What to prioritize is dependant on the product in question.

The checklist below is divided into six groups based on their influence on Supply Chain activities. The checklist that is provided to IKEA can be found in Appendix C.

Packing process

- *Efficient erection of packaging*
 - Is the packing line able to erect the packaging construction efficiently?
 - Is the packaging material and its quality suitable for the erection process in question?
- *Efficient filling of packaging*
 - Is the packing pattern suitable for the prerequisites of the supplier (number of robots/employees, number of filling activities etc.)?
 - Specifically for an automated line: If small details are supposed to be packed, are they pickable by the robots or can they be pre-packed in order to facilitate the filling process?

- *Efficient sealing of packaging*
 - Is the sealing method applicable at the supplier?
 - Is the packing line able to seal the packaging efficiently considering packaging construction, material and its quality?
- *Packaging stability*
 - Is the packaging stable enough to function efficiently in the packing line?
- *Specifically for a manual packing line:*
 - Can erection, filling and sealing of the packaging be done in an ergonomically sound manner?

Product protection

- *Protective properties of packaging*
 - Is the packaged product protected from the stresses occurring during transport, handling and storing?
- *No overhang*
 - Has pallet overhang been avoided?
 - If not, has pallet overhang been avoided on the longer sides and the 800 mm pallet dimension thereby not been exceeded?
 - If pallet overhang cannot be avoided, has measures been taken to reinforce exposed areas?
- *Prevention of theft and manipulation*
 - Does the packaging prevent the possibility of putting other objects in it, for example by having little empty space?
- *Minimize empty space in packaging / Fixation of product within packaging*
 - Has empty space in the packaging that can affect packaging stability been avoided?
 - Are the product and loose parts that, if set in motion, might damage the product or the packaging fixated?
- *Minimize empty space in means of transportation*
 - Has empty space between pallets in the transport compartment, that might give rise to damage during transportation, been avoided by the dimensions of the packaging system?

- If no, is the packaging solution stable enough to take the mechanical stresses that empty space might expose it to during transportation both from a single pallet and a double stacked pallet perspective?

- If top loading is supposed to take place during transportation, has consideration been taken to this from a product protection perspective?

▪ *Packaging stability*

- Is the packaged product able to take the static strains that it is exposed to during storing?

- Is the packaged product able to take the mechanical stresses that it is exposed to during handling?

- Is the packaged product able to take the strains that it is exposed to during transportation?

Volume efficiency

▪ *Stackability*

- Can pallets be stacked on top of each other in order to enable good volume utilization during transportation?

▪ *Storage adaptation*

- Is the packaging solution adapted in size, as far as it is possible, to the storage facilities that it will pass along the Supply Chain?

▪ *Minimize empty space in means of transportation*

- Is the packaging solution adapted in size, as far as it is possible, to the means of transportation that will be used?

- If top loading is supposed to take place during transportation, has consideration been taken to this from a volume efficiency perspective?

▪ *Minimize empty space in packaging*

- Is empty space in the packaging minimized as far as possible, thereby making room for more products on every pallet, without giving rise to unstable underhang pallets?

- Is empty space in the packaging minimized as far as possible without creating an underhang that can jeopardize stability of double stacked pallets during movement or storing?

Right amount and size

- *Packaging adapted to means of transportation*
 - Is the packaging solution adapted to the limiting measurements of the transport compartment?
- *Quantity adapted to needs of retail*
 - Has a weighting been done between the effects of adapting the quantity of a multi-pack to the needs of retail and the extra handling that it might give rise to when picking?
 - Is the quantity of the packaging solution adapted to the expected product turnover and thereby minimizes sales area handling?
- *Packaging adapted to display mode*
 - Does the packaging solution support the display mode that is supposed to be used at the sales area from a volume/area efficiency and handling perspective?

Handleability

- *Stackability*
 - Does the packaging solution allow pallets to be handled double stacked?
- *Packaging stability*
 - Are all packaging levels stable enough to be handled efficiently, separately as well as a unit, throughout the IKEA Supply Chain?
- *Ergonomical demands*
 - When manual handling occurs, is it possible to handle the different packaging levels separately in an ergonomically sound manner?
- *Minimize handling*
 - Has the packaging solution been adapted to handling requirements at the different storage facilities along the IKEA Supply Chain in order to minimize the handling needed?
 - Has the packaging solution been adapted to sales area handling requirements for the product in question in order to minimize the handling needed?
 - Has the packaging solution been designed in order to minimize the waste handling needed at the Retail Outlet?

- Has the packaging solution been adapted to loading and unloading requirements in order to minimize the handling needed?
- If the packaged product in question will be top-loaded, has the packaging solution been adapted to handling requirements of top-loaded goods in order to minimize the handling needed?

Factors important for specific product types

- *Packaging information*

- Have fragile packaged products been marked with symbols or has the packaging system been adjusted to show the characteristics of the fragile product?
- Have packaged products with special requirements regarding orientation been marked illustrating the appropriate orientation?

10 Concluding Remarks and Suggested Future Research

In this chapter the authors present their concluding remarks regarding this thesis. Suggested future areas of research related to this master thesis, both internally at IKEA and in a more general perspective, will also be accounted for.

The authors would like to bring this thesis to a close with some concluding remarks and suggestions of some possible areas for future research that have arisen, but been left unconsidered, during the thesis work. These thoughts have been divided into concluding remarks, future research from an IKEA perspective, and future research from an academic perspective.

10.1 Concluding remarks

The Packaging Scorecard cannot only be used for its intended purpose, as an evaluation tool for packaging, but also as a tool for passing on information, for example between a packaging technician and the retail outlet, or to evaluate the perception of different aspects at different stages in the Supply Chain. It can thereby be used as an aid to examine how important certain parts of the Supply Chain believe that different factors are and thus where more information might be needed. It can also be used as a tool to examine how spread information has been taken in and perceived.

Even if IKEA should choose not to implement the Packaging Scorecards as a permanent part of the product and packaging development, they can still create a basis for discussion that could contribute to an increased logistical awareness during developing work at IKEA.

10.2 Future research from an IKEA perspective

For future research, IKEA can verify the quality of the Packaging Scorecards by comparing an old packaging solution for a product with a new, proven more efficient, packaging solution. They can also thereby correct the weightings if that is considered needed.

Also, since the diversity among suppliers, regarding product range and prerequisites, is vast, deeper studies regarding supplier aspects possible to include in the Packaging Scorecard can with benefit be conducted as well as studies strengthening the Supplier Packaging Scorecard presented in this thesis. Aspects concerning other parts of the Supply Chain, such as the customer, could be beneficial to include in future studies as well as marketing related, environmental and additional logistical demands that are not examined in the context of this thesis,.

Another future area of investigation for IKEA is that the factors included in the Packaging Scorecard could be weighted according to the cost impact that each factor imposes on the packaging and corresponding parameters driving these costs could be established.

10.3 Future research from an academic perspective

A future area of research for academia that could be based on this thesis is to examine if the factors concluded, and their appertaining weightings, can be applied for other companies, both within and outside the IKEA line of business.

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This chapter will present the different sources that have been used within this master thesis. The sources altogether have been used in order to execute the study.

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Appendix A - Interview guides

Appendix A presents the interview guides used during the interviews conducted. Depending on the answers provided, attendant questions were added.

Appendix A:I Interview guide – Introductory interview

Inledande frågor:

1. Era namn?
2. Era befattningar?
3. Hur skulle ni själva vilja beskriva era arbetsuppgifter?
4. Går det bra att vi spelar in intervjun?

Övergripande frågor:

1. Vilka förpackningsmässiga faktorer tror ni blir mest betydelsefulla i framtiden?
2. Vilka anledningar anser ni det finns för att en redesign ska genomföras? Ex missar i produktutvecklingen, förändringar i produktionssystem, leverantörer, kundönskemål, produkten är out-of-date etc.?
3. Vad avgör om det väljs standardiserade eller ickestandardiserade förpackningar till en produkt? Vilka fördelar och nackdelar ser ni mellan de två alternativen?
4. Vilka regelverk tas det hänsyn till under produktutvecklingen? Exempelvis miljöbestämmelser, arbetsmässiga regleringar etc.
5. När det sker ett nytt utvecklingsprojekt, hur inkluderas kraven från S.C. i produkt /förpackningsutvecklingsprocessen? Via förp.teknikerns logistikkompetens etc.?
6. Anpassas förpackningen efter befintlig hantering eller vice versa? Existerar några specialfall?
7. Vilka faktorer inom förpackningssystemet anser ni är viktigast? Rangordning av dessa.
Exempel ges nedan:
 - a. Stapelbarhet
 - b. Hanterbarhet
 - c. Volymeffektivitet
 - d. Information på och ang. förpackningssystemet
 - e. Vikteffektivitet
 - f. Tyngdpunktspacering
 - g. Kvantiteterna i förpackningssystemet (splittning och omlastning av gods)
 - h. Produktskydd
 - i. Klimatpåverkan
 - j. Marknadsföring
 - k. Övriga faktorer

Frågor av strategisk natur:

1. Vilken förpackningsstrategi har IKEA lagt upp?
2. Vilka faktorer har ni tagit hänsyn till under framtagningen av strategierna?
3. Är de strategiska målen IKEA har förpackningsmässigt uppdelade i affärsstrategi, funktionsstrategi och arbetsstrategi?

