Modular Packaging Development: Incorporating a modular perspective in the packaging design process

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Modular Packaging Development

Incorporating a modular perspective in the packaging design process

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Lund, September 2013

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Preface

This project was conducted at the Division of Packaging Logistics, Faculty of Engineering, Lund University in cooperation with Packaging Material Development at Ericsson. The study was conducted between April 2012 and September 2013.

Initially, I would like to especially thank Carina Lind, whose guidance has steered the rest of us right and kept us focused on the right things throughout the project. Thanks also for all of the numerous practical issues you have taken care of, Carina.

The project would never have been this successful if it were not for Birgitta Ekelund's expertise. Birgitta, you have truly been an asset. Thank you for our many constructive discussions, which have been both productive and enjoyable.

I would also like to thank Mats Lundgren who has taken care of all the internal issues at Ericsson and provided the project with valuable external contacts. I was always pleased to hear that you were coming to one of our workshops.

I would like to thank the entire department Packaging Material Development. In addition to the delight of working with such competent people, it has been a pleasure getting to know all of you. I have many dear memories from the time I spent at your office. I am truly thankful for these.

Finally, I want to mention Annika Olsson and Mats Johnsson who I am very grateful to have worked with. I sincerely value having you as colleagues and friends.

Lund, Beginning of September 2013

Abstract

Title Modular Packaging Development: Incorporating a modular perspective in the packaging design process

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Problem definition The packaging engineers at Ericsson work continuously to reduce packaging related costs but they have not yet taken modularity driven costs and savings into account. Therefore it is interesting to study how the existing theories concerning modularization need to be adjusted so that they can be applied to packaging design? Is modularity a factor to consider in this field or is it negligible?

Purpose The purpose of this study is to evaluate how suitable existing modularization theories are for use in packaging design. This report presents model that can be used in an existing packaging design process to predict the consequences related to modularization.

Methodology The first part of the project modularized an existing packaging assortment at Ericsson (Pick & Pack). By doing this the theories of modularization could be evaluated. The Modular Packaging Development-model that gradually developed was in the second part of the study generalized to be applicable not only to the Pick & Pack assortment or even Ericsson's other packages, but to industrial packaging departments in general that wish to raise the awareness of modularity in packaging design.

Conclusions The first part of the project produced a modularized assortment for the Pick & Pack-activity. This assortment was modular in regard to both the packaging components' compatibility and to the measurements, in order to maximize the fill rate. Several conclusions were drawn that were used when designing the packages such as the size of the smallest box, the pallet size used and the differentiation of size and material depending on the intended use. The second part of the project resulted

in an eight-step Modular Packaging Development-model to be used in the packaging design process for the design of packaging not only in the Pick & Pack-assortment. Several supporting matrixes and tables are used throughout the model. The model is general and can be used in a variety of situations where stakeholders are striving for packaging modularity.

Sammanfattning

Titel	Modular Packaging Development: Incorporating a modular perspective in the packaging design process
Författare	John Karlsson
Handledare	Universitetslektor Mats Johnsson, Avdelningen för förpackningslogistik, Lunds tekniska högskola, Lunds Universitet Professor Annika Olsson, Avdelningen för förpackningslogistik, Lunds tekniska högskola, Lunds Universitet
Problembeskrivning	Förpackningsteknikerna på Ericsson arbetar ständigt med att minska de förpackningsrelaterade kostnaderna, men har hittills inte tagit modularitetsrelaterade kostnader och besparingar i beaktande. Därför är det intressant att analysera på vilka sätt de existerande teorierna om modularisering kan anpassas så att de kan användas vid förpackningsdesign? Är modularitet över huvud taget en faktor att ta hänsyn till eller är den försumbar?
Syfte	Syftet med detta projekt är att analysera hur lämpligt det är att arbeta med modularitet vid förpackningsdesign. Detta projekt kommer att resultera i en modell som kan implementeras i en existerande designprocess för att kartlägga de modularitetsrelaterade konsekvenserna.
Metod	Den första delen av detta projekt är att modularisera ett existerande förpackningssortiment på Ericsson (Pick & Pack). Genom att göra detta kan de existerande modulariseringsteorierna testas. Den modulariseringsmetod som gradvis utarbetades under denna del av projektet generalliserades i projektets andra del så att den kan användas inte bara på Pick & Pack, eller på Ericsson, utan på alla förpackningsavdelningar som strävar efter en ökad medvetenhet om modularitet vid förpackningsdesign.
Slutsatser	Den första delen av studien resulterade i ett modulärt sortiment för Pick & Pack-verksamheten. Detta var modulärt, både med avseende på förpackningskomponenternas kompatibilitet och på måtten på de olika förpackningarna, för att maximera fyllnadsgraden. Flera slutsatser drogs och användes sedan vid förpackningsdesignen såsom storleken på den minsta lådan, vilken pallstorlek som skulle användas och differentiering

av storlekar och material beroende på vilket sätt förpacknigen var avsedd att användas. Den andra delen av projektet resulterade i en modell bestående av åtta steg för att användas i processen vid förpackningsdesign för förpackningar. Denna modell är applicerbar på alla förpackningstyper och inte bara inom Pick & Pack-sortimentet. Ett flertal stödmatriser och -tabeller används. Modellen är generell och kan användas för olika situationer när modularitet för förpackningar är eftertraktat.

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1 Introduction

1.1 Background

1.1.1 Modularity

Even though modularity is likely to have existed far longer, the term was first used widely in the early twentieth century. The first professionals to introduce a modularity perspective in their work were architects. Albert Farwell Bemis, the man who industrialized the design and building of houses and lay the cornerstone for what later became the method of prefabricating houses, also introduced the concept of modularity to the architectural community. However, it was not until the mid-twentieth century that the idea of modularity expanded and began to be included in other disciplines (Russell, 2012, p. 257 ff.).

Modularity is today a concept that is practiced in numerous fields. Examples are as diverse as evolutionary biology, product design, art, programming and industrial production. The focus of this research is on product design, more specifically on the packaging design process, an area in which modularity is not yet a customary element (Russell, 2012, p. 261 f.).

In a modular system different parts function together and are easily changed individually without the need to make alterations to the entire system because of established interfaces. This leads to a cost effective way to provide flexibility without the need for customization. Applied to packages, different modules can be combined in ways that fulfil a range of demands that would otherwise require numerous customized packages. The concept of modularization is further elaborated on in 2.1.

1.1.2 Problem discussion and objective

Since the effects of modularity are not usually considered in the design of packaging, this specific area is of great academic interest as well as potential practical implications. Several studies have been carried out on modularity in general. The purpose of this project was partly to evaluate how applicable the methodologies used in these studies are to packaging design. The established methodologies for modular product design were then adjusted to better fit the process of packaging design.

Previous research argues that there are great savings potentials in modularizing (Erixon, 1998, p. 56) (Schilling, 2000). Although several studies have been carried out on the topic, no has been found that involve packaging as the subject of modularization. Hence, the purpose of this project was to investigate the potential, if any, in modularizing the packaging area as well. The purpose was also to investigate the necessary differences in the modularization models when working with packages in contrast to other parts of industry. The concrete outcomes of this project are those presented in 1.2.1 and 1.2.2.

1.1.3 Company description

Ericsson was founded in 1876 by Lars Magnus Ericsson. Its core activity has varied significantly ever since. Ericsson was initially a telegraph repair shop that soon started to manufacture switches and telephones. Today Ericsson is the world's leading manufacturer of wireless telecommunication and network equipment and held 35% of global market share in 2012 (Ericsson, 2013).

In 2007, Ericsson found their packaging expenses to be an increasing part of the total cost. As a result, it launched the Packaging Material Management Project, financed by the supply organization, to improve the packaging activity and make it more cost effective. The project was successful and in 2009 was institutionalized in a new department: Packaging Material Development (PMD) (Lundgren, 2010, p. 2).

PMD is a corporate R&D function located in Kista, Sweden. Its role is both strategic and operational. Its responsibilities include coordinating the packaging design carried out locally on the sites, mapping the route for future packaging design and influencing the design of new products in matters that will have consequences for packaging. In addition to being responsible for the ordinary packaging development at Ericsson, PMD initiates projects, like this modularization project, to further improve the design of new packaging.

1.2 Structure of project

It was decided early on that the initial focus should be an area called Pick & Pack since that part of the package flow was in urgent need of modularization. If this project had not started with Pick & Pack, other similar projects would have been initiated to modularize that area. Seeing as several parallel projects could easily interfere, it was decided that the first deliverable in this project would be a modularized assortment for the Pick & Pack activity. Furthermore, this provided the project with a valuable initial study evaluating the methodology.

1.2.1 Part one: Pick & Pack

In this part of the project the Pick & Pack activity was analyzed. This part of the package flow handles shipments of spare parts and products that do not have unique packages. The Pick & Pack packaging assortment consists of standardized packaging and is thus especially suitable for modularization. The details of what characterize Pick & Pack are discussed in 1.6.

In the end of September PMD was presented with a proposal for a modularized packaging assortment. This deliverable consisted of a list of modular components and a brief specification of the dimensions and characteristics of each component.

The modularized packaging assortment contains a few unique packaging components that are not compatible with each other. However, the rate of success is not measured only by a comparison between the number of available components in the existing and the future assortment, since the structure of the packaging assortment is also important for a cost effective packaging activity. Even if the project would have resulted in an equal number of packaging components as before, these could be more complementary to each other and therefore meet the requirements in a more effective way. Since the requirements have been formulated during this part of the project, a comparison of the number of packaging components before and after is deceptive because the components may fulfill different sets of demands. As stated above, another major purpose of this pilot project was to provide a vital input to the second part of this study.

1.2.2 Part two: The modular design process

PMD has a well-established design process that, apart from the design activity, also involves thorough evaluation and analysis. The second part of this project was to result in a model that could be used to complement the PMD design process in order to incorporate modularity aspects into design and decision making. The model is to be adapted into workable tools and routines. The purpose of the model is that every package designed in the future will be evaluated in regard to modularity and the impact the degree of modularization has.

1.3 Time plan

The study was conducted between April 2012 and September 2013. The different stages of the project are presented in the following Gantt chart (Figure 1).

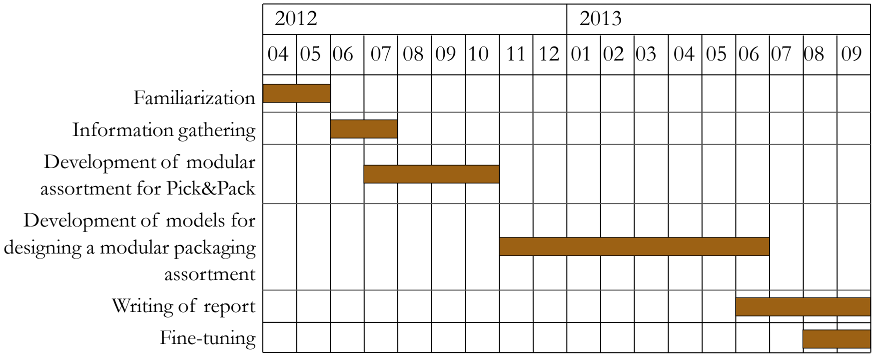


Figure 1. Gantt chart visualizing the parts in the project

Initial familiarization with the project (April-May 2012)

In this stage the people involved became familiar with the concept of modularization and previous examples in the industry. The purpose was also for the researchers at Lund University to gain basic knowledge of Ericsson's packaging function and to get to know the employees at PMD.

Information gathering (June-July 2012)

This phase was conducted from the office of PMD in Kista, outside of Stockholm. Field trips were carried out to Tallinn, Estonia and Borås, Sweden. Even though the analysis of the Pick & Pack activity was the immediate aim of the project, the gathering of information concerned the entire packaging function at Ericsson, so that only complementary information was needed when launching the second part of the project.

