The Cost Saving Potential of Standardization

- a study at a global packaging company

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Writing our thesis has been both interesting and educational. Not only have we learned how to work with component standardization at Alpha Box, but also how this department is part of a whole. We have seen the power of a large and global organization but at the same time realized the difficulties involved in making changes happen.

We are grateful to all of you at Alpha Box who participated in our master thesis, helping us to understand the company and the current situation. Especially we want to express gratitude to the employees at the Component Standardization department for taking the time to share thoughts and experience with us and contributing with helpful input to our master thesis. We also want to thank you for making us feel welcome, taking good care of us, and always having time for a cup of coffee.

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Abstract

Title: The Cost Saving Potential of Standardization -a study at a global packaging company

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Problem Discussion: To introduce a standardized component assortment takes a lot of effort in order to make real cost savings. The rationalization effect itself is important, but perhaps even more important is to state the aim of the standardization efforts in a well-defined way. How can an organization assure that they are working in a proper way? How do they know that their efforts are being interpreted into the whole organization? And, how do they know that the standardization efforts actually save money? Different components differ heavily e.g. in technical complexity and quality issues. This master thesis will, derived from potential savings, prioritize the Product Groups at Alpha Box.

Purpose: The purpose of this master thesis is to identify the parameters affecting the potential of cost savings due to standardization of components.

Methodology: The study was initiated through the performing of interviews with employees at the standardization department as well as with other actors involved in the component flow. Then different statistics and databases were analyzed in order to create ingoing parameters for a prioritization model among product groups.

Conclusions: To standardize a component assortment is difficult and requires involvement from different functions within the organization. It is essential to state a defined purpose of the standardization work and assure that the actual efforts contribute to the overall savings. Generally a high volume value and quality aspects should have significant impact when prioritizing among the components. The result of this study suggests that pumps and valves should be prioritized.

Key words: Standardization, Total Cost Analysis, Cost savings, Model for Cost Saving Potential

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1 Introduction

The introduction chapter offers a description of the problem investigated in this master thesis. The practical issues at the object of study as well as the theoretical starting point are described.

1.1 Background

”*A package should save more than it cost*”
Ruben Rausing

Ruben Rausing founded Alpha Box[1] in 1943 with the vision of making food safe and available everywhere. Today Alpha Box is one of the leading companies in processing, packaging, and distribution of food and beverages in the world.[2] However, Alpha Box faces a continuously intensified competition in the world market. For decades, Alpha Box has been one of the market leaders, with good margins in their business. This has lead to a mentality without emphasize on cost reductions. To keep this mentality could be devastating for the company’s existence. The competitors are consolidating and cheaper packaging substitutes are threatening to gain market share. Because of this, an important part of the company’s overall strategy is to emphasize price reductions with a comprehensive approach. Reduced prices will improve customer competitiveness and make Alpha Box a more attractive supplier. [3]

One way of working with cost reduction is to standardize. Given the fact that there are thousands of components within one machine and the fact that Alpha Box produces almost 600 filling- and distribution machines a year[4]; it is not hard to imagine that there is a need for standardization of the component assortment.

When standardizing, several different materials or components are replaced by a single one with all the necessary functions of the ones replaced[5]. Standardization leads to simplified handling and has proved to increase the performance through e.g. reduced purchasing costs and lower inventory levels[6]. Standardization can in fact have positive implications throughout the flow of components in a company, that is, in product development & design, manufacturing, distribution and service & maintenance[7].

[1] Alpha Box is an assumed name
[2] Alpha Box Internal Material, 2007-03-12
[3] Jönsson, D. President & CEO Alpha Box Group, 2007-01-26
[4] Alpha Box Internal Material, 2007-03-13
[5] Sanchez-Rodriguez et. al. (2006), p. 56
[6] Avery (1996), p. 203
[7] Perera et. al (1999), pp. 110-114

At Alpha Box, there are a large number of different components in the assortment used in the filling and distribution machines. The designers have had the freedom to choose components by themselves and as a result Alpha Box's component database is now overflowed with articles[8]. Alpha Box is an organization that needs to have a strong customer focus[9]. *A package should save more than it cost* was Ruben Raising's idea; numerous components are costly both for Alpha Box and also for the customers in the long run.

It can however be difficult to prove savings being made due to standardization. In order to be successful in the standardization work a considerable amount of time and resources is needed and the benefits are not obvious right away. With a model for determining the potential cost savings being made as a result of component standardization, the process of standardization can be more efficiently performed. A model makes it possible to prioritize the work based on where the greatest savings can be made.

1.2 Problem Discussion

As mentioned, standardization has proved to increase performance for an organization. But to introduce a standardized assortment takes a lot of effort in order to make cost savings. The rationalization effect itself is important, but perhaps even more important is to state the aim of the standardization efforts in a well-defined way. How can an organization assure that they are working in a proper way? How does the company know that their efforts are being interpreted into the whole organization? And, how do they know that the standardization efforts actually save money?