Frågor angående Glimma:

1. Vad låg till grund till beslutet att en redesign skulle utföras på Glimma?
2. Vad prioriterades under utvecklingen?

3. När kom de olika personerna in i utvecklingsprocessen? Vad var deras roller/ansvarsområden?
4. Vilka effekter har ni registrerat efter redesignen?

Appendix A:II Interview guide - Supplier

Inledande frågor:

1. Ditt namn?
2. Din befattning?
3. Vad innebär befattningen?
4. Går det bra att vi spelar in intervjun?

Leverantörs - relaterade diskussionsområden:

1. Diskussion kring en allmän processkartläggning hos en typisk leverantör.
2. Diskussion kring förpackningsrelaterade faktorer hos en leverantör
 - Automatiserade packlinor vs manuella packlinor
 - faktorer viktiga att tänka på vid automation
 - faktorer viktiga att tänka på vid manuell
 - Produktskydd
 - mekaniska påkänningar
 - klimatpåverkan
 - kemisk påverkan
 - stöld och manipulation
 - förpackningsstabilitet
 - Förpackningsinformation
 - pallorientering
 - pallvikt
 - pallinnehåll
 - Volym- och vikteffektivitet
 - uppnå hög fyllnadsgrad vid lagerhållning
 - Hanterbarhet
 - förpackningsstabilitet
 - ergonomiska aspekter
 - ”tillverkning” av förpackning
 - Andra värdeskapande aktiviteter
 - Minimerad resursanvändning
 - Övriga faktorer

Appendix A:III Interview guide - Transport

Inledande frågor:

1. Ditt namn?
2. Din befattning?
3. Vad innebär befattningen?
4. Går det bra att vi spelar in?

Transport - relaterade frågor:

1. Vilka påfrestningar utsätts godset för under transport (ex. mekaniska, kemiska, klimat etc.)?
2. Vilka är de mest förekommande godsskadorna under transport? Vad beror dessa på?
3. Överhäng ska ju alltid i största möjliga mån undvikas, men om detta är omöjligt rangordna de olika överhängs-alternativen efter deras prioritet att undvikas:
 - Överhäng på båda sidorna
 - Överhäng på kortsidan
 - Överhäng på långsidan
 - UnderhängMotivera valen. Vilka effekter kan överhängen ge ur transportsynpunkt?
4. Vilka risker finns för att godset ska stjälas eller manipuleras? När är riskerna som störst och hur kan man minimera dessa?
5. Ur produktskyddssynpunkt: Är det viktigt att minimera luft i förpackningarna/fixera produkten.
6. Vad händer ur produktskyddssynpunkt när det finns tomrum i transportutrymmet? Vad är viktigt att ta hänsyn till ur förpackningssynpunkt? Hur kan man minimera detta tomrum?
7. Vilka problem är de vanligast förekommande vid lastning av gods? Hur kan dessa förebyggas ur ett förpackningsperspektiv?
8. Vilka problem är de vanligast förekommande vid lossning av gods? Hur kan dessa förebyggas ur ett förpackningsperspektiv?
9. Vilken grundläggande information anser du är viktig att det finns på pallen vid lastning/lossning?
10. Hur viktig är förpackningssystemets stabilitet ur ett produktskyddsperspektiv under transport? Ur ett hanterbarhetsperspektiv?
11. Transportmedel har oftast både volym- och viktbegränsningar för det transporterade godset, hur går ni till väga för att få ut maximal nytta av transporterarna? Vad är riktlinjen, att fylla volymmässigt eller viktmässigt?
12. Vilka lastbärarmått (EUR-pall, oceanpall etc.) eftersträvas för närvarande för förpackningslösningar hos IKEA? Hur ser framtidsstrategierna ut ur lastbärarsynpunkt? Vilka mått är viktigast att eftersträva för att få en så effektiv distribution för IKEA:s gods worldwide? Varför?
13. Finns det några ergonomiska aspekter som man bör ta hänsyn till vid lastning och lossning?
14. Finns det övriga faktorer som vi inte behandlat som är viktiga ur transport- samt lastnings- och lossningssynpunkt?

Appendix A:IV Interview guides – Distribution Centre

Interview I

Inledande frågor:

1. Ditt namn?
2. Din befattning?
3. Vad innebär befattningen?
4. Går det bra att vi spelar in intervjun och dokumenterar våra observationer med hjälp av en kamera?

DC - relaterade frågor:

1. Hur ser en kartläggning av aktiviteterna ut som nya Glimma genomgår inom ett DC?
2. Hur skiljer sig detta flöde skiljer från gamla Glimma?
3. Hur ser förpackningssystemet ut för gamla resp. nya Glimma?
4. Vilka fördelar respektive nackdelar ser du med gamla och nya Glimma?
5. Vilken hanteringsutrustning används allmänt inom ett DC respektive Glimma?
6. Vilka aktiviteter förekommer generellt i detta DC?
7. Skiljer sig dessa från andra DC:s aktiviteter?
8. Vilka olika lagringstyper förekommer här?
9. Förekommer det andra lagringstyper på andra DC?
10. Är hanteringsutrustning och lagringssystem anpassade till enhetsmodulen (600x800, halvpall)?
11. Vilka typer av lastbärare används här? Vilka för och nackdelar ser ni med dessa?
12. Används andra typer av lastbärare på andra DC:s?
13. Vid vilka situationer sker en delning av godset? Hur brukar denna delning gå till?
14. Om det existerar några flaskhalsar inom hela Supply Chain, var tycker ni att de finns?
15. Om det existerar några flaskhalsar inom ett DC, var tycker ni att de finns? Hur anser ni att man skulle kunna åtgärda dem?
16. Tillfrågas DC-personalen kring sina önskemål när utvecklingen av produkter/förpackningar sker? Om detta sker, för nya och/eller redesignade produkter/förpackningar?
17. Är det något som ni ser här att produkt/förpackningsutvecklarna ofta missar? Direkta brister? Fara för personal, skada, kostnader etc.?
18. Vilka aktiviteter anser ni är mest kritiska ur ett kostnadsperspektiv? Rangordning av dessa?
19. Vilka aktiviteter anser ni är mest kritiska ur ett tidsperspektiv? Rangordning av dessa?
20. Vilka aktiviteter anser ni är mest kritiska ur ett kvalitetsperspektiv (om vi definierar kvalitet som rätt leverans i rätt tid i rätt kvantitet i rätt skick)? Rangordning av dessa?
21. Hur fungerar informationsflödet internt inom DC? Några problem/förbättringspotential?
22. Hur fungerar informationsflödet med externa parter? Några problem/förbättringspotential?
23. Om personalen upptäcker fel eller förbättringspotential, hur förs denna informationen vidare?
24. Har det någonsin skett en omkonstruktion av en produkt/förpackning efter era synpunkter? I så fall exempel?
25. Vilka aktiviteter ur ert perspektiv är mest viktiga för att underlätta arbetet och effektivisera arbetet på DC?

26. Vilka faktorer inom förpackningssystemet anser ni är viktigast? Rangordning av dessa.
Exempel ges nedan:
- Stapelbarhet
 - Hanterbarhet
 - Volymeffektivitet
 - Information på och ang. förpackningssystemet
 - Vikteffektivitet
 - Tyngdpunktspacering
 - Kvantiteterna i förpackningssystemet (uppdelning och omlastning av gods)
 - Produktskydd
 - Klimatpåverkan
 - Övriga faktorer
27. Hur ser den optimala produkt/förpackningskombinationen ut enligt dig?
28. När redesigns skett på produkter, brukar ni se märkbara förändringar?
29. Hanteras sekundärförpackningarna någon gång utan hjälpmedel? Bör hänsyn tas till om det både är män och kvinnor som lyfter?
30. Upplever ni det som stressigt på jobbet? Borde mer fokus läggas på hanterbarheten av förpackningarna?
31. Nyckelaktiviteter vid ankommande gods, lagring, och avgående gods? Finns det något som kan bli bättre?
32. Vilka upplever ni är den mest förekommande godsskadorna? Vad beror dessa på?
33. Går det bra om vi återkommer med kompletterande frågor?