The development of a modularized assortment for Pick & Pack (July-October 2012)

This part of the project produced a modularized assortment for Pick & Pack. The results from interviews were analyzed as well as documents and spreadsheets. Three workshops took place to continuously anchor the process and the final assortment at the packaging sites.

Development of models for designing a modular packaging assortment (November 2012-June 2013)

This phase was conducted over seven months, which makes it the part that spanned over the longest time. Ericsson contributed to the part of the project that was related to Ericsson in particular. Regular meetings were held between the representatives from Lund and the team from PMD.

Writing of report (June-September 2013)

The writing of this research report was mostly conducted during the summer of 2013. Meetings were held with representatives from Ericsson and Lund University where the report was evaluated.

Fine-tuning (August-September 2013)

This last part of the project consisted of meetings where the report was discussed to identify shortcomings and to verify its practical usability for Ericsson.

Since the involvement varied during the project, the Gantt chart in Figure 1 can be misleading. It presents the time during which the different parts were conducted but is not a good representation of the workload for the different segments. The weighted Gantt chart below (Figure 2) illustrates the percentage of time involved in each part of the project.

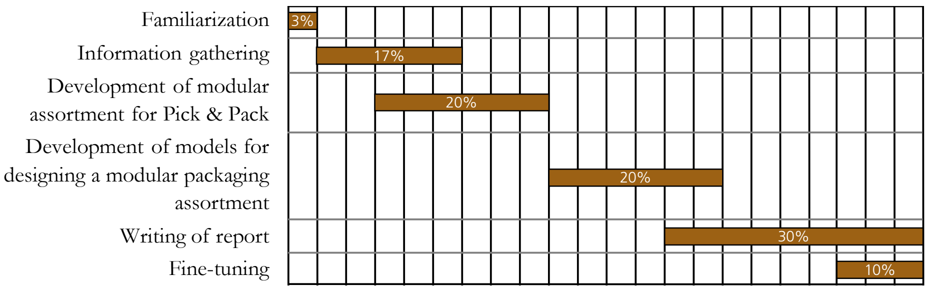


Figure 2. Weighted Gantt chart visualizing the resources allocated to each part

1.4 Focus and delimitations

Although the focus of this project was modularization of the packaging components, adjacent issues were dealt with. An example is the size of the pallets for Pick & Pack. The standardized assortment of packaging modules was derived from the pallets used at Ericsson – standard Euro pallets. It was thus necessary to question whether this pallet size had the optimum dimensions for Ericsson's products and means of transport. This matter did not fall within the scope of this project, but had to be investigated before the modularized range of packaging modules could be developed in the first part of the project.

A couple of months after this modularization project was initiated, a project aimed at lowering the overall costs of packaging and distribution was launched by another project manager, Jason Simms. However, that project did not focus at all on modularization. For these two projects to coexist it was necessary to identify any overlap in the assignments. For example, the task of optimizing the SAP system to increase the volume utilization was clearly a part of the other project, even though these problems were encountered in this project as well. Nevertheless, it was important to get continuous input from the other project on the changes they made in order to adjust this project to the new circumstances. Simms' assignment later became the basis for another project with a similar scope, managed by Per-Anders Malmberg.

1.5 Disposition

This part, Chapter 0, covers the background, structure and practical aspects of the project. Chapter 2 focuses on the methodology. That chapter is divided in one part that covers the theory of modularization and one part that explains the methods used in this this project when developing the Modular Packaging Development (MPD) model. Chapter 3 describes the first part of the project, Pick & Pack. Chapter 4 focuses on the last part of the project, the development of the MPD model. Chapter 5 covers the method for maintaining a modular assortment when designing new packaging components. The sixth and last chapter summarizes the report and the conclusions drawn in the project. The report ends with references and appendixes.

1.6 Description of package flows and explanation of terminology

The terminology at Ericsson differs from that commonly used in the packaging industry. The well-established terms *primary, secondary* and *tertiary packaging* are not used (Ericsson, PMD, 2012, p. 23). Instead, the terms used are more suited to the package flow at Ericsson. A number of these expressions are explained in the list below, along with the terms needed in the analysis in this report but that are not part of Ericsson's specific vocabulary.

1.6.1 Explanation of different package types

Single Packaging

A product specific package, designed to contain only one product. The package can be either of outer or inner package quality (Ericsson, PMD, 2012, p. 18).

Pick & Pack

A package used when shipping one or several different products to a customer. The packaging material used for Pick & Pack is standardized in order to function for different combinations of products (Ericsson, PMD, 2012, p. 17). A package from the Pick & Pack standard assortment can for example be used when shipping spare parts.

Multi Packaging

A package designed to ship several identical products. There are three types of multi packaging:

Multi Carrier for Single Packaging – An outer package designed for shipping several single packages. It can be used in every part of the logistic flow. (Ericsson, PMD, 2012, p. 20)

Multi Packaging for Components – A package used for shipping components from a supplier to an Ericsson factory. The components are used either in the production or in the packing of orders to customers and are separated with protective fitments or other protection. Examples of products packed in this type of package are sub-racks and other electronic equipment. The package can be of outer or inner package quality (Ericsson, PMD, 2012, p. 21).

Bulk Packaging – Similar to Multi Packaging for Components, but without individual protection for the products. An example of a bulk package is a box filled with cables or cabinet parts (Ericsson, PMD, 2012, p. 22).

The schematic flowchart in Figure 3 can be studied to contextualize these terms, and to better understand the package flow at Ericsson. It has been verified by employees at Ericsson (Ekelund, 2012) (Lindberg, 2012 A). Note that this is a simplified version to explain the parts of the logistics at Ericsson that fall within the scope of this project. Other areas are either deleted or heavily simplified.

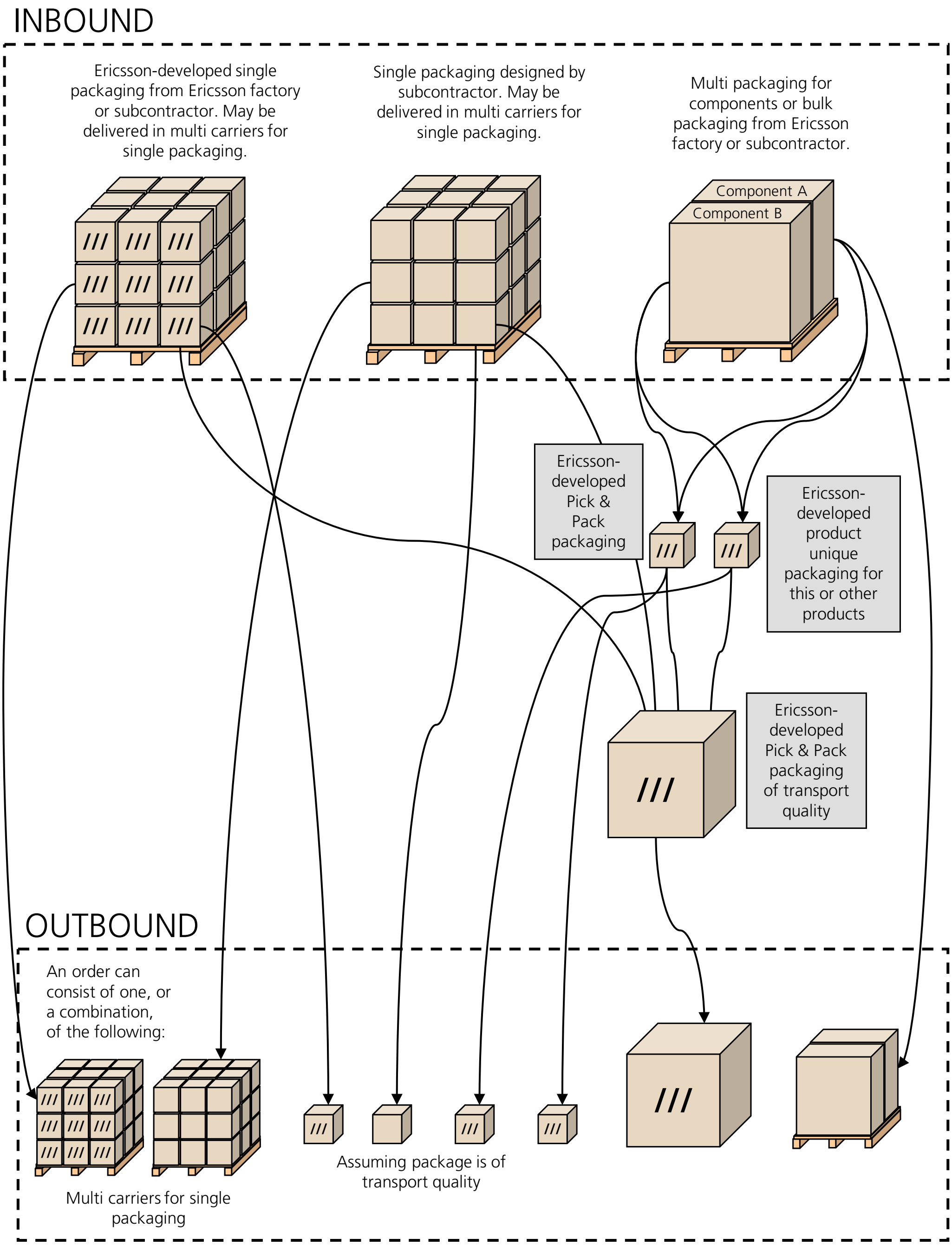


Figure 3. Contextualization of the concerned package flows at Ericsson

1.6.2 Packaging functions

The packages used at Ericsson can be divided into two categories: outer and inner packages.

Outer package

The outer package is the casing that makes up the outer surface of the handling unit[1]. The term "outer package" does not imply the existence of smaller packages, within the outer package, as opposed to the term "tertiary packaging" which does. A single package is considered an outer package when transported individually. Every handling unit includes an outer package. Outer packages are also referred to as "transport packages" or "export packages".

Inner package

Inner packages are used inside the outer package. Not all handling units contain this type of package. Single packages of outer package quality can, for example, be shipped with only the outer package.

These two terms can be easily visualized in the illustration in Figure 4. It is clear that the same box can function both as an inner package and an outer ditto. The package type is a set of requirements tied to a specific function, rather than a sort of package.

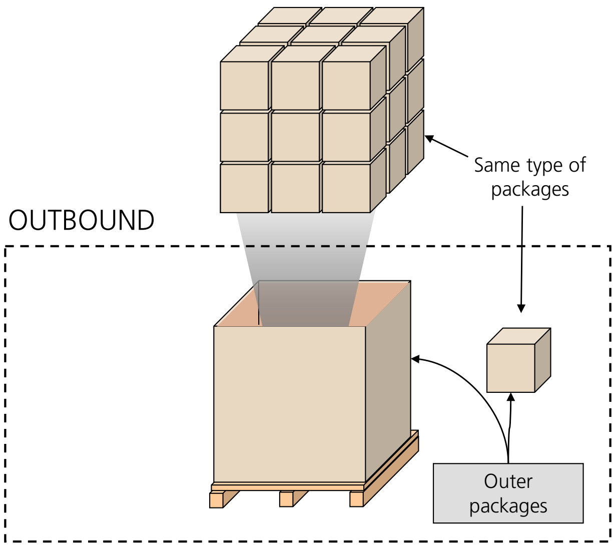


Figure 4. Visualization of the term "outer package" and "inner package"

[1] A package that is being handled separately. It can be of any size. If two handling units are joined together, they become one handling unit.

1.6.3 Quality based classification

Another way to classify the packages is related to the packaging material.

Outer package quality

The outer package is developed to protect the product from moisture and outer force. Every package sent must have an outer packaging of this kind. It is also referred to as "outer quality", "transport quality" or "export quality".

Inner package quality

A package of this kind is of lesser quality, not designed to protect the product from moisture or impact. The purpose of this packaging is merely to keep the contents together and to protect the products from damaging each other.