Component standardization is not a new function at Alpha Box. The area has been covered but the responsibility has been transferred within the organisation. As a result, the concentration of the standardization efforts has varied over the years. Today the Component Standardization (CS) department belong to the purchasing function Supplier Management Capital Equipment. Thus, the focus of the CS department has changed from being early involved in the product development process to be more commercially oriented.[10] Furthermore, the department has expanded considerably and today a wider range of components is covered. The components are divided into Product Groups with respect to their technical function.[11]

The Product Managers are the product owners of standard components. There are numerous Product Groups and only nine Product Managers.[12] The employees at the department experience a lack of structure and defined purpose of their work. Altogether the employees find it hard to prioritize. This implies that there is a request

[8] Sjöberg, S., Product Manager, CS, 2007-01-11
[9] Nilsson, S., Manager Mechanical Components, Component Purchasing 2007-03-14
[10] Lindberg, A-C., Manager CS, 2007-02-14
[11] First round interviews Product Managers, 2007-02
[12] Ibid

for guidance how to make the Product Managers' job more effective.[13] The Product Groups characteristics differ heavily e.g. in technical complexity, annual volume value purchased, and level of quality issues. Hence, here is a need for clearer direction what Product Groups to prioritize and where the potential savings can be made due to standardization.

When standardizing, there are several characteristics that needs to be taken into account. For example, how important the component is for the avoidance of downtime in production, delivery conditions, price, etc.[14] This master thesis will, derived from potential savings, prioritize the Product Groups. The prioritization can be used by the Product Managers to prioritize where to put the effort in order to contribute to the largest possible savings at the time. Emerging from a total cost perspective, cost drivers that the CS department can have an impact on will be identified. The cost drivers will be converted to parameters that compare the Product Groups to each other. Thereby the standardization work can be further developed and in the future even more contribute to a rationalized and cost-effective component handling.

In this master thesis the following research questions will be investigated:

- What kind of costs arises in a component flow?
- Which of the costs can be influenced by standardization?
- What characteristics of a component influence the cost saving potential?
- How could different type of components be prioritized?

1.3 Purpose

The purpose of this master thesis is to identify the parameters affecting the potential of cost savings due to standardization of components.

In the thesis a model based on the parameters will be designed, to determine potential cost savings. The model will work as a general guideline for similar companies that want to structure their standardization work.

1.4 Focus and Delimitations

This master thesis is situated at the Component Standardization department at Alpha Box Packaging Solutions in Lund. The focus is on purchased standard components used in filling- and distribution machines, and exclude drawn components. The costs and potential savings used in the model are only the ones that the CS department can have an impact on. The timeframe for some parameters are limited to one year. For a few parameters it has been impossible to find the information needed, and they are thereby excluded from the model.

[13] Ibid

[14] Storhagen (1995), p. 122

1.5 Company Introduction

Every day more than 331 million Alpha Box packages are distributed to hundreds of countries, “protecting what’s good”. Alpha Box, with more than 20 000 employees, develops, manufactures and markets systems for processing, packaging and distribution of food.[15]

The pioneer Dr Ruben Rausing established Alpha Box in the early 1950s. The company started as a subsidiary of Åkerlund & Rausing and began as one of the first packaging companies for liquid milk. Alpha Box expanded in 1991 into liquid food processing equipment, plant engineering, and cheese manufacturing equipment. Today Alpha Box has become one of the world’s largest supplier of packaging systems for milk, fruit juice, drinks, and much more. It is the only international company in the world today that provides integrated processing, packaging, distribution line, and plant solutions for food manufacturing.[16] Alpha Box also supplies packaging material to close to 9,000 Alpha Box filling machines currently installed at customer plants across the world.

1.6 Clarification of Vital Terms

Component Supplier delivers individual components. The components can be *standard components*, i.e. developed by the suppliers or *drawn components*, specified by Alpha Box.[17]

DC-class is a subgroup in a Product Group, containing components within the same category such as bushings, springs or cables.

D&E, Development and Engineering, includes the R&D part of Alpha Box. They are responsible for the product development. Each machine system have their own D&E department.

ECR, **Exchange Component Request**, is the procedure undertaken when a component should be replaced by a new one.[18]

First choice, a component, reviewed and recommended by Component Standardization division, offered from a recommended supplier and owned by a Product Manager.[19]

Local choice, a component that has been introduced by another person than a Product Manager, and that is not from a preferred supplier.[20]

Platform, there are different lines of filling and distribution machines. A platform is responsible for a particular machine.