Interview II

Inledande frågor:

- Ditt namn?
- Din befattning?
- Vad innebär befattningen?
- Går det bra att vi spelar in intervjun och dokumenterar våra observationer med hjälp av en kamera?

DC-relaterade frågor:

- Hur ser en kartläggning av aktiviteterna ut som nya Glimma genomgår inom ett DC?
- Hur skiljer sig detta flöde skiljer från gamla Glimma?
- Hur ser förpackningssystemet ut för gamla resp. nya Glimma?
- Vilka fördelar respektive nackdelar ser du med gamla och nya Glimma?
- Vilken hanteringsutrustning används allmänt inom ett DC respektive Glimma?
- Vilka aktiviteter förekommer generellt i detta DC?
- Skiljer sig dessa från andra DC:s aktiviteter? Hur?
- Vilka olika lagringstyper förekommer här?
- Förekommer det andra lagringstyper på andra DC?
- Är hanteringsutrustning och lagringssystem anpassade till enhetsmodulen (600x400, halvpall)?
- Vilka typer av lastbärare används här? Vilka för och nackdelar ser ni med dessa?
- Används andra typer av lastbärare på andra DC:s?
- När ett gods ska delas, vilka faktorer är viktiga att tänka på?
- Om det existerar några flaskhalsar inom hela Supply Chain, var tycker ni att de finns?
- Om det existerar några flaskhalsar inom ett DC, var tycker ni att de finns? Hur anser ni att man skulle kunna åtgärda dem?

16. Är det något som ni ser här att produkt/förpackningsutvecklarna ofta missar? Direkta brister? Fara för personal, skada, kostnader etc.?
17. Vilka aktiviteter anser ni är mest kritiska ur ett kostnadsperspektiv? Rangordning av dessa?
18. Vilka aktiviteter anser ni är mest kritiska ur ett tidsperspektiv? Rangordning av dessa?
19. Vilka aktiviteter ur ert perspektiv är mest viktiga för att underlätta arbetet och effektivisera arbetet på DC?
20. Diskussion kring faktorerna nedan:
 - a. Stapelbarhet
 - b. Hanterbarhet
 - c. Volymeffektivitet
 - d. Information på och ang. förpackningssystemet
 - e. Vikteffektivitet
 - f. Tyngdpunktspacering
 - g. Kvantiteterna i förpackningssystemet (uppdelning och omlastning av gods)
 - h. Produktskydd
 - i. Klimatpåverkan
 - j. Övriga faktorer
21. Vilka upplever ni är den mest förekommande godsskadorna? Vad beror dessa på?
22. Går det bra om vi återkommer med kompletterande frågor?

Appendix A:V Interview guide – Retail outlet

Inledande frågor:

1. Ditt namn?
2. Din befattning?
3. Vad innebär befattningen?
4. Går det bra att vi spelar in intervjun och dokumenterar våra observationer med hjälp av en kamera?

Varuhus -relaterade frågor:

1. Hur ser en kartläggning av aktiviteterna som en produkt genomgår från ankomst till försäljning på varuhuset? Finns det en färdig processkarta?
2. Vilka är de kritiska faktorerna vid varje aktivitet? (Exempelvis när, var och hur sker upppackningen, vad är viktigast, att det går snabbt, lite förpackningsmaterial, hjälpmedel etc?)
3. Ser det generellt ut så på alla IKEA:s varuhus?
4. Vilka aktiviteter genomgår gamla respektive nya Glimma?
5. Effekter av byte från gamla till nya Glimma?
6. För- och nackdelar mellan gamla och nya Glimma?
7. Hur ser förpackningssystemet ut för gamla respektive nya Glimma?
8. Vilken hanteringsutrustning används generellt vid ett varuhus? Vilken används för Glimma?
9. Vilka olika förvaringstyper förekommer på ett varuhus? Hur förvaras Glimma?
10. Ser det generellt ut så på alla IKEA:s varuhus?
11. Är hanteringsutrustning och lagringssystem anpassade till enhetsmodulen (600x400)?
12. Vilka olika typer av lastbärare används här? Vilka för- och nackdelar ser ni med dessa?
13. Används andra typer av lastbärare på andra varuhus?
14. Om det existerar några flaskhalsar inom hela Supply Chain, var tycker ni att de finns?
15. Om det existerar några flaskhalsar inom ett varuhus, var tycker ni att de finns? Hur anser ni att man skulle kunna åtgärda dem?
16. Är det något som ni ser här att produkt/förpackningsutvecklarna ofta missar? Direkta brister, fara för personal, skada, kostnader etc.?
17. Vilka aktiviteter anser ni är mest kritiska ur ett kostnadsperspektiv? Rangordning av dessa?
18. Vilka aktiviteter anser ni är mest kritiska ur ett tidsperspektiv? Rangordning av dessa?
19. Vilka aktiviteter ur ert perspektiv är mest viktiga för att underlätta arbetet och effektivisera arbetet på ett varuhus?
20. Allmän diskussion kring faktorerna nedan:
 - Stapelbarhet
 - Hanterbarhet
 - Volymeffektivitet
 - Information på och ang. förpackningssystemet
 - Vikteffektivitet
 - Tyngdpunktsplacering
 - Kvantiteterna i förpackningssystemet (uppdelning och omlastning av gods)
 - Produktskydd
 - Klimatpåverkan
 - Övriga faktorer

21. Vilka upplever ni är den mest förekommande godsskadorna?
22. Går det bra om vi återkommer med eventuella kompletterande frågor?

Appendix B - Packaging Scorecard definitions

Appendix B presents the Packaging Scorecard definitions that were sent out together with the Packaging Scorecards containing suggestions of factors that could be included in the IKEA version of the Packaging Scorecard.

PACKAGING SCORECARD DEFINITIONER - LEVERANTÖR

Packningsprocess

Effektiv resning av förpackningen

För att få en så effektiv resning av förpackningen som möjligt gäller det att förpackningslösningen är anpassad till de förutsättningar som finns på den existerande packlinan, manuell som automatisk. Exempelvis är långa och låga sidor på en förpackning svåra att vika både manuellt och automatiskt.

Effektiv fyllning av förpackningen

För att få en så effektiv fyllning av förpackningen som möjligt gäller det att förpackningslösningen är anpassad till de förutsättningar som finns på den existerande packlinan, manuell som automatisk. Exempelvis ska man vid en automatisk packlina undvika att packa smådetaljer, som små påsar med skruvar, eftersom dessa är svårt att plocka för robotarna.

Effektiv förslutning av förpackningen

För att få en så effektiv förslutning av förpackningen som möjligt gäller det att förpackningslösningen är anpassad till de förutsättningar som finns på den existerande packlinan, manuell som automatisk. Exempelvis ska man vid en manuell packlina undvika att tejpa för mycket eftersom detta sliter på handlederna hos de anställda.

Förpackningens stabilitet

Vid all hantering vid packlinan, manuell som automatisk, så är det viktigt att förpackningen är stabil så att hanteringen blir effektiv. Detta kan exempelvis gälla vid pallläggningen där stabiliteten är viktigt både för roboten och den anställde som hanterar staplingen.

Ergonomiska krav (manuell packlina)

Förpackningar som hanteras manuellt bör vara anpassade till ergonomiska krav för att möjliggöra hög effektivitet och samtidigt minimera risken för arbetsskador hos personalen. Vid en manuell packlina innebär detta att ergonomisk hänsyn måste tas till faktorerna ovan vid utformningen av förpackningssystemet.

Produktskydd

Förpackningens skyddande egenskaper

Förpackningens förmåga att i olika miljöer skydda produkten från mekaniska, klimatrelaterade, kemiska eller elektrotekniska påfrestningar.

Inget överhäng

Inom en lastpalls eller annan lastbärarens area är produkterna relativt väl skyddade, men om det finns överhäng i någon riktning ökar risken att produkterna/förpackningarna skadas mot varandra vid hantering. Om överhäng förekommer kan detta även inverka negativt på volymutnyttjande/fyllnadsgrad.

Förebygga stöld och manipulation

Om möjligt ska en förpackning ha egenskaper som skyddar produkten mot stöld eller manipulation.

Minimera tomrum i förpackningen / Fixering av produkten i förpackningen

Tomrum inuti en förpackning ger produkten möjlighet att röra sig, vilket gör att risken för produkt- och förpackningsskador ökar. Om tyngdpunkten flyttas kan förpackningen utsättas för påfrestningar som den kanske inte klarar av.

Förpackningens stabilitet

Ett stabilt förpackningssystem kan minimera risken att skador uppkommer vid hantering. Förpackningssystemet bör även vara utvecklat så att det klarar lagring under längre perioder utan att dess egenskaper försämras nämnvärt.