The terms "outer package" and "inner package" are exclusive: a package is either of an outer or inner type, but cannot be both. The same can be said for the terms "outer package quality" and "inner package quality".

It is important to make a distinction between the "outer package" and "inner package" and the "outer package quality" and "inner package quality". The distinction is necessary for the reasoning in this report.

2 Methodology

2.1 Modularization

Modularization makes it possible to divide a product into smaller parts for replacement of individual parts (Pekkarinen & Ulkuniemi, 2008). The purpose of modularization is not to find the optimal level of segregation in the product architecture, but rather to understand the relationship between the parts and their respective interfaces. This decomposition creates a greater understanding of the company standard and unique items and their potential for separation. The unique components are those that create value in services and thus are essential for the company (Hsuan Mikkola, 2007) (Hsuan & Voss, 2009). When standard and unique items can be separated, it becomes possible for the company to work with the modularization and the company becomes aware of its core competencies.

One risk when modularizing is that the modules will not fulfill the customers' requirements as before. Thus, it is important to give the customers and other stakeholders the opportunity to participate in the process, in order to identify the specific customer needs. Modularization can take place throughout the supply chain, in the company itself or perhaps only in one section. Modularization can also be implemented by a department within the company by splitting a range of business processes, with the intention of serving other departments more effectively. (Hsuan Mikkola, 2007)

Reduction of the complexity of structures, processes or systems reduces the response time to volatile changes in the market. Targeted simplification is the only reasonable answer to non-value-adding complexity. The logistics industry has produced some revolutionary simplifications in the past few decades, such as the container or the Euro pallet, which have dramatically simplified core logistics processes. (Hougaard Leeth & Roth, 2009)

It is not always possible to systematically and permanently remove complexity. However, the general rule is to simplify, where possible, structures (e.g. by reducing levels of hierarchy, increasing spans of control or decentralization and increased delegation), processes (e.g. streamlining, standardization or modularization) (Hougaard Leeth & Roth, 2009) and adaption.

Several researchers offer suggestions as to how companies should modularize their systems, only a few contribute to the service of which the package is a part. As mentioned, it is difficult to break down services into modules, as they are often intangible. However, it is a necessity when it comes to delineating unique and standardized modules. That is why a system perspective is assumed so that the focus is raised to a higher level. When examining the supply chain level, different processes in different companies are carried out when a service is requested. These processes – depending on whether they are part of the overall performance or simply a supplement to support it – make production feasible. For example, a transport company relies on its car suppliers, which should thus be seen as being part of the system, despite the fact that car suppliers are not directly involved in service production.

2.2 Reasons for modularization

There are several reasons for modularization, even though it is difficult to fully review all of the consequences in advance. Some aspects are discussed here. A further discussion on the financial benefits of modularization and how to estimate them can be found in 4.7.

The most visible and obvious result of modularization is larger volumes are purchased of fewer different packaging components. This can result in volume discounts and enable central procurement, since the number of unique modules is reduced.

Since the standardized modules have general specifications, not tied to a specific manufacturer, they are more suitable for outsourcing (Hsuan Mikkola, 2003, p. 439). This means that the competition will increase for the supplier, which may lead to lower prices for identical components. There are also benefits related to sourcing of not being dependent on a single supplier (Langlois & Savage, 2000). Baldwin and Clark (2000) argue that modularization can bring a firm's R&D activities closer to its supplier network due to shared knowledge contributions of technical and commercial innovations. A modular product architecture may also help to optimize and manage the supply chain. Baldwin and Clark go on to argue that modularity shifts the responsibility to suppliers, hence promoting competition among module suppliers.

The need for storage space may be reduced. This will not necessarily be a savings potential since the packing sites have already made some kind of selection of what packaging components to use.

Since a number of packaging components will be removed from the catalog from which the sites can choose, the overhead expenses of keeping these redundant packaging components will be eliminated.

There are also effects that will not necessarily lead to financial savings. Modularity has positive impacts on aspects such as a firm's specialization (Langlois & Savage, 2000) (Fine & Whitney, 1996), product variety (Schilling, 2000) and new product development flexibility (Sanchez, 1995) (Schilling, 2000) (Baldwin & Clark, 2000) (Ulrich & Eppinger, 2008).

Another outcome of modularization is the prevention of corruption. This point was raised by Robert Mellin (Mellin, 2012), Head of Ericsson Distribution Logistics. According to Mellin, who previously worked with corruption prevention, the purchase of packaging material is generally overlooked as a risk zone for corruption, although the purchasing orders in total involve large amounts of money each year. This is the kind of operation where local purchasers are able to establish contracts based on unclear factors. A more standardized assortment of packaging components will presumably lead to a more centralized procurement and thus lower the risk of corruption.

2.3 Modularization of packages

Experience and case studies from product design areas have shown that the development of modular package designs can have many positive effects on the total flow and handling of information and materials, from development and purchasing to storage and delivery. A modular designed package will also create a base for continuous packaging development and updating. It will support strategic decisions and simplify their implementation. Erixon has developed a method called Modular Function Deployment (MFD) based on Quality Function Deployment (QFD) and mainly for product design (Erixon, 1998). This report introduces the Modular Packaging Development (MPD) model and focuses on modularization of packages.

Erixon (1998) has used MFD in a number of real industrial cases and it has shown a number of advantages. First of all, it structures the product development process, which leads to rational product assortments. Secondly, it provides feedback to the synthesis phase, especially when the user becomes acquainted with the method. Thirdly, the method supports learning feedback and enhances the ability to "get it right the first time". Fourthly, it enables creative thinking and encourages teamwork, thus facilitating the implementation of Concurrent Engineering. The fifth advantage is that modular products are more competitive because they have grown out of a systematic procedure in which every detail has been sufficiently treated from customer requirements to finished product. Finally, the method guides the design iterations in which the results of changes are measured, obsolete ideas are scrapped, promising ideas are revised and new ideas are born.

2.4 Information gathering

The first part of the project was to gather information from stakeholders. The purpose was twofold: To the question, *What aspects are most important for the ideal package?,* and as a way for the researchers involved to quickly become familiar with the Ericsson-specific terminology and the parts of the supply chain that were involved.

Qualitative interviews were involved to collect this information. Qualitative information gathering was chosen over quantitative for these reasons:

- The small number of respondents made it impossible to get a valid statistical basis.
- The complexity of the problem made it difficult to decide on relevant questions in advance.

- The different roles of the respondents ruled out the use of a standardized questionnaire.

In order to gain input from different stakeholders, the target group for the interviews was made up of packaging engineers, the packers on site, personnel from sourcing, sales, logistics and managers. A list of the respondents is presented in Appendix A. A more extensive review of the stakeholders and how they were reached can be found in 3.1.

To answer the main question mentioned above, questions and possible follow-up questions were generated before the interviews commenced. This list of around fifty questions was reviewed between every interview. New questions were added and redundant ones removed. Prior to the interviews the relevance of the questions in the list were assessed. The questions pertinent to the respondent's assumed knowledge base and remit were extracted and used as a starting point for the discussion.

After the initial information gathering the focus was directed at the Pick & Pack activity. Statistics were collected as a basis for the analysis, which can be found in 3.3. The statistics mainly provided information concerning volume and price at different sites.

Since the purpose of the second part of the project was to develop a model based on the experience gained in the first part, it was decided that the inclusion of several experts and stakeholders would be central to the Pick & Pack project. Not only should these stakeholders be able to give input to the development of the modular packages, but to the development of the model itself. Thus, several workshops were held in the Pick & Pack project where the details of the model were also being established.

2.5 Classification of requirements

There are several similar terminologies used for describing and classifying the demands and requirements that stakeholders have regarding packaging. One of the most established models for this was formulated in 1984 by Noriaki Kano (Kono, et al., 1984). This model was later used to describe packaging qualities in an article by Martin Löfgren and Lars Witell (Löfgren & Witell, 2005). Figure 5 is a visualization of the Kano model.

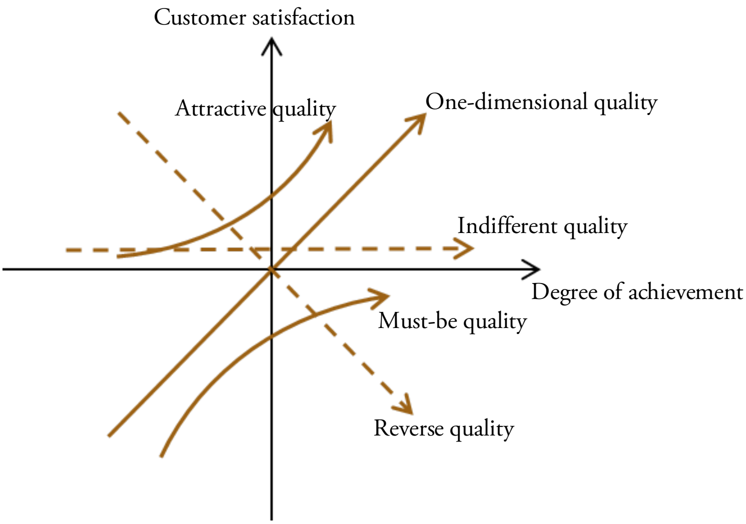


Figure 5. Kano's model of attractive quality

The requirements from the stakeholders in this study can be classified as having attractive, must-be or one-dimensional qualities. The indifferent or reverse packaging qualities are naturally not subject to stakeholder requirements. It is not necessary in this case to separate the one-dimensional and the attractive qualities. Therefore, the requirements in this report will be classified as either basic (requesting must-be qualities) or additional (requesting one-dimensional or attractive qualities).

3 Pick & Pack

3.1 Stakeholder identification

The first step in the gathering of information was the identification of stakeholders and how to reach them. Below is an explanation of the stakeholders identified.

Product

What requirements does the product have regarding its package? What qualities are most important to ensure the safe delivery of the goods?

The packaging engineers at PMD have ample knowledge of this. There are also numerous documents regulating requirements such as impact protection and water proofing when packing different products.

Packing sites

What requirements are formulated by the packing sites and the packing personnel? What is important or necessary when packing a product?

This group of stakeholders was reached by visiting factories and speaking to packaging engineers at different packing sites.

Distributor

What does the distributor require when loading, shipping and unloading the shipment?

This stakeholder was reached through EDL – Ericsson Distribution Logistics. They are aware of possible problems for the distributors. Since they are in contact with the distributors, these too were directly involved in the project.

Customer

One of the most important stakeholders is the customer. The customer can either be Ericsson personnel or an external customer.

The customers' opinions were gathered through the customer-oriented departments such as the sales or regional distribution departments at Ericsson.

Sourcing

Sourcing can identify parts of this project that will contribute to their work. Limiting the number of different packaging components can make it possible for the sourcing department to have a higher rate of centrally procured purchases.

To get the sourcing department's views, interviews with the staff responsible of purchasing packaging material were arranged.

Company

The expectations from the management on the packages are not necessarily taken into account by other stakeholders. Thus, the company will be classified as a separate stakeholder.

Managers at Ericsson provided this input. These managers came both from within and outside PMD.

3.2 Stakeholder requirements

The main purpose of the interviews was to identify what the different stakeholders considered to be the most important aspects of packaging. The findings from these interviews are presented below. The list of respondents is presented in Appendix A.

Product requirements on the package

Outer package must provide water resistance.
Outer package must be stackable.
Inner package must protect the components within the outer package from damaging each other.
All packages must meet criteria defined in the documents *General Requirements for Packaging Material Design*.

Requirements made by packing sites

The packaging components should be affordable.
The packages should be robust and endure rough handling.
Every package should have room for the necessary labels.
The barcodes on the labels must be visible and easy to scan when the goods are stacked.
The modules should have standardized measurements, derived from pallet size.
The need for packaging material on site should be fulfilled by as few modules as possible.
The packages should be easy to rig.
Pallets must be compatible with existing forklift trucks.