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[15] Alpha Box Internal Material, 2007-03-12
[16] ibid
[17] Davidsson V, Magnusson P, Master Thesis (2003), p.13
[18] Sjöberg, S., Product Manager, CS, 2007-01-11
[19] Ibid
[20] Ibid

PCFinder, is a retrieval system used to find the components that are already introduced as an Alpha Box number. The components are searchable by Product Group and shown in order of priority.[21]

Preferred Supplier, is the supplier recommended for a specific product or Product Group, based on fulfilment of commercial and technical specifications. Components from a Preferred Supplier are presented as the Corporate Standard and the *first and second choice* assortment in the system PCFinder.[22]

Product Group, is a group of components with about the same technical function such as hydraulic, fasteners and operator panels. A Product Group is further divided into DC-classes.

Product Manager, have the technical responsibility for the Product Groups. They own all of the first choice components.

Purchased Components, are components from a manufacturer's ordinary assortment.

Savings, the definition of savings in this master thesis is "cost reductions being made due to standardization efforts".

Second choice, a component that is delivered from a preferred supplier, but that has not been examined and approved by a Product Manager.[23]

[21] Internal Material, 2007-03-15
[22] Alpha Box Internal Material, 2007-03-15
[23] Sjöberg, S., Product Manager, CS, 2007-01-11

1.7 Disposition

The disposition of the master thesis is shown in Figure 1 below.

Figure 1: The disposition of the master thesis.

2 Method

In this chapter the methodology used in the master thesis is described. Areas such as a description of the practical procedure of the work, source of criticism and method theory are brought up.

This chapter defines and describes the methodological approach. No matter the nature of the study, it is important to state the methods used beforehand. This is important since without a defined method, it is difficult to know which results are actually real and what are effects from the study itself.[24]

In this study the system of the component flow at Alpha Box is in focus. Our work concerns the handling of standard components and how the supply chain is organized. The subsystems are the Product Groups and the persons within the organization that have an impact on the potential cost savings due to standardization. This approach can be associated with the *systems theory*. The systems approach is built around the idea of a system as a group of objects that interacts, for example a solar system or an ecosystem[25]. The purpose of using the approach in this study is to attain a holistic view, in order to better fulfill our purpose. The concept of interaction is essential in a systems approach, and points out the importance of studying, following, understanding and planning for change in complex environments, where multiple factors influences each other[26]. When using the systems approach it is essential to understand how the system develops and how the system is dependent of its history. [27]

The starting point in this master thesis is the empirical findings, which is used to form the model that serves as a part of the theoretical contribution of the thesis. Consequently, the master thesis has an *inductive* approach as the research is based on empirical studies that are used to draw the theoretical conclusions[28]. The study began with a basic empirical investigation that was used to state the problem and form the purpose. Thereafter, theories on the subject were examined. The theoretical framework was later used as a support and starting point for the further investigation, but the main part of the analysis was not to compare the results with former theoretical evidence. By using an inductive approach, the study was carried out more open minded, not bounded to testing certain hypotheses.

The study has been carried out in 4 steps as visualized in Figure 2, followed by a more detailed description of each step.

[24] Jacobsen (2002), p. 20
[25] Wallén (1996), p. 29
[26] Ibid
[27] Wallén (1996), p. 30
[28] Wallén (1996), p. 47

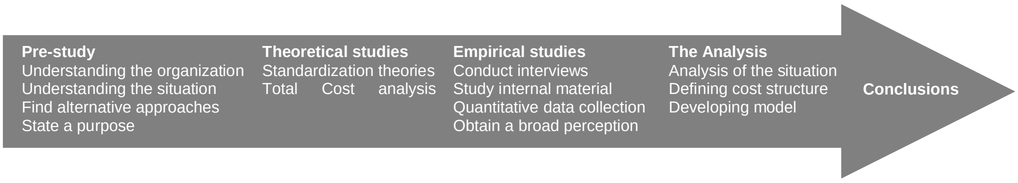

Figure 2: The master thesis process

2.1 Pre-Study

This master thesis started with a pre-study in order to achieve an understanding of the current situation and contemporary problems and challenges in the component handling and standardization work at Alpha Box. The pre-study was carried out through interviews and studies of internal material. The interviews were held with the nine Product Managers focusing on how the CS department works and how the work with the components is carried out today. The output of the pre-study was various ideas of research areas. Three alternative approaches for the master thesis where worked out and presented to the tutor and other stakeholders at Alpha Box. The alternatives were then discussed and the settled purpose was a modified version of one of the alternatives. When the problem discussion and purpose were set it was sent to all of the tutors and feedback meetings were held. The aim was to assure that all stakeholders were satisfied with the stated purpose.