Volym- och vikteffektivitet

Lageranpassning

Om enhetslasterna (pall + last) är maximerade med avseende på mått, vikt etc. till de lagertyper (djupstapling etc.) som finns att tillgå hos leverantören, medför detta att en bra volymeffektivitet/fyllnadsgrad kan uppnås.

Hanterbarhet

Stapelbarhet

För att kunna genomföra en effektiv lastning kan stapelbarhet vara önskvärt ur ett hanterbarhetsperspektiv, exempelvis kan två pallar lastas samtidigt med en truck. Stapelbarhet kan även vara eftersträvarvärt vid olika typer av lagring.

Ergonomiska krav

Förpackningar som hanteras manuellt bör vara anpassade till ergonomiska krav för att möjliggöra hög effektivitet och samtidigt minimera risken för arbetsskador hos personalen. Hos leverantören gäller detta ur hanterbarhetsperspektiv främst vid lastning, exempelvis när de toppfyller transporten (undantag vid manuell packlina som behandlas ovan).

Förpackningens stabilitet

Ett stabilt förpackningssystem kräver mindre ansträngning att hanteras på ett säkert sätt och minimerar även risken för hanteringsrelaterade skador.

PACKAGING SCORECARD DEFINITIONER - TRANSPORT

Produktskydd

Förpackningens skyddande egenskaper

Förpackningens förmåga att i olika miljöer skydda produkten från mekaniska, klimatrelaterade, kemiska eller elektrotekniska påfrestningar.

Inget överhäng

Inom en lastpalls eller annan lastbärarens area är produkterna relativt väl skyddade, men om det finns överhäng i någon riktning ökar risken att produkterna/förpackningarna skadas mot varandra vid hantering. Om överhäng förekommer kan detta även inverka negativt på volymutnyttjande/fyllnadsgrad.

Förebygga stöld och manipulation

Om möjligt ska en förpackning ha egenskaper som skyddar produkten mot stöld eller manipulation.

Minimera tomrum i förpackningen / Fixering av produkten i förpackningen

Tomrum inuti en förpackning ger produkten möjlighet att röra sig, vilket gör att risken för produkt- och förpackningsskador ökar. Om tyngdpunkten flyttas kan förpackningen utsättas för påfrestningar som den kanske inte klarar av.

Minimera tomrum i transportutrymmet

När det finns tomrum mellan gods i ett transportutrymme, t.ex. när pallarna har underhäng, stöds inte godset av annat närliggande gods. Detta gör det möjligt för godset att röra på sig på pallan under transport, vilket i sin tur kan medföra att förpackningar går sönder och att en hel pall, eller stapel av pallar, kollapsar.

Information på förpackningen – Pallvikt

Information om pallvikt kan anges på förpackningen för att undvika dålig stapling, exempelvis stapling av en tung pall ovanpå en lättare pall. Informationen är också fördelaktig för truckförarna när de hanterar pallan.

Information på förpackningen – Pallorientering

Information om hur pallarna ska orienteras kan vara bra både för de som lastar containrar, trailers etc. för att undvika godsskador, men också bra för truckförarna när de hanterar pallarna. Förpackningssystemet är utformat för att vara orienterat på ett bestämt sätt och får exempelvis inte vändas uppochner även om detta skulle vara enklare för lastande personal.

Information på förpackningen – Pallinnehåll

Det kan vara bra för bland andra truckföraren att veta vad innehållet i en pall är så att hantering kan anpassas därefter. Varor av glas har exempelvis andra krav på varsamhet än varor av trä. Inom detta kriterium syftar vi till huvudsakligen för märkning av pallar med glas och speglar.

Förpackningens stabilitet

Ett stabilt förpackningssystem kan minimera risken att skador uppkommer vid hantering. Förpackningssystemet bör även vara utvecklat så att det klarar lagring under längre perioder utan att dess egenskaper försämras nämnvärt.

Volym- och vikteffektivitet

Minimera tomrum i transportutrymmet

För att uppnå ett bra volymutnyttjande, och därmed hålla transportkostnaderna nere, är det viktigt att minimera tomrum under transport.

Minimera tomrum i förpackningen

För att minimera transportkostnaderna är det viktigt att inte transportera onödig ”luft” och därför bör förpackningarna innehålla så lite tomrum som möjligt.

Stapelbarhet

För att uppnå bra volymutnyttjande under transport är det fördelaktigt att kunna stapla enhetslaster ovanpå varandra.

Rätt mängd och storlek

Anpassning av förpackningen till transportutrymmet

Det är önskvärt att förpackningssystemet som en enhet är anpassat i storlek till transportmedlet.

Hanterbarhet

Stapelbarhet

För att kunna genomföra en effektiv lastning och lossning kan stapelbarhet vara önskvärt ur ett hanterbarhetsperspektiv, exempelvis kan två pallar lastas samtidigt med en truck.

Förpackningens stabilitet

Ett stabilt förpackningssystem kräver mindre ansträngning att hanteras på ett säkert sätt och minimerar även risken för hanteringsrelaterade skador.

Ergonomiska krav

Förpackningar som hanteras manuellt bör vara anpassade till ergonomiska krav för att möjliggöra hög effektivitet och samtidigt minimera risken för arbetsskador hos personalen. Inom transportdelen gäller detta främst vid lastning och lossning, exempelvis vid toppfyllning.

Minimera hantering

All hantering kräver resurser men ger inget extra värde för kunden och bör därför minimeras. För transportdelen gäller detta främst vid lastning och lossning.

PACKAGING SCORECARD DEFINITIONER – DC

Produktskydd

Förpackningens skyddande egenskaper

Förpackningens förmåga att i olika miljöer skydda produkten från mekaniska, klimatrelaterade, kemiska eller elektrotekniska påfrestningar. I ett DC är exempelvis de mekaniska påfrestningarna stora under hantering och lagring.

Inget överhäng

Inom en lastpalls eller annan lastbärarens area är produkterna relativt väl skyddade, men om det finns överhäng i någon riktning ökar risken att produkterna/förpackningarna skadas mot varandra vid hantering. Att inte undvika överhäng är att föredra, men kan överhäng inte undvikas är det viktigast att hålla bredden (800 mm för EUR-pall) intakt.

Förebygga stöld och manipulation

Om möjligt ska en förpackning ha egenskaper som skyddar produkten mot stöld eller manipulation.

Minimera tomrum i förpackningen

Tomrum inuti en förpackning ger produkten möjlighet att röra sig, vilket gör att risken för produkt- och förpackningsskador ökar. Om förpackningens tyngdpunkt flyttas kan den utsättas för påfrestningar som den kanske inte klarar av.

Förpackningens stabilitet

Ett stabilt förpackningssystem kan minimera risken att skador uppkommer vid hantering. Förpackningssystemet bör även vara utvecklat så att det klarar lagring under längre perioder utan att dess egenskaper försämras nämnvärt.

Volym- och vikteffektivitet

Lageranpassning

Om enhetslasterna (pall + last) är maximerade med avseende på mått och vikt till de olika lagertyper (automatlager etc.) som finns att tillgå medför detta att en bra volymeffektivitet/fyllnadsgrad kan uppnås. En bra anpassning innebär bland annat att tomrum som kan uppstå i lagren vid överhäng kan minimeras.

Rätt mängd och storlek

Kvantiteten anpassad till varuhusens behov

Förpackningslösningen ska vara utformad så att det är enkelt att tillgodose varuhusens kvantitetsbehov. Ofta så är inte alla varuhus intresserade av att få in hela pallar med samma produkt. Detta ställer krav på att det finns multipack som motsvarar mängden de vill ha till varuhuset (undantag soffor etc. som kan beställas en och en). Anledningen är att man vill hantera så få förpackningar som möjligt för att tillgodose varuhusen med kvantiteterna de vill ha.

Modulanpassning när pallar mixas

Vid mixningen av pallar är det fördelaktigt om de enskilt förpackade produkterna och multipacken på något sätt är uppbyggda enligt ett enhetligt måttsystem (längd, bredd, höjd), ett sk. modulsystem. Detta gör att man med flera mindre förpackningar av olika storlekar ändå kan uppnå en bra fyllnadsgrad på den mixade pallen. Modulanpassade förpackningar gör det även enklare att skapa stabila enhetslaster, vilket i sin tur möjliggör dubbelstapling.

Hanterbarhet

Stapelbarhet

Förpackningens förmåga att klara av belastningar som uppstår när pallar staplas ovanpå varandra etc.

Förpackningens stabilitet

Ett stabilt förpackningssystem kräver mindre ansträngning att hanteras på ett säkert sätt och minimerar även risken för hanteringsrelaterade skador.

Ergonomiska krav

Förpackningar som hanteras manuellt bör vara anpassade till ergonomiska krav för att möjliggöra bra effektivitet och samtidigt minimera risken för arbetsskador hos personalen.