Requirements made by distributors

The packages should be robust and endure rough handling.
The information on the package should be visible and clear.
No small bags, letters or boxes should exist in the packaging assortment allowed.
Module sizes should be derived from industry-standard dimensions.
Pallets must be compatible with existing forklift trucks.

Requirements made by customers

The disposal of used packaging must be easy and inexpensive and there should be no unnecessary packaging.

Bangladesh, Liberia, Nepal, Bhutan (part of year) and India (part of year) require the goods to be sealed in plastic and packed in wooden boxes (as specified in the document *Special Packing and Marking of Goods*).

The product should have sufficient protection.

The packaging should be possible to open and reseal without damaging it.

The package should have visible and clear information regarding content, recipient etc.

The package should have visible and clear information on how to open the package when that is not evident.

Requirements made by sourcing

No packaging components should be supplier unique.

The demands on the manufacturer and the material should be few and low.

The assortment should contain few modules in order to archive higher volumes.

It must be possible to manufacture the packaging material globally.

Requirements made by the company

The package should carry Ericsson's core values.

The total package flow must have high volume utilization.

The package is not allowed to add unnecessary weight.

The packaging components should be affordable.

The package related claims must be held at minimum.

The initial investment must be reasonable.

There must be correct information for every module (declaration of material, blueprint, product specification, etc.).

The packages must be verified to protect different contents. The max load and other limitations must be specified.

3.3 Analysis of data material

When this project started, a summary of the different Pick & Pack modules used on some of the sites already existed. However, the data was incomplete and partially outdated. To update and structure this summary, the product numbers for the components registered at each site were extracted and sent to the respective sites for revision. The personnel at the sites were asked to enter the estimated consumption for 2012 and if needed, to add or remove product numbers. The product numbers were also sent to the sourcing department. They provided the price for each component as well as the volume specified in the contract. Consequently, the final spread sheet contained information about product number, description, price in different regions, what sites were using the component and the predicted volume by both the sourcing department and the personnel at the concerned packing sites. The packing sites were Katrineholm and Borås in Sweden, Tallinn in Estonia and Nanjing (ENC) in China. These were chosen because some of the data already existed for them. Originally, more sites were to be included, but were omitted since it proved hard to extract the relevant data for these sites. The four sites were deemed to provide the study with data that was sufficiently spread geographically and business area wise.

It was apparent that there were discrepancies between the estimated volume that was provided by the sourcing department and the volume predicted at the packing sites. On average, the volume predicted by the sites was 25 838 and the volume predicted by the sourcing department was 21 861. However, the average difference between the sites' and the sourcing department's predictions was 14 256. To understand how the individual differences can be so much more significant than the differences of the averages, see the illustration in Figure 6. It shows an example where the averages of the two series are not far apart. However, the individual data points show great differences between the series.

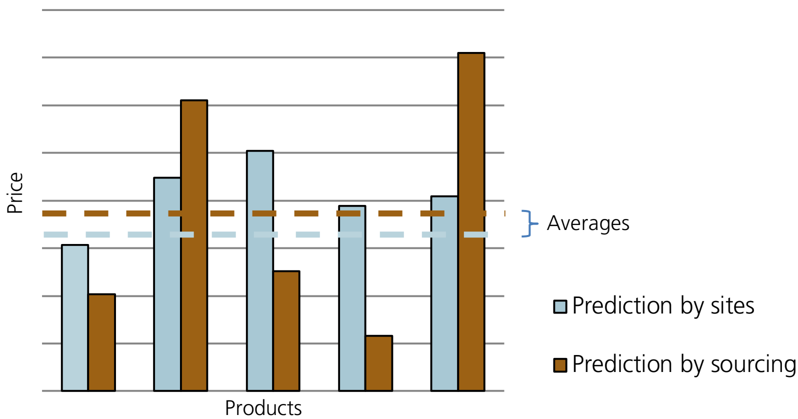


Figure 6. Illustration of the relationship between the volume predictions (fabricated data)

An explanation for this is could be that the contracts were negotiated according to the total volume for each site, and not based only on the volumes used in the Pick & Pack operation. Another reason is that the quantities of Pick & Pack packaging used do not correlate with the sales of certain products and are therefore harder to predict than the product-unique packages, which match the predicted sales numbers.

This compilation contains 130 different packaging components. 102 of these (79%) were only used at one packaging site; 73 (56%) were not purchased through a contract. These values are expected to change after the assortment has been modularized.

Now the focus will turn to the packing sets rather than the individual components. Tables presenting the existing packing sets in Pick & Pack can be found in Appendix B and Appendix C.

3.4 Notable arguments and conclusions from stakeholder interviews and statistical analysis

In some cases, the answers provided in different interviews were not consistent. This irregularity was noticed in terms of the different opinions of the respondents and in their diverse understanding of facts. These cases were further investigated together with areas where the information gathered differed from the praxis today when developing packages. Some of the discrepancies that were confirmed had implications for the project.

3.4.1 The use of envelopes and small boxes in the Pick & Pack assortment

In the present Pick & Pack assortment, there are no boxes smaller than the one shown in Figure 7 (product number: RTK 174 12/1). It holds 2.3 liters.

Figure 7. RTK 174 12/1

However, only the packing site in Borås uses this size. The smallest box at other sites is even larger. A mapping of the smallest boxes available at the concerned sites is presented in Table 1.

Site	Product ID	Number of litres
Borås, Sweden	RTK 174 12/1	2.3
Tallinn, Estonia	RTK 193 4147/50	6.0
Katrineholm, Sweden	RTK 212 10	8.3
ENC, China	RTK 212 10	8.3

Table 1. The smallest boxes available at the reviewed sites

The project run by Simms (mentioned in 1.4) discovered great problems with the smaller goods in particular. Many examples were found of very small products and spare parts attached to the bottom or top of the box or floating around in masses of cushioning material. Examples can be seen in Figure 8 and Figure 9. (Simms, 2012)

Figure 8. Example of low fill rate. Cushioning material to the right.

Figure 9. Example of low fill rate. Product attached to the bottom of the box

Nearly every respondent was content with the absence of small packages and expressed great concern for the introduction of smaller boxes than they were already using. Apart from Simms, no one could see the possibility of having small boxes or envelopes, although some of them acknowledged a need for such packages.

The criticism expressed for smaller packaging mainly consists of a fear that more goods would be lost or damaged during transport. Rickard Ström at Ericsson Distribution Logistics confirms that this is a valid point (Ström, 2012). They too are concerned that the existing distribution channels will not be able to handle small packages. The person responsible for the logistics service providers at Ericsson, Helena Thomas, is also of the opinion that the smaller goods run a greater risk of being damaged or lost (Thomas, 2012). A manager at one of the logistics service providers, Panalpina, confirms that this is indeed a problem when handling goods (Carlsson, 2012). Moreover, small packages pose a problem in the labeling process since the labels might not fit the most convenient location on the package.

Simms on the other hand, is of the opinion that these possible problems have to be solved in the near future. The distribution channels must be reorganized in a way so that they can handle small packages as well. When it comes to the labeling issue, Simms is of the opinion that this problem too has to be solved. Having excess packaging only so that the label will fit is, according to Simms, the wrong way to approach this matter.

3.4.2 The use of inner packages of inner package quality in Pick & Pack

The praxis today regarding the different use of packages of different quality standards is not easily represented. The praxis varies significantly between the sites. Table 2 presents an approximate model that takes the majority of orders into account. Note that there will be many exceptions from this model since the composition of Pick & Pack orders varies considerably.

Package type	Quality standard
Outer package	Always outer package quality
Product specific package	Inner or outer package quality
Inner package from standard assortment	Inner or outer package quality

Table 2. The use of different quality standards for Pick & Pack

The outer package must always be of outer quality. There is no reason to believe this rule is not complied with at most sites. Product specific packaging can either be of inner or outer quality. The reason for product specific packaging to be of outer quality is that it allows the product to be shipped individually. There is no reason to question the choice of quality of the product specific packages in this project since the choice of package quality is assessed individually based on sales figures. However, concerning the last package type in Table 2, it is quite possible that improvements need to be made.

Nearly every respondent had a strong opinion about the use of inner packages of inner package quality in the Pick & Pack industry. Most of the packaging engineers at PMD and on the packing sites agreed that every package – including the inner ones – should be strong enough to protect the content without any additional protection. According to them, no one can be certain that the inner package will not be used as an outer ditto somewhere in the distribution line. They also expressed concern that the packaging personnel, when packing a box, do not know if that box will be a part of a greater order and later on put in an outer box.

Not every respondent at PMD or the packing sites were certain it was truly necessary to pack the products in multiple packages of outer package quality, but only one expressed a direct request for inner packages in the Pick & Pack assortment. Apart from this respondent, the only two stakeholders to identify a need for inner packages in the Pick & Pack range were Jason Simms and the respondents at Ericsson Distribution Logistics. According to the staff at that department, there is sufficient control over the distribution line to believe that small boxes within a larger one will not be transported individually, at least not regularly. Consequently, these boxes could be of a cheaper quality. In some rare cases exceptions may appear. In these cases, the site that is splitting the outer package and dividing its contents is responsible for repacking the goods in a suitable way for further transport. However, in some cases it is not necessary to repack the products. In the last part of the distribution line, the goods may be transported individually inside a car. For this, the inner package is sufficient protection.

How frequently a package of outer quality from the standard Pick & Pack assortment is put inside an outer package is hard to know. The workshop participants agreed this happens on a regular basis but that the occurrence varies considerably between sites. The statistics provided by Magnus Lindberg, packaging engineer in Borås, indicate that the majority of the smaller boxes of outer quality used in Borås are indeed used as inner packages in larger outer packages. The outer quality box (RTK 519 1620) seen in Figure 10, is an example of this. From January to April 2012, 19 003 of these were sent, 18 500 of which (97%) were sent inside another box (Lindberg, 2012 B) (Lindberg, 2012 C). It is not certain that it would have been possible to use packages of inner quality in each of these 18 500 cases, but the high percentage of boxes sent inside others indicates a large savings potential, and came as a surprise to many of the stakeholders involved.

Figure 10. RTK 519 1620

The only remaining obstacle for using the inferior quality standard for inner packages is that the packaging personnel will not necessarily know when a small package is going to be sent inside an outer box, or as an individual package. It is crucial to solve this communication problem. Otherwise, this diversification regarding packaging quality cannot be fully implemented.

3.5 Developing a modularized Pick & Pack assortment

3.5.1 Selection of base dimensions

All of the base measurements were derived from the standard Euro pallet. This was decided at workshop one after consultation with one of the logistics service providers (Carlsson, 2012) and with Ericsson Distribution Logistics (Thomas, 2012). To produce the measurements for the half pallet, the whole pallet was divided into two equal halves where the longest sides were equal to the previous shorter dimension. This procedure was repeated to get the base dimensions for the 1/4-box and all of the smaller sizes. The setup resulted in a modular packaging assortment (base dimension-wise) where several packages of different sizes can be combined and still maximize the use of the base area of the pallet. This is easily understood by reviewing Figure 11 or contemplating the technique used for the international standard of paper sizes. Two A4 or four A5 sheets of paper can fit on one A3 sheet (however, the ratio between the pallet sides will vary depending on size).

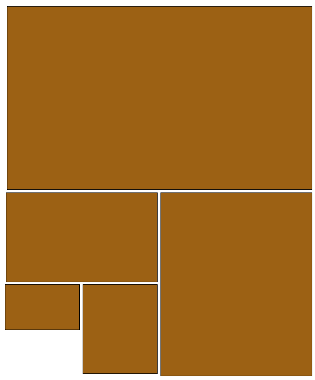


Figure 11. Illustration of the modular system for the base areas

The modular measurements that are produced when applying this method to a Euro pallet can be seen in Table 3.