2.2 Theoretical Studies

The theories chosen for this master thesis commence from two main areas; Component Standardization and Total Cost Analysis. The *Component Standardization* area covers topics such as costs influenced by standardization and what kind of component characteristics that make a component appropriate to standardize. Component Standardization theories consider the whole process for the component and what effect it has on efficiency and emerging costs. The *Total Cost Analysis* framework includes theories such as Total Cost of Ownership, Life Cycle Costing and Supply Chain Costing. The function of this framework is twofold. Firstly, it was used to explore the theoretical cost drivers in the Total Cost of Ownership and Life Cycle Costing. Secondly, the work procedure used in Supply Chain Costing was used operatively to find the cost drivers influencing the component flow. The cost drivers found where compared to the theoretical cost drivers. To find the cost drivers that the CS department could influence the cost drivers where examined with standardization theory. Some of the costs where then quantified and put in the model. An illustration of the cost driver finding process is found in Figure 3.

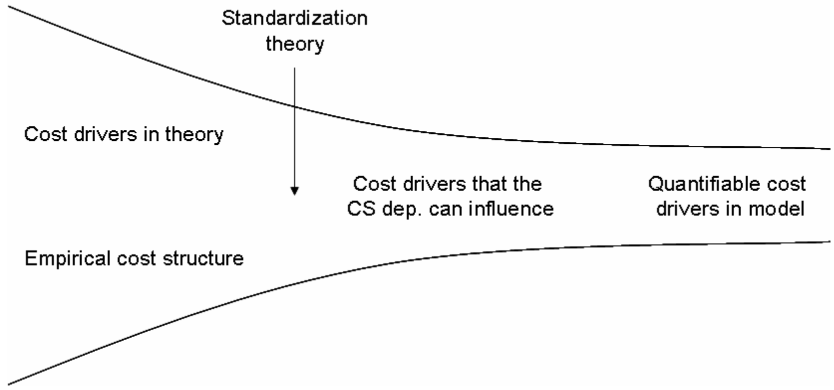

Figure 3: The cost driver finding process.

The theoretical material has been found in both journal articles and books. The articles were found in ELIN at Lund University Library. We have also studied other master thesis discussing similar issues and found valuable references on the subject. One essential task in the search of theories has been to find multiple sources in the different areas. The choice of theories has also been discussed with our tutors at the university. These two activities both increase the validity of the study and have helped us to set up the right measurements for the study.[29]

2.3 Empirical Studies

When starting the deeper empirical studies we had a stated problem and a purpose. We also had knowledge of theories on the subject. The aim of the deeper empirical studies was to achieve a better understanding and to get a broader picture of how standardization affects the component handling. This was conducted trough interviews with employees along the whole component flow. The interviews were focused on the costs affected by standardization and the activities performed by the different functions. It was vital to get input from as many perspectives as possible, since various sources not only are important in the theoretical area but also in the empirical study to obtain high validity[30].

The empirical material was also collected from internal investigations at Alpha Box. Mainly the information was found at the Alpha Box internal web but it also includes internal investigations such as internal evaluations of the Product Groups at the CS department. A complementary part of the empirical research was the thorough investigation of the component database PCFinder. All categories where counted, with respect to number of articles, share of first choice, share of local choice etc. Calculations of the volume value per Product Group were also made, based on purchasing statistics. These kind of hard facts were used to balance the ingoing qualitative aspects of our model.

[29] Yin (1994), p. 34
[30] Ibid

2.3.1 Interviews

The empirical information is partly based on interviews. The persons interviewed were employees from different departments at Alpha Box that in one way or another are involved in the component handling. Many of the interviewees also had experience of standardization. The interviews where set up with some questions prepared beforehand, in order to ensure that the discussion where kept around the right subject. When interviewing individuals that do not work with the research area this was especially important since otherwise there was a risk of lost focus. The interview normally lasted for about an hour, and there were always at least two persons interviewing to ensure that everything was properly understood and documented. After the interview the hand notes were re-written in electronic form and saved on the virtual project portal. To reduce the interpretation problems the original notes were kept as well.

2.4 The Analysis

The component cost structure was analyzed based on the empirical and the theoretical information. The empirical data consists of information given from the interviews and is focused on how costs emerge at Alpha Box. The purpose of the theories was to get input to how costs normally emerge. The challenge then was to give a more exhaustive account of the component cost structure at Alpha Box.

Through brainstorm sessions the costs in the theories and the costs found through the empirical studies were compared and analyzed. In a second stage they were analyzed taking the standardization theories into account. The output was a number of parameters affecting the potential for cost savings in the Product Groups when standardizing. These parameters where then used as an input to the model.

The aim of the model was to measure the potential of costs savings among the Product Groups. The input information was weighted so the impact on the result corresponded with the estimated impact. The challenge of the model was the fact that it to some extent quantifies qualitative data which involves estimations. To strengthen the result it has been important to present to the reader when estimations have been done. It has been crucial to make the analysis as transparent as possible so that the reader can form ones own opinion about the thesis. The model is programmed in Excel so that CS can use it without the need of learning and using a new program.

The model is not the answer to all of the issues concerning the component standardization work at Alpha Box. There are a lot of other dimensions that need to be taken into account and some of them are discussed in the general analysis of the situation. This is important so that the impact of the model is placed in its context. This analysis also raises the need for further studies.