Minimera hantering i lager

Hantering i lager kräver resurser men ger inget extra värde för kunden och bör därför minimeras.

Plockbarhet

När pallar mixas är det viktigt att förpackningarna som plockas/hanteras enkelt kan hanteras och staplas för att få en så effektiv plockprocess som möjligt.

PACKAGING SCORECARD DEFINITIONER - VARUHUS

Produktskydd

Förpackningens skyddande egenskaper

Förpackningens förmåga att i olika miljöer skydda produkten från mekaniska, klimatrelaterade, kemiska eller elektrotekniska påfrestningar.

Inget överhäng

Inom en lastpalls eller annan lastbärarens area är produkterna relativt väl skyddade, men om det finns överhäng i någon riktning ökar risken att produkterna/förpackningarna skadas mot varandra vid hantering.

Förebygga stöld och manipulation

Om möjligt ska en förpackning ha egenskaper som skyddar produkten mot stöld eller manipulation.

Minimera tomrum i förpackningen

Tomrum inuti en förpackning ger produkten möjlighet att röra sig, vilket gör att risken för produkt- och förpackningsskador ökar. Om förpackningens tyngdpunkt flyttas kan den utsättas för påfrestningar som den kanske inte klarar av.

Information på förpackningen – Pallvikt

Information om pallvikt kan anges på förpackningen för att undvika dålig stapling, exempelvis stapling av en tung pall ovanpå en lättare pall. Informationen är också fördelaktig för truckförarna när de hanterar pallen.

Information på förpackningen – Pallorientering

Information om hur pallarna ska orienteras kan vara bra både för de som lastar containrar, trailers etc. för att undvika godsskador, men också bra för truckförarna när de hanterar pallarna. Förpackningssystemet är utformat för att vara orienterat på ett bestämt sätt och får exempelvis inte vändas uppochner även om detta skulle vara enklare för lastande personal.

Information på förpackningen – Pallinnehåll

Det kan vara bra för bland andra truckföraren att veta vad innehållet i en pall är så att hantering kan anpassas därefter. Varor av glas har exempelvis andra krav på varsamhet än varor av trä.

Förpackningens stabilitet

Ett stabilt förpackningssystem kan minimera risken att skador uppkommer vid hantering. Förpackningssystemet bör även vara utvecklat så att det klarar lagring under längre perioder utan att dess egenskaper försämras nämnvärt.

Volym- och vikteffektivitet

Lageranpassning

Om enhetslasterna (pall + last) är maximerade med avseende på mått och vikt till de olika lagertyper (automatlager etc.) som finns att tillgå, medför detta att en bra volymeffektivitet/fyllnadsgrad kan uppnås. En bra anpassning innebär bland annat att tomrum som kan uppstå i lagren vid överhäng kan minimeras.

Rätt mängd och storlek

Kvantiteten anpassad till varuhusets behov

Förpackningslösningen ska vara utformad så att det är enkelt att tillgodose varuhusens kvantitetsbehov. Ofta så är inte alla varuhus intresserade av att få in hela pallar med samma produkt. Detta ställer krav på att det finns multipack som motsvarar mängden de vill ha till varuhuset (undantag soffor etc. som kan beställas en och en).

Förpackningen anpassad till displaymetod

Beroende av hur produkten ska displayas på varuhusens försäljningsområde så ställs olika krav på förpackningssystemet och detta måste tas hänsyn till under designprocessen. Exempelvis så skiljer sig kraven på kvantiteten i ett förpackningssystem och dess storlek när man placerar produkter på en halvpall direkt på golvet i jämförelse med när man placerar in ett tråg med produkter på ett hyllplan.

Hanterbarhet

Stapelbarhet

Förpackningens förmåga att klara av belastningar som uppstår när pallar staplas ovanpå varandra, exempelvis under lagring.

Förpackningens stabilitet

Ett stabilt förpackningssystem kräver mindre ansträngning att hanteras på ett säkert sätt och minimerar även risken för hanteringsrelaterade skador.

Ergonomiska krav

Förpackningar som hanteras manuellt bör vara anpassade till ergonomiska krav för att möjliggöra hög effektivitet och samtidigt minimera risken för arbetsskador hos personalen.

Minimera hantering i lager

Hantering i lager kräver resurser men ger inget extra värde för kunden och bör därför minimeras.

Minimera hantering i försäljningsområdet

Beroende på hur produkten ska displayas på försäljningsområdet, så bör förpackningssystemet vara designat så att all hantering relaterad till denna aktivitet är minimerad.

Minimera hantering av förbrukat förpackningsmaterial

Allt förpackningsrelaterat avfall från förpackningssystemet bör minimeras eftersom detta orsakar extra hantering. Den hantering som uppkommer bör göras så effektiv som möjligt, exempelvis genom att göra wellpapplådor enkla att vika och bära med sig.



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Appendix C - Packaging and Product Development Process Checklist

This checklist is proposed to be used by the employees at IKEA of Sweden during the packaging and product development process in order to support the logistical aspects that should be taken into account.

When developing a packaged product, what the customer desires must be kept in mind. Other aspects besides the product specifications themselves influence how attractive the product is to potential customers, and it is essential to consider these aspects. The packaging can be one mean of achieving what the customer values except for what the product itself can provide.

The packaging related matters presented in the checklist below are essential to consider during the product and packaging development process in order to achieve the goals of efficiency throughout the Supply Chain and low cost to the customer. In the Packaging Scorecard, consequences of the factors in each separate part of the Supply Chain have been considered, but in the checklist what is considered is their effect on the entire Supply Chain as a whole.

The ideal case, and also what is to be strived towards during the product and packaging development process, is for the packaging system to earn a positive answer to every question. If any factor is not fulfilled and thereby receives a negative answer, an evaluation should be made as to whether or not a redesign is necessary and possible.

If all factors in the checklist cannot be fulfilled, they have to be weighed against each other from case to case in order to achieve the best possible overall solution. What to prioritize is dependant on the product in question.

Packing process

- | | Yes | No |
|---|--------------------------|--------------------------|
| ▪ <i>Efficient erection of packaging</i> | | |
| - Is the packing line able to erect the packaging construction efficiently? | <input type="checkbox"/> | <input type="checkbox"/> |
| - Is the packaging material and its quality suitable for the erection process in question? | <input type="checkbox"/> | <input type="checkbox"/> |
| ▪ <i>Efficient filling of packaging</i> | | |
| - Is the packing pattern suitable for the prerequisites of the supplier (number of robots/employees, number of filling activities etc.)? | <input type="checkbox"/> | <input type="checkbox"/> |
| - Specifically for an automated line: If small details are supposed to be packed, are they pickable by the robots or can they be pre-packed in order to facilitate the filling process? | <input type="checkbox"/> | <input type="checkbox"/> |
| ▪ <i>Efficient sealing of packaging</i> | | |
| - Is the sealing method applicable at the supplier? | | |
| - Is the packing line able to seal the packaging efficiently considering packaging construction, material and its quality? | <input type="checkbox"/> | <input type="checkbox"/> |
| ▪ <i>Packaging stability</i> | | |
| - Is the packaging stable enough to function efficiently in the packing line? | <input type="checkbox"/> | <input type="checkbox"/> |
| ▪ <i>Specifically for a manual packing line:</i> | | |
| - Can erection, filling and sealing of the packaging be done in an ergonomically sound manner? | <input type="checkbox"/> | <input type="checkbox"/> |

Product protection

- | | | |
|---|--------------------------|--------------------------|
| ▪ <i>Protective properties of packaging</i> | | |
| - Is the packaged product protected from the stresses occurring during transport, handling and storing? | <input type="checkbox"/> | <input type="checkbox"/> |
| ▪ <i>No overhang</i> | | |
| - Has pallet overhang been avoided? | <input type="checkbox"/> | <input type="checkbox"/> |
| - If not, has pallet overhang been avoided on the longer sides and the 800 mm pallet dimension thereby not been exceeded? | <input type="checkbox"/> | <input type="checkbox"/> |