	Whole pallet size	Half pallet size	1/4 - pallet size	1/8 - pallet size	1/16 - pallet size
Length	1200	800	600	400	300
Width	800	600	400	300	200

Table 3. Modular base sizes

When the base measurements were compared to the existing assortment of Pick & Pack boxes, most of the boxes (32 out of 38) could easily be replaced by one of the standard sized boxes since they had similar dimensions. The remaining eight boxes could not be modularized, since their measurements were too far from the modular dimensions. In all these cases the closest modular dimensions were an already existing box. Should these odd sized boxes be modularized, it would simply lead to a discarding of the sizes. It was therefore decided at workshop two that these eight boxes should not undergo the same process as the other boxes in the Pick & Pack assortment. The far left column in Appendix B shows what modules the existing boxes were classified as. Appendix C presents the unique boxes that could not be classified.

3.5.2 Selection of heights

The selection of heights for the boxes was made at workshop two. One of the cornerstones of the discussion was the postulate that today's box assortment had evolved to its current state and represented the need for different packaging sizes. Thus, the starting point was the existing box heights for the base dimensions.

It was decided that the heights too should be modular in the same way as the base dimensions. The principle is that, for example, four layers of small boxes should fit into a larger whole pallet container. If only three layers are needed, there is a whole pallet container for that as well. This principle results in an assortment where boxes of different heights maximize the height of the pallet container. It also results in a selection of pallet container heights where the differences between the measurements correspond to the smaller modular dimensions. To be able to choose this set of sizes, two initial values had to be determined: the dividing ratio (the base for deriving smaller sizes and the difference between pallet container heights) and the maximum pallet container height. While adjusting these values, the resulting pallet container heights were observed. The input values were chosen so that the generated pallet container heights were similar to the current ones. The measurements were then compared to standard measurements for different shipping methods to affirm that the box heights did not result in a mismatch of important standard dimensions, such as the maximum height for air freight. The heights for the different base sizes are presented in Table 4.

<table>
<tr><th></th><th colspan="4">Whole pallet size</th><th colspan="3">Half pallet size</th><th colspan="3">1/4 - pallet size</th><th colspan="2">1/8 - pallet size</th><th colspan="3">1/16 - pallet size</th></tr>
<tr><td>Length</td><td colspan="4">1200</td><td colspan="3">800</td><td colspan="3">600</td><td colspan="2">400</td><td colspan="3">300</td></tr>
<tr><td>Width</td><td colspan="4">800</td><td colspan="3">600</td><td colspan="3">400</td><td colspan="2">300</td><td colspan="3">200</td></tr>
<tr><td>Height (excl. pallet)</td><td>985</td><td>657</td><td>493</td><td>328</td><td>657</td><td>493</td><td>328</td><td>493</td><td>328</td><td>164</td><td>328</td><td>164</td><td>164</td><td>82</td><td>41</td></tr>
</table>

Table 4. Modular dimensions

The maximum height for the whole pallet was set at 985 mm (excluding pallet). The participants at workshop two agreed this box was not suited for use in the Pick & Pack flow but could be needed in other parts of the package flow. That is why it is crossed out in Table 4.

3.5.3 Adding packages optimized for using endways

The participants at workshop two identified a need for flat boxes. These are practical when shipping cables and other flat goods. Consequently, the very low heights of the 1/8 and 1/32 pallet sized boxes were added. The participants agreed, however, that these boxes should be optimized to be packed standing on one side so that the labels could be read and scanned without the need to repack. The measurements were therefore slightly adjusted to be modular in the orthogonal direction. The height of this box (when lying) is a fraction of one of the base measurements. One pallet can therefore be filled with smaller boxes on their endways and still have an optimal volume utilization in that level of the packaging. The measurements of the added boxes are given in Table 5.

	Approx. 1/8-pallet size box, endways	Approx. 1/32-pallet size box, endways
Length	328	200
Width	300	164
Height	61	100

Table 5. The added boxes to be used endways

The 1/16 boxes have low height versions as well. These can already be put on their side and be modular in one of the directions. Either they can be put in four rows on their 300 mm side lengthwise, or on their 200 mm in the orthogonal direction. The height will then be 200 mm and 300 mm, respectively. These dimensions are not modular, but the 300 mm height will fit the 328 mm sleeve satisfactorily. In the cases when many boxes of this size are to be shipped, the packages can be packed on their 200 mm side and generate a height of 300 mm. The height (when lying) is not modular either but since the packages are so thin, the consequences of not fitting an exact number of packages on a pallet will be limited.

3.5.4 Explanation of the different box functions

In workshop one, when the general principles of the packaging assortment were discussed, three different needs for packaging were determined, each with its own characteristics. It was considered a legitimate assumption that there were potential savings to be made if the packages were differentiated according to the corresponding requirements.

The basis of the differentiation is size and quality. Packages of the outer sizes are optimized for the use on pallets. Their dimensions are thus derived from the measurements of a Euro pallet (1200*800 mm). The packages of the inner dimensions are designed for use within the outer boxes, having slightly decreased dimensions (based on 1100*750 mm). The difference in quality is a consequence of the different uses of the packages. A package that is being transported within an outer box does not have to be of as high a quality as an outer box. For more information on this, see 3.4.2.

Outer size – outer quality

Packages that will be sent separately in some part of the distribution chain. Most packages today are of this type.

Inner size – outer quality

Packages that can be sent separately in some part of the distribution chain but are put in an outer container when initially packed.

Inner size – inner quality

Packages that are transported within an outer box throughout the entire distribution chain.

3.5.5 Representing the future assortment

The matrix presented in Table 6 was constructed in which the rows are made up of the three packaging types. The columns consist of the different modular sizes. Consequently, each field in the matrix represents a specific box size (the column) with a particular function (the row).

	Whole pallet size				Half pallet size			1/4 - pallet size		
Length	1200				800			600		
Width	800				600			400		
Height (excl. pallet)	985	657	493	328	657	493	328	493	328	164
Outer size Outer quality										
Inner size Outer quality										
Inner size Inner quality										

	1/8 - pallet size		Approx. 1/8-pallet size box, endways	1/16 - pallet size			Approx. 1/32-pallet size box, endways
Length	400		328	300			200
Width	300		300	200			164
Height (excl. pallet)	328	164	61	100	82	41	100
Outer size Outer quality							
Inner size Outer quality							
Inner size Inner quality							

Table 6. Representation of box sizes and packaging functions (table divided into two parts)

It is vital to understand the difference between the box sizes in the columns in Table 6, and the exact measurements of the boxes. The boxes in the 1/4-box column are all modules of the 1/4 size. However, this does not necessarily mean that the boxes base area is exactly 600 x 400 mm. The precise dimensions are a result of several design technicalities such as thickness of material, the chosen packaging solution, ergonomic factors and tolerance levels. The inner boxes in particular deviate from the theoretical module sizes since they are designed to fit inside other modules.

3.5.6 Reducing packaging types and choosing packaging solutions

After the matrix was constructed, the need to have boxes in each field was questioned. For example, no need was expressed for a whole pallet box of inner dimensions – for obvious reasons. This process reduced the number of different box types from 51 to 25. The discarded box types are marked in blue in Table 7.

The final step in this procedure was to decide which packaging solution to use for each box type. The solution chosen was entered in each of the 25 fields of the matrix. The decision was made after a qualitative discussion and was based on previous and current packaging solutions and the directions for improvement expressed by the packaging technicians attending workshop three.

<table>
<tr><th></th><th colspan="4">Whole pallet size</th><th colspan="3">Half pallet size</th><th colspan="3">1/4 - pallet size</th><th colspan="2">1/8 - pallet size</th><th>Approx. 1/8-pallet size box, endways</th><th colspan="3">1/16 - pallet size</th><th>Approx. 1/32-pallet size box, endways</th></tr>
<tr><td>Length</td><td colspan="4">1200</td><td colspan="3">800</td><td colspan="3">600</td><td colspan="2">400</td><td>328</td><td colspan="3">300</td><td>200</td></tr>
<tr><td>Width</td><td colspan="4">800</td><td colspan="3">600</td><td colspan="3">400</td><td colspan="2">300</td><td>300</td><td colspan="3">200</td><td>164</td></tr>
<tr><td>Height (excl. pallet)</td><td>985</td><td>657</td><td>493</td><td>328</td><td>657</td><td>493</td><td>328</td><td>493</td><td>328</td><td>164</td><td>328</td><td>164</td><td>61</td><td>100</td><td>82</td><td>41</td><td>100</td></tr>
<tr><td rowspan="2">Outer size Outer quality</td><td rowspan="2">Card-board sleeve with pallet</td><td>Card-board sleeve with pallet</td><td rowspan="2">Card-board sleeve with pallet</td><td rowspan="2">Card-board sleeve with pallet</td><td rowspan="2">Card-board sleeve with pallet</td><td>Card-board sleeve with pallet</td><td rowspan="2">Card-board sleeve with pallet</td><td>FEFCO 0201</td><td>FEFCO 0201</td><td rowspan="2">FEFCO 0201</td><td>FEFCO 0201</td><td rowspan="2">FEFCO 0201 or 0216 inline</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Plywood sleeve with pallet</td><td>Plywood sleeve with pallet</td><td colspan="2">Crease line box</td><td>Plywood box</td></tr>
<tr><td>Inner size Outer quality</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>FEFCO 0201 or 0216 inline</td><td>FEFCO 0427</td><td>FEFCO 0201</td><td>FEFCO 0427</td><td>FEFCO 0427</td><td>FEFCO 0427</td></tr>
<tr><td>Inner size Inner quality</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>FEFCO 0201</td><td>FEFCO 0201</td><td></td><td></td><td>FEFCO 0427</td><td>FEFCO 0201</td><td>FEFCO 0427</td><td>FEFCO 0427</td><td>FEFCO 0427</td></tr>
</table>

Table 7. Visualization of the different sizes and packaging material and type (discarded combinations marked in blue)

In most cases only one packaging solution was possible, but regarding the 1/4 size boxes that were 493 mm and 328 mm in height, no consensus was reached when it came to the use of crease line boxes[2]. Therefore, the modular assortment contains crease line boxes as well as boxes of the FEFCO 0201 type for that particular size. The packaging solution for the 1/8 size cardboard boxes were not decided on either. A study will be conducted before choosing one of the two possible packaging solutions. In this case, it was clear that there was only a need for one of the box types.

Possible discounts for higher order volumes were not taken into account at this stage. Thus some modules may be discarded by sourcing in order to increase the purchase quantity of another package of the same size. Naturally, only boxes of an inferior quality standard can be excluded.

The assortment of plywood boxes is a subset in this study. Some of the sizes were chosen for plywood boxes as well. This decision was also based on the current packaging range and aims for the plywood boxes to be sufficiently distributed among the different sizes to satisfactorily cover the demand.

3.6 Implementation

At the time of the publication of this report, the implementation of the Pick & Pack project is still ongoing. The technical design of the packages is finished and a choice of supplier has been made after three competing companies submitted price suggestions. A two-day workshop was recently conducted in Borås with representatives from different sites. The focus of this workshop was to test pack the new packages, which has been ordered in small quantities, in order to catch initial problems at an early stage.

One problem that was identified during the design phase was that if the 1/4-pallet inner boxes were optimized for use inside a whole pallet container, two of them would not fit in a half pallet container. The theoretical, schematic models that were used before did not take package thickness into account. However, this problem could be dismissed after the design of packages had been reworked.

The number of packages in the assortment was reduced from 32 to 28 in this project. However, the new packages have a completely reworked design that will hopefully result in additional cost reductions and benefits in several areas other than modularity. The complete economic consequences of this study and the reduction of packaging components remain to be seen.

[2] The term crease line box refers to a box with more than one possible height. The height is chosen when the box is mounted by folding the cardboard at different levels. The possible heights have corresponding creasing lines to make them easier to mount.

4 Modular Packaging Development

The model developed in the second part of the project is called Modular Packaging Development (MPD) and consists of eight steps. An overview is presented in Figure 12. In sections 4.1 to 4.8 the functions of the different steps are explained in detail. Most of them have supporting tables or matrixes that visualize the concepts. Note that all the data in the example tables presented are fabricated and have only an indicative function.