2.5 Qualitative and Quantitative Data

This study contains qualitative data in the form of interview results. The interviews and qualitative studies in general are valuable since they can be used to achieve deeper understanding. On the other hand, it is harder to generalize the results from qualitative studies beyond the studying object in question[31]. The information must therefore be managed and developed further to be usable. Our aim has been to capture the details and underlying explanations that a qualitative data collection can offer, but by transferring it to quantifiable data, we make it easier to generalize. Some data however, is completely quantitative, as the results of the PCFinder and the volume value investigations. This information complements the more qualitative aspects in order to obtain a broad perspective. A significant part of the analysis has been to quantify the subjective part of the empirical data. This was essential in order to form the model.

2.6 Validity, Reliability and Objectivity

This master thesis aims to be credible. There are three ways of obtaining credibility; validity, reliability and objectivity. These ways of obtaining credibility are mainly associated with quantitative research.[32] Since this master thesis aims to develop a quantitative model, we believe that it is legitimate to obtain credibility through using the concepts of validity, reliability and objectivity. To be able to establish quality of the research the validity and reliability should be tested. An empirical study must be relevant (valid) and trustworthy (reliable).[33]

Construct validity is about setting up the right measurements for the scope and in this study it was assured by the choice to investigate many various sources, both in the theoretical and empirical field. Especially in the empirical field it has been important for us to gather information from a broad perspective to understand the impact of the standardization work in the whole component flow. Of great importance is also the communication with supervisors and other stakeholders. Our tutor at Alpha Box has been updated every week on the working process and has also got access to our written material as soon as possible. This was also critical in order to control that the material only consisted of non-confidential information. This should all increase our construct validity since multiple sources of evidence were used and the draft were reviewed by key informants. Some effort were also put into selecting the specific types of changes that are to be studied in relation to the objectives, and also to show that the chosen measurement reflect those changes.[34] A constant issue has been to define why the chosen set of measurements is appropriate for the study and much effort has been put into explaining and motivating the different choices made.

The *external validity* deals with the issue whether the findings are true even when they are situated outside the study[35]. We focus on the component flow at Alpha Box and the current prerequisites here. By keeping them in mind, and analyzing their impact on our research question, it is possible to make use of the results elsewhere. This is important since the most common circumstance when external validity

[31] Björklund & Paulsson (2003), p. 63
[32] Jacobsen (2002), p. 21
[33] Ibid
[34] Yin (1994), p. 34
[35] Locke et al. (2004), p. 126

becomes important is when one sample is included in the study but the results are applied on another group[36].

The working material has constantly been stored at the virtual project portal. This includes meeting notes, drafts, interview notes and other types of documentation during the research time. The material has also been stored in its original document form, e.g. hand notes. This helps securing the *reliability* of the project research, were it is of great importance that all procedures are documented. One way of doing this is to make every step as operational as possible, almost as with accounting, were everything should be able to undergo auditing at any time[37].

Interviews have been a significant source of information in this study, which makes it important to be aware of the fact that interviews are considered to have low *objectivity*[38]. This is because the person conducting the interviews may affect the interviewees. Therefore it has been important to clarify and motivate the different choices made by the authors. In the analysis section, effort has been put into explaining the methodology used by the authors, when valuating and choosing among parameters given by interviewees. This gives the reader a chance to form ones own opinion about the results, hence, the objectivity of the study will be strengthened as objectivity measures to which extent valuations will have an impact on the findings[39].

2.7 Source Criticism

Our empirical data is partly collected via interviews of people from different parts of the Alpha Box Packaging Solutions. The interviewees are dependent on the component database or have an impact on the management of standard components. We had to rely on these peoples opinion regarding component handling and standardization. This means that it has been important for us to keep in mind that the interviewees probably have their own interest at stake and we have had to look at the whole picture and what benefits the organization the most. To handle this problem, we were always at least two persons interviewing, so that we could discuss and analyze the answers together. The fact that persons from different functions, and thereby with different focus, have been interviewed strengthens the credibility in a total perspective. Also we have been discussing these issues with our tutors both at school and at Alpha Box.

During the interviews all of the information must be interpreted, both questions and answers. Important for us has been to ask as direct and clear questions as possible, to avoid misinterpretations, and the questions has always been discussed in the group beforehand. Another important fact is that we have been situated at Alpha Box, and, thus, always have had the opportunity to ask follow up questions when something was unclear.

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[36] Ibid
[37] Yin (1994), p. 37
[38] Björklund & Paulsson (2003), p. 61
[39] Ibid

3 Theoretical Framework

The theory chapter describes the theoretical framework of this master thesis. Standardization theory is presented with focus on cost saving effect, Total Cost Analysis is used with focus on cost categories and the practical use of Supply Chain Costing is presented.