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- | | Yes | No |
|---|--------------------------|--------------------------|
| - If pallet overhang cannot be avoided, has measures been taken to reinforce exposed areas? | <input type="checkbox"/> | <input type="checkbox"/> |
| ▪ <i>Prevention of theft and manipulation</i> | | |
| - Does the packaging prevent the possibility of putting other objects in it, for example by having little empty space? | <input type="checkbox"/> | <input type="checkbox"/> |
| ▪ <i>Minimize empty space in packaging / Fixation of product within packaging</i> | | |
| - Has empty space in the packaging that can affect packaging stability been avoided? | <input type="checkbox"/> | <input type="checkbox"/> |
| - Are the product and loose parts that, if set in motion, might damage the product or the packaging fixated? | <input type="checkbox"/> | <input type="checkbox"/> |
| ▪ <i>Minimize empty space in means of transportation</i> | | |
| - Has empty space between pallets in the transport compartment, that might give rise to damage during transportation, been avoided by the shape/dimensions of the packaging system? | <input type="checkbox"/> | <input type="checkbox"/> |
| - If no, is the packaging solution stable enough to take the mechanical stresses that empty space might expose it to during transportation both from a single pallet and a double stacked pallet perspective? | <input type="checkbox"/> | <input type="checkbox"/> |
| - If top loading is supposed to take place during transportation, has consideration been taken to this from a product protection perspective? | <input type="checkbox"/> | <input type="checkbox"/> |
| ▪ <i>Packaging stability</i> | | |
| - Is the packaged product able to take the static strains that it is exposed to during storing? | <input type="checkbox"/> | <input type="checkbox"/> |
| - Is the packaged product able to take the mechanical stresses that it is exposed to during handling? | <input type="checkbox"/> | <input type="checkbox"/> |
| - Is the packaged product able to take the strains that it is exposed to during transportation? | <input type="checkbox"/> | <input type="checkbox"/> |

Volume efficiency

- *Stackability*
 - Can pallets be stacked on top of each other in order to enable good volume utilization during transportation?



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- *Storage adaptation*

	Yes	No
- Is the packaging solution adapted in size, as far as it is possible, to the storage facilities that it will pass along the Supply Chain?	<input type="checkbox"/>	<input type="checkbox"/>

- *Minimize empty space in means of transportation*

- Is the packaging solution adapted in size, as far as it is possible, to the means of transportation that will be used?	<input type="checkbox"/>	<input type="checkbox"/>
- If top loading is supposed to take place during transportation, has consideration been taken to this from a volume efficiency perspective?	<input type="checkbox"/>	<input type="checkbox"/>

- *Minimize empty space in packaging*

- Is empty space in the packaging minimized as far as possible, thereby making room for more products on every pallet, without giving rise to unstable underhang pallets?	<input type="checkbox"/>	<input type="checkbox"/>
- Is empty space in the packaging minimized as far as possible without creating an underhang that can jeopardize stability of double stacked pallets during movement or storing?	<input type="checkbox"/>	<input type="checkbox"/>

Right amount and size

- *Packaging adapted to means of transport*

- Is the packaging solution adapted to the limiting measurements of the transport compartment?	<input type="checkbox"/>	<input type="checkbox"/>
--	--------------------------	--------------------------

- *Quantity adapted to needs of retail*

- Has a weighting been done between the effects of adapting the quantity of a multi-pack to the needs of retail and the extra handling that it might give rise to when picking?	<input type="checkbox"/>	<input type="checkbox"/>
- Is the quantity of the packaging solution adapted to the expected product turnover and thereby minimizes sales area handling?	<input type="checkbox"/>	<input type="checkbox"/>

- *Packaging adapted to display mode*

- Does the packaging solution support the display mode that is supposed to be used at the sales area from a volume/area efficiency and handling perspective?	<input type="checkbox"/>	<input type="checkbox"/>
--	--------------------------	--------------------------

Handleability

- | | Yes | No |
|--|--------------------------|--------------------------|
| ▪ <i>Stackability</i> | | |
| - Does the packaging solution allow pallets to be handled double stacked? | <input type="checkbox"/> | <input type="checkbox"/> |
| ▪ <i>Packaging stability</i> | | |
| - Are all packaging levels stable enough to be handled efficiently, separately as well as a unit, throughout the IKEA Supply Chain? | <input type="checkbox"/> | <input type="checkbox"/> |
| ▪ <i>Ergonomical demands</i> | | |
| - When manual handling occurs, is it possible to handle the different packaging levels separately in an ergonomically sound manner? | <input type="checkbox"/> | <input type="checkbox"/> |
| ▪ <i>Minimize handling</i> | | |
| - Has the packaging solution been adapted to handling requirements at the different storage facilities along the IKEA Supply Chain in order to minimize the handling needed? | <input type="checkbox"/> | <input type="checkbox"/> |
| - Has the packaging solution been adapted to sales area handling requirements for the product in question in order to minimize the handling needed? | <input type="checkbox"/> | <input type="checkbox"/> |
| - Has the packaging solution been designed in order to minimize the waste handling needed at the Retail Outlet? | <input type="checkbox"/> | <input type="checkbox"/> |
| - Has the packaging solution been adapted to loading and unloading requirements in order to minimize the handling needed? | <input type="checkbox"/> | <input type="checkbox"/> |
| - If the packaged product in question will be top-loaded, has the packaging solution been adapted to handling requirements of top-loaded goods in order to minimize the handling needed? | <input type="checkbox"/> | <input type="checkbox"/> |

Factors important for specific product types

- | | | |
|---|--------------------------|--------------------------|
| ▪ <i>Packaging information</i> | | |
| - Have fragile packaged products been marked with symbols or has the packaging system been adjusted to show the characteristics of the fragile product? | <input type="checkbox"/> | <input type="checkbox"/> |
| - Have packaged products with special requirements regarding orientation been marked illustrating the appropriate orientation? | <input type="checkbox"/> | <input type="checkbox"/> |



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Appendix D – The IKEA Packaging Scorecard

The IKEA Packaging Scorecard is a systematic analysis method that has been developed in order to evaluate the supply chain contributions of different packaging systems. The aim of the method is to improve packaging systems regarding their supply chain performance.

The Packaging Scorecard method

An efficient packaging system is a catalyst to fulfil the supply chain efficiency. The Packaging Scorecard is a systematic analysis method that evaluates how packaging performs in the supply chain. The method has three advantages:

- It provides and describes significant packaging related demands in the studied supply chain
- It can be used to enhance the logistical performance of the packaging system
- It provides important information regarding the prerequisites of the studied supply chain and creates opportunities for better logistical supply chain efficiency

Creation of the IKEA Packaging Scorecard

Packaging related demands (criteria) from each part of the IKEA supply chain (Supplier, Transport, Distribution Centre and Retail Outlet) were first collected during interviews and observations. The criteria found were placed in separate scorecards corresponding to each part of the studied supply chain. These scorecards were after that sent out to adequate personnel at each part of the IKEA supply chain, where they weighted the demands corresponding to their relevance at each specific part of the supply chain. The weight ranged between 0 and 100 where 0 indicated irrelevance and the importance of the criteria increased as the weight increased. From the collected weightings the IKEA Packaging Scorecard was created. In order to show each criteria's importance relative the other criteria in the Packaging Scorecards, a normalization of the weights was done by dividing each separate weight with the added weight of all criteria.

Table D.1 illustrates an example of a Packaging Scorecard for a supplier and shows the most significant packaging related criteria to consider from a suppliers perspective. The corresponding weightings in the table symbolize the importance of the criteria, with weightings ranging from 0-100% of importance. These weightings are according to the method provided by different contact persons operating at the specific part of the supply chain that the Packaging Scorecard is supposed to represent. After the weightings are provided, the weighted criteria are normalized as follows; the weighted criteria are summed in total and each weighted criterion is then divided by the total. This gives the normalized weight which represents the relative significance of each criterion.

How to use the IKEA Packaging Scorecard

The method is used in the following manner: A packaging solution is evaluated by receiving a score from 0 and 4 (0=criterion not applicable for the packaging, 1=not approved, 2=approved, 3=well approved, 4=requirements fulfilled excellently), depending on how well it fulfils the different criteria. The next step is multiplying each score with the corresponding normalized weight. An example is shown below in Table 3.2. The weighted average score is calculated as follows: $0,083 \times 2 + 0,083 \times 1 + 0,111 \times 3 + 0,139 \times 3 + 0,194 \times 4 + 0,194 \times 4 + 0,194 \times 2 = 2,94$. This weighted average packaging score gives an indication of how well the packaging is performing in the separate parts of the supply chain. The resulting weighted



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average scores from the different parts of the supply chain are then added and give together the total packaging score for a packaging solution.

CRITERIA	WEIGHT	NORMALIZED WEIGHT	SCORE
Flow information	30	8,3%	2
Other value-adding properties	30	8,3%	1
Volume and weight efficiency	40	11,1%	3
Right amount and size	50	13,9%	3
Machinability	70	19,4%	4
Product protection	70	19,4%	4
Packaging costs	70	19,4%	2
Weighted average packaging score			2,94

Table D.1. Example of a Packaging Scorecard for a supplier (Dominic C. & Olsmats C. (2001) Packaging Scorecard - A method to evaluate packaging contribution in the supply chain. Report no 200. Packforsk. Kista. Table 5-1. p 24).