The MPD-model

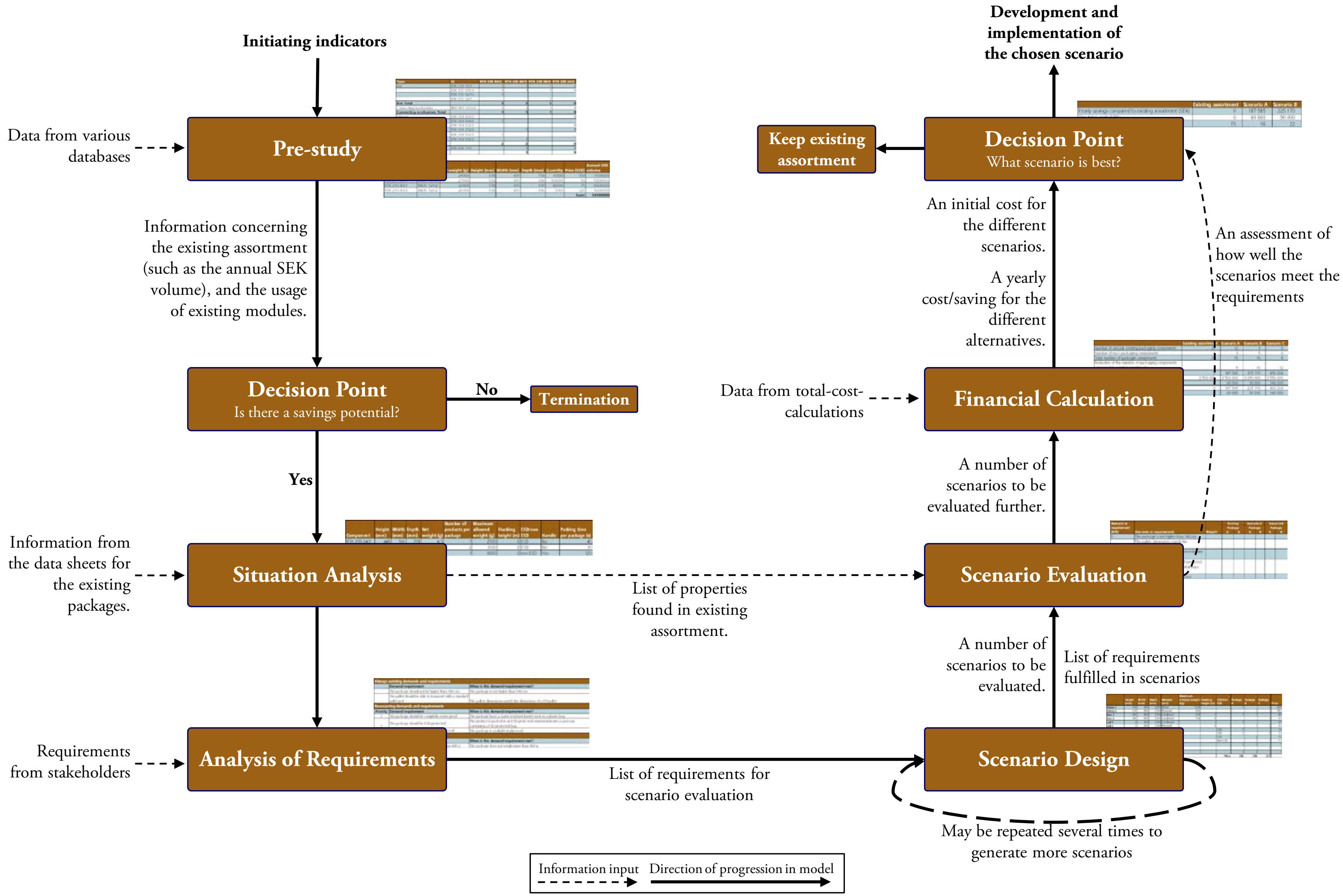
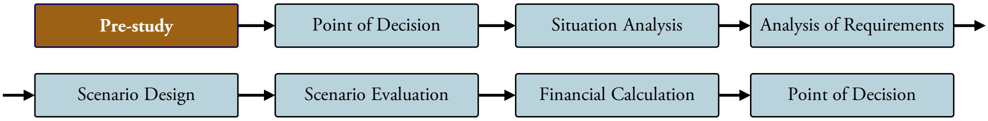


Figure 12. Overview of the Modular Packaging Development (MPD) model

4.1 Pre-study



The first step in the MPD model is the pre-study. The purpose of this step is to provide input to the decision making in the next step. The pre-study is initiated by one or several indicators. These can be observed by packaging engineers, managers, packing personnel, distributors or other stakeholders. Examples of such indicators are:

- The packaging assortment within an area (a description of what can be considered an area is discussed below) has been allowed to grow over time and it is therefore hard to get an overview of the available packages. It is probable that cost reductions can be made if the assortment would undergo the modularization process.

- There have been, or will be, drastic changes in the usage of certain packages. The packages may not be suited for being shipped in the new quantities and will possibly benefit from a new design. The ways that the packages are used may also change. This may lead to a suboptimal usage, since the package is not used in the way that was intended.

- Several of the packages within a particular area are designed by the supplier. This means that these packages are not subject to supplier competition. Another problem is the vulnerability that will result from being dependent on a single supplier.

- The strategies for packaging development, or for the entire company, have been changed. This may result in the need to redesign a part of the packaging assortment. Such a decision may be to optimize packages to sea freight rather than land and air freight or to stop using a certain packaging material.

- Technical advancements have made it possible to pack more effectively than before.

One of the two supporting charts in this step is the primary data table, Table 8. This chart maps price, quantity and basic packaging properties for the packaging components that are being analyzed. The data that will be used in the next step is the annual SEK volume (to help roughly estimate the savings potential), as well as the basic packaging functions (to identify reasons for a diverse packaging assortment). While the quantities for the different packages are being studied, one should also investigate if there are any anticipated radical adjustments to the quantities in the future. In that case, this should also be taken into consideration in the next step.

One conclusion that can be drawn from the example in Table 8 is that the annual SEK volume, 14M SEK, will act as a significant lever for any savings being made (this decision can vary between companies and depends on many factors such as the turnover of the packaging activity and the financial situation of the company). It is also clear that the basic properties of the packages do not differ that much, which also indicates a potential for modularization.

Package	Used for packing	Net weight (g)	Height (mm)	Width (mm)	Depth (mm)	Quantity	Price (SEK)	Annual SEK volume
Package A	Product 1	2400	518	470	156	10000	150	1 500 000
Package B	Product 2	2350	518	480	186	100000	50	5 000 000
Package C	Product 3	2240	536	470	190	80000	75	6 000 000
Package D	Product 4	2630	518	470	186	5000	320	1 600 000
							Sum:	**14 100 000**

Table 8. Example of a primary data table (fabricated data)

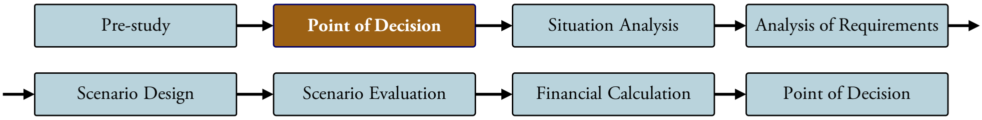
The second supporting chart used in this step in the process is the variance matrix, Table 9. This is preferably made into a pivot table so that the different sorts of packaging components are grouped. This chart visualizes how many of the components are being used in several different packaging solutions. If most of the components are only used in one packaging solution, it may indicate a larger savings potential than if several components are being used in multiple different packing sets.

The boxes in the example in Table 9 may indicate a potential for modularization since only one of the boxes (box 1) is used in more than one of the packing sets. This, as well as the analysis of most of the support tables, is a matter of opinion and experience.

Type	ID	Package A	Package B	Package C	Package D	**Grand total**
Box	Box 1		1		1	**2**
	Box 2				1	**1**
	Box 3	1				**1**
	Box 4			1		**1**
Connecting mechanism	Connector 1	1	1	1	1	**4**
Fitment	Fitment 1				1	**1**
	Fitment 2	1				**1**
	Fitment 3				1	**1**
	Fitment 4		1		1	**2**
	Fitment 5	1				**1**
	Fitment 6		1			**1**
Foil	Foil 1		1		1	**2**

Table 9. Example of a variance matrix

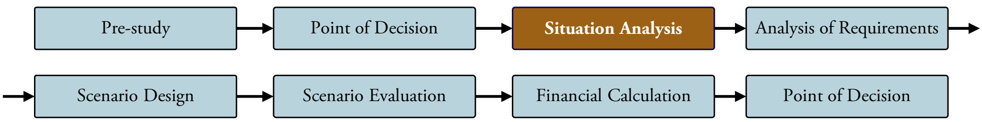
4.2 Point of decision



In step two, the decision is made if there is a potential in redesigning this part of the packaging assortment. The decision can be made by personnel working with packaging design and packaging modularity and does not necessarily have to involve managers since this decision does not have considerable economic effects. It is only a decision of whether to go further in the modularization process. Since the input data on which this decision is based is qualitative, the decision itself cannot be calculated quantitatively. It is based on the outcome of the pre-study, where these results indicate a savings potential:

- The annual SEK volume is significant and the quantity is not expected to decrease
- The annual SEK volume is less than is considered significant, but the quantity is likely to increase in the future.
- There are a larger number of components than should be necessary.
- The basic packaging properties are in some cases similar for the different packages.
- None or only a few of the components are used in several different packing sets.
- There is no reason for this packaging assortment to be diverse.
- There are other reasons for redesigning this part of the packaging assortment such as the indicators mentioned in 4.1.

4.3 Situation analysis



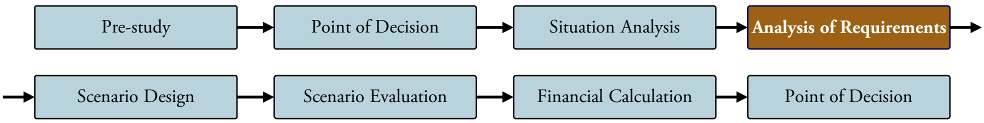
Another supporting table is used in this step in the process. The table is called the situation matrix, and its purpose is to map the analyzed packages to the different packaging properties. An illustration is presented in Table 10. The column headings are flexible and may vary depending on what part of the packaging flora is being studied. The columns should together cover the central functionality for the analyzed assortment and the differences between the packing sets.

The result of this step is not used in the following one, but in the scenario evaluation later in the process. The purpose is to map the functionality of the existing assortment to identify any functionality that can be lost when switching to a new packaging assortment. It is possible to take the results from this step and use them when designing the scenarios, but the participants at the workshops pointed out the risks of basing the scenarios too much on the existing assortment and thereby not being as innovative.

Package	Height (mm)	Width (mm)	Depth (mm)	Net weight (g)	Number of products per package	Maximum allowed weight (g)	Stacking height (m)	ESD/ non ESD	Handle	Packing time per package (s)
Package A	518	470	156	2400	1	2500	6	ESD	No	45
Package B	518	480	186	2350	2	3000	2	ESD	No	30
Package C	536	470	190	2240	1	8000	0	non ESD	Yes	120
Package D	518	470	186	2630	2	3000	2	non ESD	No	80

Table 10. Example of a situation matrix

4.4 Analysis of Requirements



In this step in the process, the purpose is to map every requirement these packages are subject to. These should be constructed so they are either satisfied or not, and does not need to be applied to every product. To facilitate the investigation of the requirements, they are divided into three categories:

- Always existing requirements – The requirements that are applicable to every package. Basic needs concerning, for example, vital protection or labeling.

- Reoccurring requirements – These requirements are preferable chosen from a drop down menu, since they are frequently used. From the drop down menu, the user can tick the requirements that are applicable for that specific package type.