This chapter aims to outline current knowledge and give a background to the empirical study. First, the area of *component standardization* is studied, a central part of the master thesis. The focus is a basic introduction on how standardization affect different functions in the company, and what kind of costs component standardization can reduce.

The area of *total cost analysis* is examined in order to give a perspective of costs arisen in component purchasing. With this perspective it will be easier to focus on the cost perspective, but most important, by using this framework, the risk of leaving out important cost issues is reduced. Besides, the categorization of costs made in theory is helpful. Three theoretical approaches are examined; Total Cost of Ownership, Life Cycle Costing, and Supply Chain Costing.

3.1 Component Standardization

Component standardization is a strategy developed to handle the problems with an excessive product variety[40]. The underlying thought of standardization is "the replacement of several materials/components by a single component that has all the functionalities of the materials/components it replaces"[41]. That is, similar components will be replaced by one generic component with a broader function; sometimes also referred to as "component commonality"[42]. There are two main ways to standardize; either to redesign, in order to make one common component replace several unique ones or to postpone, which means that the assembly of unique components is postponed to a later stage in the process[43]. In this thesis the first alternative will be considered.

There are three perspectives when performing component standardization[44];

- *Within a product*: Several different components in a product are replaced by one generic component.
- *Among products*: Several unique components in different products are replaced by one generic component.
- *Among product generations*: One generic component is used in different products or upgraded versions.

[40] Perera et. al (1999), p. 109
[41] Sanchez-Rodriguez et. al. (2006), p. 56
[42] Perera et. al (1999), p. 110
[43] Fong et. al (2004), p.124
[44] Perera et. al (1999), p. 110

Significant for the component base in a manufacturing company is that the components have very different characteristics. Some are standard products and some are supplier/company specific, and they also differ in consumption rate and price level[45]. This thesis will consider standard components. When standardizing, there are several characteristics that need to be taken into account[46]. Examples of characteristics are importance for avoiding downtime in production, how expensive the component is and what the delivery conditions are.

3.1.1 Cost Saving Potential

Standardization has proved to increase performance through for example reduced purchasing costs, lower inventory levels and improved supplier delivery performance[47]. Standardization can also improve common operational performance measures in production such as set up and holding costs, order quantity economies, inventory costs and production costs[48]. The component that is used as replacement is often more expensive than at least some of the unique ones it replaces, but given a high budget level, there is always a cost reduction when standardizing, even when the replacing component is much more expensive[49].

The components with the greatest potential for cost savings could possibly be the commercially available and off-the shelf products, like for example screws. The reason is that the engineer responsible for choosing the item, hardly priorities by making a solid investigation. The designer will choose a screw with sufficient characteristics, without thinking of calculating the value.[50]

When standardizing, the *purchasing* power is better leveraged. To be able to standardize, the purchasing function needs to be centralized to gain a good overview. With this overview, it is possible to map out the components in stock and with the help of the users, analyze if the variety could be reduced. An excessive component variety is often more an effect of different local choices than different characteristics on the products of the supplier. A reduced supplier base means lowered costs due to price reductions, less administration and less handling.[51]

The standardization of the components in existing products is important. However, the saving potential may be higher if the standardization is introduced at an earlier stage so that the standardized assortment is included in future designs. To do this, it is essential that the designers follow guidelines right at the beginning in a product design. Then changes in the product design that require additional costs may be

[45] van Weele (2005), p. 75
[46] Storhagen (1995), p. 122
[47] Avery (1998), p. 203
[48] Sanchez-Rodriguez et. al. (2006), p.57
[49] Fong et. al (2004), pp.131-132
[50] Perera et. al (1999), p. 111-112
[51] Avery (1998), p. 203

avoided.[52] Various costs are involved in *product development*, e.g. engineering design costs, drawing costs, and computer processing costs, all possible to influence by standardization. If the component can be used for new generations of products, the development costs can be substantially decreased. The standardization will also have positive implications on the component database, since it will be a lot easier to keep an updated and accurate record.[53]

In *manufacturing*, three cost drivers are of major concern, material costs, facility costs and production costs. Standardization can have positive implications on most parts of the material costs e.g. material costs per unit, procurement costs and material management costs. This is mainly because standardization leads to the possibility of buying a smaller variety in larger volumes, which in turn opens up for quantity discounts. Fewer vendors increase the delivery reliability and avoid unexpected losses, and thereby bulk inventory can be reduced.[54]

Another effect of component standardization is potentially reduced labor costs. This is because a reduced product variety reduces the training time required for the employees. If the same component often is used, the repair time in production will be reduced. It will also be easier for an employee to work at different sites.[55]

The costs in the *distribution* phase, affected by component standardization, are inventory costs. The inventory, and thereby inventory costs, changes in three ways due to standardization actions, with the same service level remained. First, the optimal total inventory level is reduced. Secondly, the inventory level of the standardized components is lower then the inventory level of all the replaced components. Finally, the inventory level of the unique (non-standard) components is increased. The sum of these effects is a reduced inventory level, despite the third effect.[56]