The aim with the Packaging Scorecard method is to provide a better overview and understanding of the packaging system performance throughout the supply chain. This can be done in two ways. The first way to make use of the results is to identify the most important aspects to consider at a stage in the supply chain, in Table D.1 the most critical aspects are for example *Machinability*, *Product protection* and *Packaging costs*. The Packaging Scorecard implies that effort should be taken to reduce the *Packaging costs* and that *Other value-adding properties* leaves room for improvement. But since *Other value-adding properties* has a rather low weight this aspect is not as critical to improve as *Packaging costs*. The second way to use the results is to use the total supply chain packaging score to compare the performance of different packaging solutions in order to decide the most efficient solution from a whole supply chain perspective or to trace and evaluate the consequences of a change in the packaging solution from a whole supply chain perspective. An example of this can be that a product has a certain packaging solution that scores a total weighted average score of 12,34 (2,61 at the supplier, 2,02 during transport, 3,01 at the DC, 2,19 at the retailer and 2,51 by the consumer). A small change in the packaging solution to improve the packaging performance during transport gives raise to other scores at the rest of the parts of the supply chain and the total weighted average score for the packaging shifts to 11,91 (2,09 at the supplier, 3,23 during transport, 2,21 at the DC, 2,06 at the retailer and 2,32 by the consumer). This implies that the change that improves the performance at one stage of the supply chain in the total have a negative effect from a whole supply chain perspective. By using the Packaging Scorecard these negative changes can be discovered and avoided.



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The IKEA Supplier Packaging Scorecard – automatic packing line

Product
Packaging version
Date
Packaging Technician

CRITERIA AUTOMATIC PACKING LINE	WEIGHT	NORM. WEIGHT	SCORE
Packing process			
Efficient erection of packaging	100	0,119	
Efficient filling of packaging	100	0,119	
Efficient sealing of packaging	100	0,119	
Packaging stability	85	0,101	
Product protection			
Protective properties of packaging	60	0,071	
No overhang	75	0,089	
Minimize empty space in packaging / Fixation of the product within packaging	50	0,060	
Packaging stability	70	0,083	
Volume efficiency			
Storage adaptation	60	0,071	
Handleability			
Stackability	60	0,071	
Ergonomical demands*	-		
Packaging stability	80	0,095	
WEIGHTED AVERAGE PACKAGING SCORE			
* Weight depends on supplier			



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The IKEA Supplier Packaging Scorecard – manual packing line

Product
Packaging version
Date
Packaging Technician

CRITERIA MANUAL PACKING LINE	WEIGHT	NORM. WEIGHT	SCORE
Packing process			
Efficient erection of packaging	85	0,098	
Efficient filling of packaging	75	0,086	
Efficient sealing of packaging	75	0,086	
Packaging stability	80	0,092	
Ergonomical demands	100	0,115	
Product protection			
Protective properties of packaging	60	0,069	
No overhang	75	0,086	
Minimize empty space in packaging / Fixation of the product within packaging	50	0,057	
Packaging stability	70	0,080	
Volume efficiency			
Storage adaptation	60	0,069	
Handleability			
Stackability	60	0,069	
Ergonomical demands*	-		
Packaging stability	80	0,092	
WEIGHTED AVERAGE PACKAGING SCORE			
* Weight depends on supplier			



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The IKEA Transport Packaging Scorecard

Product
Packaging version
Date
Packaging Technician

CRITERIA	WEIGHT	NORM. WEIGHT	SCORE
Product protection			
Protective properties of packaging	100	0,089	
No overhang	80	0,071	
Minimize empty space in packaging / Fixation of the product within packaging	100	0,089	
Minimize empty space in means of transportation	50	0,045	
Packaging stability	100	0,089	
Volume efficiency			
Minimize empty space in means of transportation	100	0,089	
Minimize empty space in packaging	80	0,071	
Stackability	100	0,089	
Right amount and size			
Packaging adapted to means of transport	100	0,089	
Handleability			
Stackability	90	0,080	
Packaging stability	100	0,089	
Ergonomical demands	60	0,054	
Minimize handling	60	0,054	
WEIGHTED AVERAGE PACKAGING SCORE			



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The IKEA Distribution Centre Packaging Scorecard

Product
Packaging version
Date
Packaging Technician

CRITERIA	WEIGHT	NORM. WEIGHT	SCORE
Product protection			
Protective properties of packaging	90	0,091	
No overhang	80	0,081	
Minimize empty space in packaging / Fixation of the product within packaging	90	0,091	
Packaging stability	100	0,102	
Volume efficiency			
Storage adaptation	80	0,081	
Right amount and size			
Module adaptation when mixing pallets	20	0,020	
Quantity adapted to needs of retail	70	0,071	
Handleability			
Stackability	95	0,096	
Packaging stability	100	0,102	
Ergonomical demands	80	0,081	
Minimize storage handling	100	0,102	
Picking ability	80	0,081	
WEIGHTED AVERAGE PACKAGING SCORE			



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The IKEA Retail Outlet Packaging Scorecard

Product
Packaging version
Date
Packaging Technician

CRITERIA	WEIGHT	NORM. WEIGHT	SCORE
Product protection			
Protective properties of packaging	80	0,065	
No overhang	100	0,082	
Prevention of theft and manipulation	60	0,049	
Minimize empty space in packaging / Fixation of the product within packaging	75	0,061	
Packaging stability	100	0,082	
Volume efficiency			
Storage adaptation	100	0,082	
Right amount and size			
Quantity adapted to needs of retail	100	0,082	
Packaging adapted to display mode	85	0,069	
Handleability			
Stackability	50	0,041	
Packaging stability	75	0,061	
Ergonomical demands	100	0,082	
Minimize storage handling	100	0,082	
Minimize sales area handling	100	0,082	
Minimize waste handling	100	0,082	
WEIGHTED AVERAGE PACKAGING SCORE			

The IKEA Supplier Packaging Scorecard

- definitions of demands

Packing process

Efficient erection of packaging

In order to achieve an efficient erection of the packaging, the packaging solution needs to be adapted to the prerequisites of the packing line in question for both manual and automated packing lines. For example, long and low sides of a packaging are hard to fold for both manual and automated packing lines.

Efficient filling of packaging

In order to achieve an efficient erection of the packaging, the packaging solution needs to be adapted to the prerequisites of the packing line in question for both manual and automated packing lines. Small details should for example be avoided if the packing line is automated since details are hard for robots to pick. The filling pattern should also not be too complex or include difficult activities when using an automated packing line since this might not be possible for a robot to achieve.

Efficient sealing of packaging

In order to achieve an efficient erection of the packaging, the packaging solution needs to be adapted to the prerequisites of the packing line in question for both manual and automated packing lines. For example, taping should be avoided since this is straining for the personnel at manual packing lines and complex sealing procedures should be avoided when using automated packing lines.

Packaging stability

For both manual and automated packing lines, it is important that the packagings are stable in order to achieve an efficient handling. For example, when handling the packaging in the packing line or putting the packagings on a pallet, packing stability is important both for a robot and a person.

Ergonomical demands (manual packing lines only)

Packagings that are handled manually should be adapted to ergonomic demands in order to achieve an efficiency as high as possible and at the same time minimize risk of work related injury among the personnel. For a manual packing line, this means that ergonomic aspects connected to the factors above need to be considered during the development process.

Product protection

Protective properties of packaging

Protective properties of packaging refers to the ability of the packaging to protect the product in different environments from mechanical, climate-related, chemical and electro technical stresses. Mechanical stresses are for example large during handling and when storing. Specific conditions at the suppliers should be considered and evaluated during the packaging development process.

No overhang

Within the outer boundaries of the pallet or load carrier, the products are quite safe, but if there is overhang in any direction the products are exposed to a greater risk of damages occurring.



IKEA of Sweden

Minimize empty space in packaging / Fixation of product within packaging

Empty space within the packaging gives the product room to move around, whereby the risk of product and packaging damages increases. If the centre of gravity shifts, the packaging is subjected to increased stresses that the packaging may not withstand.

Packaging stability

A stable packaging system could minimize the risk of damage occurring during handling. Packaging stability influences stackability and increases the ability of the packaging to withstand the strains put on it during handling and storing.

Volume efficiency

Storage adaptation

If the unit loads (pallet + goods) are maximized regarding dimensions and weight to the different types of storage facilities (automated storage facilities etc.) that exist, this can give good volume efficiency. Good adaptation means among other things that empty space that can arise in the storage facilities, caused by pallet overhang, can be minimized.

Handleability

Stackability

In order for loading to be efficient, stackability can be beneficial from a handleability perspective. For example, two pallets can be handled at once if they are stackable.

Ergonomical demands

Packagings that are handled manually should be adapted to ergonomical demands in order to enable good efficiency and at the same time minimize the risk of work related injury. This is important to consider when for example top loading.