- Unique requirements – The user has the possibility to enter specific requirements here. An example of this is an uncommon requirement such as unusual coloring.

The requirements are classified as either basic or additional. The basic requirements are vital for the function of the package and the additional requirements are requests from the stakeholders that are not imperative. For more information on this, see 2.5.

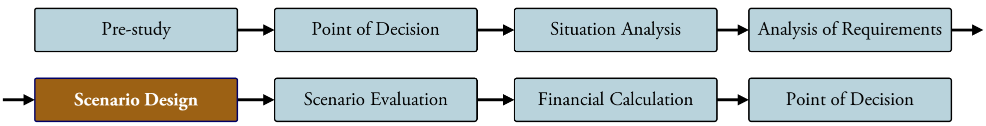
A requirement that does not apply to every product must be phrased so that it is clear what products are affected. If product 1 must be able to be shipped in a plywood package, the requirement could be “A package in plywood should be available for product 1.”

The requirements are concreted in the column to the right. Table 11 is an example of a requirement table.

Always existing requirements		
Basic/ additional	Requirement	When is this requirement met?
Additional	The package should not be higher than 140 cm	The package is not higher than 140 cm
Additional	The pallet should be able to be transported with a standard pallet jack	The pallets dimensions match the dimensions of a Euro pallet
Reoccurring requirements		
Basic/ additional	Requirement	When is this requirement met?
Basic	Every package should be completly water proof	Every package have a water resistent barrier such as a plastic bag
Basic	The package for product 1 and 2 should be ESD-protected	Product 1 and 2 are packed in an ESD-protected environment into a package containing an ESD protected bag.
Additional	A package in plywood should be available for product 1	A package in plywood is available for product 1
Unique requirements		
Basic/ additional	Requirement	When is this requirement met?
Additional	The package for product 3 should not weigh more than 400g	The package for product 3 does not weigh more than 400 g

Table 11. Example of a requirements table

4.5 Scenario design



In this step in the model the scenarios that will be evaluated in the next step, are designed. There is a support table in this step as well that serves as a tool for the packaging engineer carrying out the design. It is called a scenario matrix (Table 12) and is maps the different scenarios to the packaging components that are included in the construction. The scenario matrix only covers one scenario. Consequently, the designer will need to repeat this step and create one matrix for every scenario being designed. The columns are chosen so that the differences between the components are clearly noticeable. The prices in the far right column are provided by the supplier after being sent an RFI. The volume prediction needed in the RFI is based on volume predictions for the products together with the package allocation matrix (Table 13). The routine for this is explained below. From these prices, the price for the different packages can easily be calculated, based on the components included. The purpose of this matrix is to visualize the packaging components that are being used in the designed packages.

	Height (mm)	Width (mm)	Depth (mm)	Material (mm)	Maximum allowed weight (kg)	Stacking height (m)	ESD/non ESD	No. of components in package A	No. of components in package B	No. of components in package C	No. of components in package D	Price (per unit, SEK)
Pallet 1	144	800	1200	Wood	1500			1		1	1	150
Pallet 2	120	800	1200	Plywood	800				1			180
Box 1	600	800	1200	Cardboard	600	2		1	1		1	45
Box 2	400	800	1200	Cardboard	900	4				1		60
Lid 1	4	800	1200	Cardboard		2		1			1	20
Lid 2	5	800	1200	Plywood		4			1	1		30
Fitment 1				Styrofoam			ESD	1			2	10
Fitment 2				Styrofoam			ESD	1		1		15
Fitment 3				Styrofoam			ESD		2			15
Fitment 4				Styrofoam			Non ESD		1	1	1	10
Strap 1		1		Plastic				1	2		1	1
Strap 2		2,5		Plastic						1	1	1
Label 1		15	10	Coated paper				1	1	1		1
							Price	**242**	**298**	**267**	**247**	

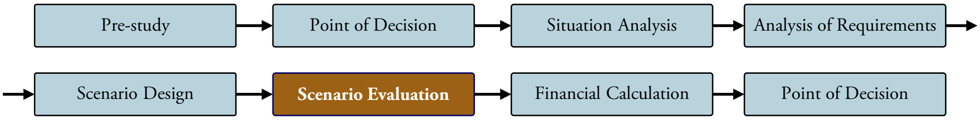
Table 12. Example of a scenario matrix

In connection with the scenario matrix, there should also be a package allocation matrix that maps the designed packages to the products that should be packed. There are several reasons for doing this. One is to provide volume data for the RFIs used to obtain prices for the scenario matrix. The sales predictions for the products are transferred to the corresponding packages by using the package allocation matrix. In cases where several packages are available for one product (as in the cases of products 1 and 5 in Table 13), the ratio between the packages must be approximated. When the predictions of the volumes for the different packages have been established, the volume for each component can be produced by using the data in the scenario matrix. The package allocation matrix is also used to produce the data for the total cost calculation in the last step in the MPD model, and in the evaluation in the next step. Since the requirements are tied to the different products and not packages, it is necessary to connect these requirements to the packages in order to evaluate them. An example of a package allocation matrix can be seen in Table 13.

	Package A	Package B	Package C	Package D
Product 1	X	X		
Product 2		X		
Product 3				X
Product 4			X	
Product 5	X			X

Table 13. Example of a package allocation matrix

4.6 Scenario evaluation



The purpose of this step is to evaluate how the different scenarios fulfill the requirements listed in the requirements table. The first step is to enter data in the two columns to the left in the evaluation table, Table 14. The data is copied from the column to the right and the requirements classification column to the left in the requirements table.

The set of requirements should be compared to the columns in the situation matrix, constructed in the situation analysis step. If there are any properties of the existing assortment present in the situation matrix that are not already in the list of requirements, this should be challenged. It implies that the existing assortment has functionalities that the new assortment may not necessarily have. If the functionality should indeed be present in the new assortment as well, the properties should be formulated as requirements and added to the list of requirements in the evaluation table. They should also be classified as basic or additional requirements, as are the other requirements in the list.

The requirements should also be given a factor (one to five, five being most important) according to their estimated importance. The factor for the basic requirements should be set to five.

The fulfillment of each of the requirements is evaluated for every scenario and the results are registered in the matrix. Some requirements may only affect one of the products. In these cases, the package allocation matrix can be used to clarify what packages should be assessed. If, for example, a requirement is that it should be possible to ship product 3 in a plywood box, the package allocation matrix will indicate what packages are designed for product 3. If one of these packages is a plywood box, the requirement can be considered fulfilled for that scenario.

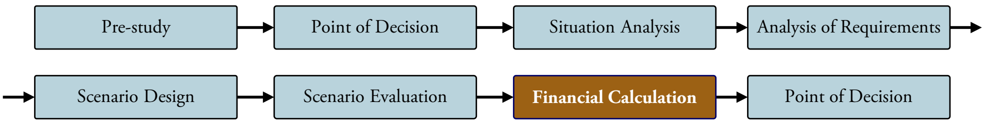
Finally, the total score is calculated by adding the factors of the requirements fulfilled by each scenario. These results in a number of points indicating what scenarios best satisfy the requirements. In the example in Table 14 scenario B has the highest score since it fulfills every requirement. Scenario A has only 16 points because it does not fulfill the first and fifth requirement (worth in total six points).

If any of the scenarios does not fulfill the basic requirement, the scenario should be discarded already at this stage.

Basic / additional requeriement	Requirement	Importance	Existing	Scenario A	Scenario B
Additional	The package is not higher than 140 cm	3	Yes	No	Yes
Additional	The pallets dimensions match the dimensions of a Euro pallet	4	Yes	Yes	Yes
Basic	Every package have a water resistent barrier such as a plastic bag	5	No	Yes	Yes
Basic	Product 1 and 2 are packed in an ESD-protected environment into a package containing an ESD protected bag.	5	Yes	Yes	Yes
Additional	The package for product 1 is available in plywood	3	Yes	No	Yes
Additional	The package for product 3 does not weigh more than 400 g	2	No	Yes	Yes
		Score	**15**	**16**	**22**

Table 14. Example of an evaluation table

4.7 Financial calculation



4.7.1 Calculation of savings potential template

The calculation of savings potential template can be divided into several smaller parts. The first is the breakdown of all yearly costs related to packaging. The nature of this depends greatly on the information structure of the company. A business that has much data on the expenses related to packaging may have a more detailed cost analysis. An example of a breakdown can be seen in Table 15.

Activity	Yearly cost (SEK)
Packaging material	406 000 000
Freight	364 000 000
Handling	196 000 000
Storage	196 000 000
Damage	98 000 000
Disposal	140 000 000
Total	**1 400 000 000**

Table 15. Example of a breakdown of yearly packaging-related costs (fabricated data)

In this case the values are known or approximated. Since this is partly the basis on which the decision is being made in the next step, the purpose is to get an idea of the savings potential. If the data is unreliable, a rough estimation will be sufficient. The parts that the total cost is divided into are not fixed, but the more parts there are, the more reliable the results will be. If the yearly cost for only one activity is known, one way to estimate the other parts is to approximate the percentage distribution between the parts and thereby determine the yearly cost for every activity. An example of this can be seen in Table 16. In that example the yearly cost of the packaging material is known (406M SEK, highlighted in gray). The distribution of the total yearly packaging related costs are estimated (highlighted in blue). Finally the yearly costs are calculated (highlighted in pink) based on the estimated percentages. The percentages in Table 16 are the estimations used at Ericsson.

Activity	Estimated percentage	Yearly cost (SEK)
Packaging material	29%	406 000 000
Freight	26%	364 000 000
Handling	14%	196 000 000
Storage	14%	196 000 000
Damage	7%	98 000 000
Disposal	10%	140 000 000
Total		**1 400 000 000**

Known
Estimated
Calculated

Table 16. Calculating the distribution of packaging related costs based on the known cost of one activity (fabricated data)

After the costs have been explored, the focus shifts towards the vision for the entire packaging assortment. An approximation has to be made of how much the number of packaging components can be expected to be reduced if every part of the packaging flora would undergo this process (Table 17). This approximation should be adjusted over time when the rate of modularization has been empirically produced.

Total number of packaging components at company today	2000
Number of packaging components after the company's entire assortment has been subject to the modularization process	1300
Reduction of number of packaging components	700

Table 17. Example of an approximation of reduction of the number of packaging components (fabricated data)

Every cost driving activity identified earlier must also be assigned a percentage for how much that yearly cost is expected to be reduced in this vision. Examples of aspects to consider when estimating the savings potentials are presented in Table 18.

Activity	Examples of aspects to consider
Packaging material	Volume discounts when buying fewer different components
Freight	Stacking height and packing possibilities are better documented for modularized assortment
Handling	Personnel familiar with handling of modularized packages
Storage	Less storage space needed since the number of different componets are reduced
Damage	The modular packages will likley be better tested
Disposal	Fewer disposal vessels may be needed if fewer different materials are used

Table 18. Examples of aspects to consider when estimating the savings potential

In the example in Table 19, the yearly cost of packaging material is expected to be reduced by 2%, which is 8.12M SEK. In total the possible yearly savings for this example would be 1.75%, which is 24.5M SEK. However, these savings are only likely to occur when the entire packaging assortment is modularized and the number of packaging components has been reduced to 1300. When using the model, some or all of the percentages can eventually be replaced by the empirical data. This will result in a more precise calculation over time. When doing these estimations at Ericsson, the total yearly savings were calculated to 1%

Activity	Cost (SEK)	Approximation of yearly savings after the entire packaging assortment has undergone this process (and the number of packaging components are 700)	Possible yearly savings (SEK)
Packaging material	406 000 000	2%	8 120 000
Freight	364 000 000	1%	3 640 000
Handling	196 000 000	4%	7 840 000
Storage	196 000 000	1%	1 960 000
Damage	98 000 000	3%	2 940 000
Disposal	140 000 000	0%	-
Total	**1 400 000 000**	**1.75%**	**24 500 000**

Table 19. Example of individual approximations of yearly savings for the activities (fabricated data)

With the data and approximations above, the yearly savings potential per reduced packaging component can be calculated (Table 20). The result (35 000 SEK / reduced packaging component) will be the template when calculating the total savings.