When the produced product goes into usage, the costs that occur are for example *maintenance*, breakdown and backup spare part costs. Maintenance costs can be decreased since one of the cost drivers is labor time, this decreases when components are standardized, because the mechanics can work faster with components familiar to them. Other parts of maintenance costs could be lowered with standardization, such as tooling costs and training costs for employees.[57]

Backup spare costs are also saved when standardizing. A well known example is the extra wheel in an automobile, possible to use at any time when needed. Costs related

[52] Perera et. al. (2007), p. 6
[53] Perera et. al. (1999), pp. 110-112
[54] Ibid
[55] Avery (1998), p. 203
[56] Baker et al (1986), pp. 985-986
[57] Perera et. al (1999), p. 114

to breakdowns can also be decreased. Studies have shown that with the same number of total backup spare parts, the probability of system availability increases.[58]

3.1.2 The Effect of Standardization on Supplier Relations

The standardization of components is tightly connected to the standardization of the supplier base, which is dependent on the relations with the suppliers. In many cases it is more important to have a good relation to the supplier than the actual choice of supplier. The most advantageous supplier relation can be decided by determining the need for closeness and stability.[59] Close relationships are not necessary better but can be valuable in many cases. It is often a requirement in order to achieve effectiveness and in some cases it is necessary if a company wants to develop a long term supplier-customer commitment.[60] A close relation is often both time and cost consuming and not possible to obtain with all suppliers. A preferred situation is a mix of different kind of relations. Sometimes it would be an advantage to develop close relations, maybe even an integrated relation, to assure stability and effectiveness. However, in other cases an arm-length relation is preferable as it gives increased freedom to switch. An arm-length relation is especially useful when the speed of technical change is high.[61]

Single sourcing is often a necessity when developing a close relation with a supplier since it increases the security of the supplier. The supplier is assured that the partnership will continue as a result of the effort given by both parts. There are two issues with single sourcing. The first one involves the problems that can occur when the buying company gets too dependent on a single supplier. Through the usage of alternative suppliers the assurance of material supply increases. The second issue concerns the possibility to control the price levels. On the other hand, single sourcing enhances the buying company's negotiation strength. Because of the concentration of the purchases to a single source the buyer becomes more interesting as a partner.[62]

3.2 Total Cost Analysis

There are many techniques and approaches that concern calculation of a product's cost through the supply chain[63]. Total Cost of Ownership, Life Cycle Costing, Activity Based Costing and Supply Chain Costing are some examples of methods used to achieve a more accurate picture of an organization's total costs. A popular way to illustrate the total costs is to use the iceberg metaphor. The only part visible above the surface is the tip of the iceberg which in this case symbolizes the price. Below the surface the iceberg widens and the majority of the cost volume is found, and the hidden costs are concealed. Examples of hidden costs are; supplier

[58] Ibid
[59] Gadde & Håkansson (1998), p58
[60] Mattsson S-A (1999), p 84
[61] Gadde & Håkansson (1998), p59
[62] Gadde & Håkansson (1998), p 61
[63] LaLonde & Pohlen (1996), pp. 2-3

management costs, administration costs, and maintenance costs.[64] The iceberg is illustrated in Figure 4.

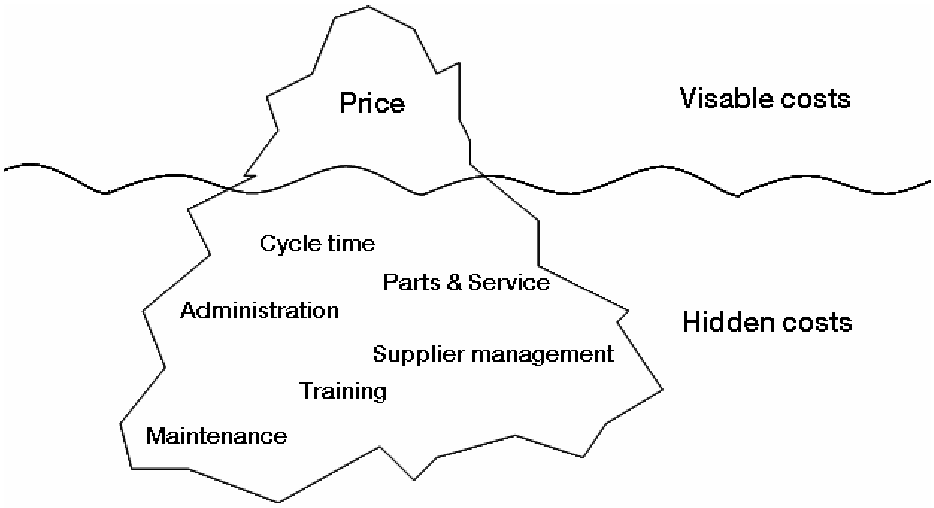

Figure 4: The iceberg metaphor[65]