Packaging stability

A stable packaging system requires less effort to be handled in a safe manner and stability also minimizes the risk of handling related damages to product and packaging.

The IKEA Transport Packaging Scorecard

- definitions of demands

Product protection

Protective properties of packaging

The ability of the packaging to protect the product in different environments from mechanical, climate-related, chemical and electro technical stresses. Mechanical stresses are for example large during handling and when storing.

No overhang

Within the outer boundaries of the pallet or load carrier, the products are quite safe, but if there is overhang in any direction the products are exposed to a greater risk of damages occurring.

Minimize empty space in packaging / Fixation of product within packaging

Empty space within the packaging gives the product room to move around, whereby the risk of product and packaging damages increases. If the centre of gravity shifts, the packaging is subjected to increased stresses that the packaging may not withstand.

Minimize empty space in means of transportation

When there is empty space between the goods in a transportation vehicle, e.g. when underhang exists, the goods are not supported by other goods. This makes it possible for the goods to shift during transportation, which in turn may have the effect that packaging brakes and the entire pallet, or stack of pallets, collapses.

Packaging stability

A stable packaging system could minimize the risk of damage occurring during transportation. Packaging stability influences stackability and increases the ability of the packaging to withstand the strains put on it during transportation.

Volume efficiency

Minimize empty space in means of transportation

To achieve the best possible cube utilization, and thereby lower transportation costs, it is important to minimize empty space during transportation.

Minimize empty space in packaging

The less empty space transported in packagings, the more products there are room for in total during transport. Thus, minimizing empty space in packagings can enable more products to be transported.

Stackability

In order to achieve good cube utilization during transportation, it is beneficial to be able to stack unit loads on top of each other. If pallets cannot be stacked, it would be possible to transport only one layer of pallets.



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Right amount and size

Packaging adapted to means of transport

The packaging system is to be adapted to meet the quantity demands throughout the supply chain. For example, the size and quantity of the packaging system should ease and make handling and distribution efficient by e.g. being unitized and by enabling a high coefficient of fullness in the means of transport.

Handleability

Stackability

In order for loading to be efficient, stackability can be beneficial from a handleability perspective. For example, two pallets can be handled at once if they are stackable.

Packaging stability

A stable packaging system requires less effort to be handled in a safe manner and stability also minimizes the risk of handling related damages to product and packaging.

Ergonomical demands

Packagings that are handled manually should be adapted to ergonomical demands in order to enable good efficiency and at the same time minimize the risk of work related injury. This is important to consider when for example top loading.

Minimize handling

All handling requires resources but adds no value to the customer and should therefore be minimized. Considering transport, this applies mainly during loading.

The IKEA Distribution Centre Packaging Scorecard

- definitions of demands

Product protection

Protective properties of packaging

The ability of the packaging to protect the product in different environments from mechanical, climate-related, chemical and electro technical stress. At a DC handling and storing activities are examples of sources of product and packaging damage.

No overhang

Within the outer boundaries of the pallet or load carrier, the products are quite safe, but if there is overhang in any direction the products are exposed to greater risk of bumping into object during handling that may cause packaging and/or product damage. The risk of objects such as trucks bumping into the goods is also greater.

Minimize empty space in packaging / Fixation of product within packaging

Empty space within the packaging gives the product room to move around, whereby the risk of product and packaging breaking will increase. If the centre of gravity shifts, the packaging is subjected to increased stresses that the packaging may not withstand.

Packaging stability

A stable packaging system could minimize the risk of damage occurring during handling. Packaging stability influences stackability and increases the ability of the packaging to withstand the strains put on it in a Distribution Centre.

Volume efficiency

Storage adaptation

If the unit loads (pallet + goods) are maximized regarding dimensions and weight to the different types of storage facilities (automated storage facilities etc.) that exist, this can give good volume efficiency. Good adaptation means among other things that empty space that can arise in the storage facilities, caused by pallet overhang, can be minimized.

Right amount and size

Module adaptation when mixing pallets

When mixing pallets, it is beneficial if the separate packaged products and multi-packs in some way have dimensions according to a uniform set of dimensions (length, width, height), a so called module system. This makes it possible to achieve good volume efficiency on the mixed pallet with several smaller packagings of different sizes. Module adapted packagings also make it easier to create stable unit loads, which in turn enables double stacking.

Quantity adapted to needs of retail

The packaging solution should be designed so that it is easy to accommodate the quantity needs of the Retail Outlets. All Retail Outlets are not interested in receiving entire pallets of the same product, which places demands on that multi-packs exist that correspond to the desired quantity (exceptions are sofas etc. that can be ordered separately). The reason is that it is desirable to handle as few packagings as possible but still give the Retail Outlets the quantity they need.

Handleability

Stackability

In order for loading and unloading to be efficient, stackability can be beneficial from a handleability perspective. For example, two pallets can be handled at once if they are stackable.

Packaging stability

A stable packaging system requires less effort to be handled in a safe manner and stability also minimizes the risk of handling related damages to product and packaging.

Ergonomical demands

Packaging handled manually should be adapted to ergonomical demands in order to facilitate good handling efficiency and to minimize risk of work related injury. This is important to consider when for example unloading top loaded products.

Minimize storage handling

Storage handling requires resources and is not value-adding, and should therefore be minimized. For example, a multi-pack should contain an appropriate number of products in order to minimize picking activities at a DC.

Pickability

When creating mixed pallets, it is important that the objects picked are easily handled and stacked in order to make the picking activities as efficient as possible. Picking requires resources and is not value-adding, whereby it should be minimized.

The IKEA Retail Outlet Packaging Scorecard

- definitions of demands

Product protection

Protective properties of packaging

The ability of the packaging to protect the product in different environments from mechanical, climate-related, chemical and electro technical stress. For example handling and storing expose goods to mechanical stresses.

No overhang

Within the outer boundaries of the pallet or load carrier, the products are quite safe, but if there is overhang in any direction the products are exposed to greater risk of bumping into object during handling that may cause packaging and/or product damage. The risk of objects such as trucks bumping into the goods is also greater.

Prevention of theft and manipulation

If possible, packaging design should have properties that protect from theft as well as any kind of product manipulation. For example, it is possible to put unwanted object into packaging's trough holes ("handles") made for facilitating handling.

Minimize empty space in packaging / Fixation of product within packaging

Empty space within the packaging gives the product room to move around, whereby the risk of product and packaging breaking will increase. If the centre of gravity shifts, the packaging is subjected to increased stresses that the packaging may not withstand.

Packaging stability

A stable packaging system could minimize the risk of damage occurring during handling. Packaging stability influences stackability and increases the ability of the packaging to withstand the strains put on it at a Retail Outlet.

Volume efficiency

Storage adaptation

If the unit loads (pallet + goods) are maximized regarding dimensions and weight to the different types of storage facilities (automated storage facilities etc.) that exist, this can give good volume efficiency. Good adaptation means among other things that empty space that can arise in the storage facilities, caused by pallet overhang, can be minimized.

Right amount and size

Quantity adapted to needs of retail

The packaging solution should be designed so that it is easy to accommodate the quantity needs of the Retail Outlets. All Retail Outlets are not interested in receiving entire pallets of the same product, which places demands on that multi-packs exist that correspond to the desired quantity (exceptions are sofas etc. that can be ordered separately).

Packaging adapted to display mode

The mode of display at the sales area places different demands on the packaging system, and this should be kept in mind in the design process. For example, the demands placed on the packaging system regarding quantities and size when displaying products on a half-pallet directly on the floor, or when displaying it in a tray in a display rack, are very different.

Handleability

Stackability

Stackability refers to the ability of a packaging system to withstand the stresses caused when stacking pallets etc. on top of each other. When for example storing in a retail outlet, stacking might occur, which makes it necessary for the packaging system to be able to withstand the corresponding stresses.

Packaging stability

A stable packaging system requires less effort to be handled in a safe manner and stability also minimizes the risk of handling related damages to product and packaging.

Ergonomical demands

Packaging handled manually should be adapted to ergonomical demands in order to facilitate good handling efficiency and to minimize risk of work related injury.

Minimize storage handling

Storage handling requires resources and is not value-adding, and should therefore be minimized. For example, easy placement in the self service storages is beneficial.

Minimize sales area handling

Depending on how the product is supposed to be displayed at the sales area, the packaging system should be designed to minimize handling related to this activity. For example, if the product is to be presented on a shelf the packaging should be easy to open and the product easy to display. Another example is to develop packagings that are easy to open.

Minimize waste handling

All waste generated from the packaging system should be minimized due to the extra handling that it requires. For example, when all products in a multi-pack are sold, there should be as little waste as possible and the waste that exists should consist of as few materials as possible, thus easing disposal.