Yearly savings pontential	24 500 000 SEK
Number of reduced packaging components	700
Average yearly savings potential per reduced packaging component	35 000 SEK

Table 20. Example of calculation of average yearly savings potential per reduced packaging component (fabricated data)

This template is the only part of this step (elaborated in 4.7.1) that is used later in the model. This part of the process is only carried out occasionally when calculating a new template.

4.7.2 Consolidation of the financial data

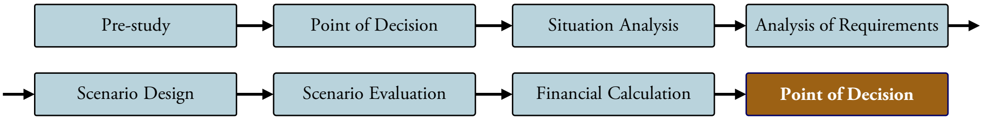
The last step in preparing for the final decision making is to consolidate the financial figures. An example can be seen in Table 21. The expected modularity related savings are calculated by multiplying the saving template produced earlier (4.7.1) by the number of reduced packaging components. Scenario A in the example in Table 21 reduces the number of packaging components by five. This is multiplied by the savings potential template (35 000 in this example, see 4.7.1 for more information) to calculate the expected yearly modularity related savings (175 000, in this example). In order to achieve these modularity related savings, it is vital that the rejected components are not possible for the sites to order in the future.

The total cost analysis will result in a yearly cost and a one-time cost. It should take into account most of the differences between the scenarios, and the effect they will have on the total costs. Examples of these differences are changes in fill rate, more or less expensive packages, changes in packing time and changes in the storage space needed. The one-time cost will include investment in new machines and development costs for designing new packaging components. Producing models for a total cost calculation does not fall within the scope of this project. The model can be similar, though, to the one Ericsson uses, which is based on a master thesis from Lund University 2009 (de la Motte & Persson, 2009).

	Source of data	Existing assortment	Scenario A	Scenario B
Number of already existing packaging components	Counted in the scenario-matrixes	20	12	5
Number of new packaging components	Counted in the scenario-matrixes	0	3	5
Total number of packaging components	Counted in the scenario-matrixes	20	15	10
Reduction of the number of packaging components compared to existing assortment	Calculated by subtracting the total number of packaging components in this scenario from the existing number of packaging components.	0	5	10
Expected yearly modualrity related savings (SEK)	Calculated by multiplying the reduction of the number of packaging components by the savings-potential-template.	0	175 000	350 000
Total cost calculation - yearly costs (SEK)	Total cost calculation	3 500 000	3 500 000	3 650 000
Difference in yearly costs compared to existing assortment (SEK)	Calculated by subtracting the yearly costs from the existing yearly costs.	-	0	-150 000
Yearly savings compared to existing assortment (SEK)	**Calculated by adding the expected yearly modularity savings to the difference in yearly costs compared to existing assortment.**	**0**	**175 000**	**200 000**
One-time-cost (SEK)	**Total cost calculation**	**0**	**60 000**	**90 000**

Table 21. Example of consolidation of financial data (fabricated data)

4.8 Point of decision



The basis for the decision is the outcome of the financial calculation together with the results from the scenario evaluation. An example can be seen in the decision table in Table 22. The financial data is copied from the two bottom rows in the consolidation of financial data (Table 21) and the score from the scenario evaluation is copied from the evaluation table (Table 14). The decision table will provide the decision makers with adequate information to make a well-informed decision. How this is done varies considerably from company to company but there are usually well-established routines for evaluating business cases and reviewing a one-time cost in relation to a yearly saving. Since this could have significant economic consequences, it is more important that this decision involves managers and department heads than the first point of decision, at the beginning of the process.

In the example in Table 22, Scenario B appears to be the most beneficial. The one-time cost is higher but compared to the difference in yearly savings for the two scenarios, the difference between the one-time costs may be considered insignificant. Moreover, the score from the scenario evaluation is higher for scenario B.

	Existing assortment	Scenario A	Scenario B
Yearly savings compared to existing assortment (SEK)	0	175 000	200 000
One-time-cost (SEK)	0	60 000	90 000
Score from scenario evaluation	15	16	22

Table 22. Example of decision table (fabricated data)

5 Modularity in the design of new packaging

To make a packaging assortment modular, it is not enough to continuously redesign different parts of the existing packaging flora. It is also vital that the new packages that are designed do not add superfluous unique packaging components with unique interfaces to the assortment being modularized.

The method of evaluating the modularity-related consequences of the design of new packaging components uses the same theories as the MPD model. The operative part of the model is based on the consolidation of the financial data found in Table 21. It is slightly adjusted to this area of use. The result can be seen in Table 23.

Before using the matrix, the packaging engineer must define a number of alternatives consisting of different numbers of new components. Contrary to the consolidation of financial data in the MPD model there is no need to note the number of existing components since none of the alternatives are able to reduce the number of existing components in the packaging assortment. The template that is being used to determine the economic consequences of adding new packaging components is the same as the savings potential template that is used in the MPD model.

The outcome of the evaluation is the same decision basis as the MPD model. The calculations will produce both a yearly cost and a one-time cost.

	Source of data	Alternative A	Alternative B	Alternative C
Number of new packaging components	The specifications of the alternatives	0	2	8
Expected yearly modualrity related losses caused by the increase of packaging components (SEK)	Calculated by multiplying the number of new packaging components by the template (savings potential template from the MPD model).	0	70 000	280 000
Total cost calculation - yearly costs (SEK)	Total cost calculation	940 000	840 000	650 000
Yearly costs (SEK)	**Calculated by adding the expected yearly modularity related losses to the TTC - yearly costs**	**940 000**	**910 000**	**930 000**
One-time cost (SEK)	**Total cost calculation**	**0**	**30 000**	**120 000**

Table 23. Example of evaluation of new design (fabricated data)

6 Conclusions

The result of the first part of the project was the modularization of the Pick & Pack assortment, presented in Chapter 3. A number of improvements were made such as the differentiation of inner and outer quality. The methodology used in the Pick & Pack part of the project was generalized in Chapter 4 and presented as the Modular Packaging Development model. The savings potential in using a modular as opposed to a non-modular assortment was roughly estimated to be 1% for Ericsson. The total financial benefit however, has to take into consideration the reduced number of new packaging designs.

Although everyone involved in the project considers modularization an important factor to take into account in the packaging design at Ericsson, it may not be suitable for every company. The potential can easily be assessed once the statistics needed for the model are in place.

Even though the MPD model is general and not Ericsson specific, it must be adjusted to the specific company using it. It is imperative that all of the stakeholders' requirements are identified correctly and that the financial data needed for the final analysis are determined. The statistics regarding volumes and prices must also be reliable. In regard to these requirements, only a well-functioning and experienced packaging department has the potential to work with modularization.

It is desirable that packaging engineers with modularity competence in the future will be involved in product design in order to steer the design to modular dimensions and already existing interfaces.

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Appendix A: List of respondents interviewed in the Pick & Pack project

Name	Position	Interview date (2012)
Anders Ekelöf	Hardware Developer, PMD	June 11
Anita Möller	Configuration Manager, PMD	June 5
Beatrice Buzsaky Johansson	Hardware Developer, PMD	June 8
Birgitta Ekelund	System Designer, PMD	June 14
Helena Thomas	Manager Logistics Provider Development	June 29
Henrique Ribeiro	Senior Quality Process Engineer, Brazil	June 19
Jason Simms	Commercial Manager	June 20
Jonas Lagerstedt	Strategic Sourcing Manager, Mölndal	June 11
Magnus Lindberg Q	Process Developer, Borås	May 31
Maria Sandberg	Industrial Engineer – Packaging, Kumla	June 15
Marios Pettersson	Regional Distribution Manager	June 19
Mats Lundgren	Head of PMD	June 20
Miguel Gonzalez Q	Verification Engineer, PMD	June 15
Per-Anders Malmberg	Project Manager, Optimized Packaging	Aug. 23
Piers Byford	Requirement & Environmental Compliance, PMD	June 13
Qin Hong	Store Shift Leader, China	June 14
Rickad Ström	Warehouse process supervisor	June 15
Robert Kuba	CoS Reduction Driver	Aug. 14
Robert Lozano	System Designer, PMD	June 13
Rolf Andersson I	Global Commodity Mgr Electromechanics	June 13
Stanislav Strokov	Packaging Engineer, Tallinn	June 12
Terho Tiala	Logistics, Ericsson Distribution Logistics	June 11
Thomas Arneberth	Hardware Developer, PMD	June 8
Thony Karlsson A	Production engineer, Katrineholm	June 14
Tony Westlund	Hardware Developer, PMD	June 18
Xu Xiaochun	Packaging Engineer, China	June 14
Anders Ekelöf	Hardware Developer, PMD	June 11

Appendix B: Table of existing Pick & Pack pack sets of modular measurements

Class	Design	H	W	L	Type	Product ID
Whole pallet size	Plywood box	695	787	1163	N/A	2/RTK522646/3
		883	787	1163	N/A	2/RTK522818/3
		821	820	1220	RTK512	RTK512158
		820	800	1200	N/A	RTK512156/3
	Crease line box	800/640/450	809	1209	N/A	RTK5191648
	Cardboard sleeve + plywood lid	445	800	1200	N/A	RTK198053/1
		700	800	1200	N/A	RTK198053/2
		820	800	1200	N/A	RTK198053/3
	Plywood sleeve + plywood lid	820	800	1200	N/A	RTK512053/3
Half pallet size	Plywood box	520	600	800	N/A	RTK512257/3
	Crease line box	800/640/450	600	800	N/A	RTK5191661
	Cardboard sleeve + plywood lid	531	600	800	N/A	RTK198050
		711	600	800	N/A	RTK198051
		831	600	800	N/A	RTK198052
1/4-pallet size	Crease line box	350/214	378	568	FEFCO 0201	RTK106301/3
		450/270	400	600	FEFCO 0201	RTK198142
	Cardboard box	203	391	579	FEFCO 0205	RTK198010/03
		243	410	613	FEFCO 0201	RTK21263
		431	410	613	-	RTK212100
		460	400	600	FEFCO 0205S	RTK17415/1
		500	400	600	FEFCO 0205	RTK198010/06
		630	430	590	FEFCO 0201	RTKV9990202
		1000	430	630	FEFCO 0201	RTKV9990204

Class	Design	H	W	L	Type	Product ID
1/8-pallet size	Crease line box	291/225/175	283	373	FEFCO 0201	RTK106301/2
		390/200	300	390	FEFCO 0201?	RTK198141
	Cardboard box	55	280	395	FEFCO 0427	RTK9934147/50
		203	297	391	FEFCO 0205	RTK198010/02
		219	309	416	-	RTK21233
1/16-pallet size	Cardboard box	109	203	297	FEFCO 0205	RTK198010/01
		118	215	330	FEFCO 0427	RTK21210

Appendix C: Table of existing Pick & Pack pack sets of unique measurements

Design	H	W	L	Liters	Type	Product ID
Cardboard box	50	130	240	1.6	FEFCO 0427	RTK9934147/34
	90	135	190	2.3	FEFCO 0427	RTK17412/1
	71	280	510	10,1	FEFCO 0427	RTK5191619
	125	290	295	10,7	FEFCO 0427	RTK9934147/20
	145	405	428	25.1	FEFCO 0201	RTK9934143/52
	150	360	505	27.3	FEFCO 0201	RTK9934147/39
	130	380	560	27.7	FEFCO 0427	RTK5191620
Crease line box	191/125	183	283	9.9	FEFCO 0201	RTK5191648