3.2.1 Total Cost of Ownership

Total Cost of Ownership (TCO) is one model for specifying costs in the supply chain. The TCO concept considers not only the price of an item; all costs related to the specific item are taken into account. It is essential to implement a long-term perspective in order to correctly valuate the buying situation[66]. Three criteria must be fulfilled when implementing a TCO model. First, other costs than the initial purchasing price has to be considered from a long-term perspective. Second, the impact of the purchase on other business functions in the company must be considered. Third, the cost impact of all activities performed in the purchasing situation need to be measured.[67]

The implementation of TCO is one way to better understand the costs that affect a purchased item. The costs are found by mapping the entire acquisition process, from the customer request for an item and until the returns or follow-up on credits, defective items, or invoicing problems. The aim is to find the activities. By analyzing flows and activities an organization can decide which activities add value and which do not[68]. It is essential to identify the inputs, processes and outputs for each activity, in order to analyze the costs of theses activities[69]. By categorizing the costs into

[64] Gadde & Håkansson (1998), p. 55
[65] Avery (1996), p. 45
[66] Ellram & Siferd (1993), p. 165
[67] Ferrin & Plank (2002), p.18
[68] Ellram & Siferd (1993), p. 165
[69] Ellram & Siferd (1993), p. 175

activities it will be easier to understand and recognize the costs. When the activities are found the following questions should be answered: [70]

- Which activities consume the most time?
- What are the costs of these activities?
- What drives the level of these costs?
- For which costs is information readily available?

Studies have shown that it is not possible to develop a generic model for all costs involved. The company that is to implement TCO has to develop its own model and find its own specific costs. But the same cost categories are found in most of the cases and the structure of the costs are often alike. So when implementing TCO, inspiration can be found in other implemented cases.[71]

3.2.2 Life Cycle Costing

Life Cycle Costing, LCC, is a method for total cost analysis with emphasis on the total life cycle cost of an item. The aim of using LCC is to be able to evaluate investment options more effectively and to consider the impact of all costs. Thereby LCC could contribute to effective management and facilitate in choosing between different alternatives.[72]

By quantifying different options, the best possible cost structure for acquiring, owning and operating a physical asset is found. The methodology starts with identifying cost elements of interest. Then the cost structure is created, the costs are grouped in order to identify potential trade-offs. As a third action, a mathematical expression is created that estimates the cost of the item based on independent variables. Further on, a method for formulating the LCC is established, including eight different steps. The first four steps are; establish the operating profile, establish the utilization factors, identify all cost elements and determine critical cost parameters. The last four steps concern pricing and discounting of the identified costs.[73]

There are a range of suggestions of how to group the costs, one example is to use the categories engineering, manufacturing, distribution, service costs and sales costs. Another suggestion is to categorize in use, ownership and administration. There are a number of elements considered in LCC, in order to make an as accurate judgement as possible. The *initial capital costs* are measured with respect to purchasing costs, financing costs and installation and training costs. The *life of the asset* is predicted both in functional, physical and technological terms. A *discount rate* is also calculated, for example by comparing with the price of borrowed funds. The operating and maintenance costs are for example, labour, material, equipment and

[70] Ellram & Siferd (1993), p. 169
[71] Ferrin & Plank (2002), p. 28
[72] Woodward (1997), p.337
[73] Woodward (1997), p.336-339

establishment costs. The *disposal cost* is the costs of demolition, scrapping and selling.[74]

LCC is highly dependent on the *information* available, and it is important to keep the potential cost savings in proportion to the costs of collecting data and analyze information. It is also a fact that LCC is very dependent on estimations and assumptions. This means that there is a requirement to make uncertainty and sensitivity analyses in order to improve quality of the results.[75]

3.2.3 Cost Categories

The total cost analysis starts with categorizing the upcoming costs when handling a specific product. Ferrin & Plank (2002), identified 13 categories of different cost drivers in TCO. The categories are the results of the authors own opinion when trying to estimate the relation between the different answers given in their study of 115 companies.[76] As a complement, a model from Ellram & Siferd (1993) has been used for categorization.[77] Below the different costs mentioned in literature are rendered, in the category where best suited.

Price
Of course the initial price affects the cost of a component. Conditions like price stability and capital expenditure due to price level, affects the cost[78]. Also the time it takes performing activities like price negotiation should be included. The negotiation is based on quality, quantity, freight costs and delivery condition aspects[79].

Supplier relations
Mentioned cost drivers in the category transactions are for example administration of post-purchase agreements, ease of transaction, small orders, procurement and long-term savings[80]. Communication with the suppliers involves activities like communicating forecasts, preparing and sending orders and making invoice adjustments[81]. The Supplier Relations cost category includes drivers such as partnering costs, trust, supplier ability to grow, and service by supplier[82].

Quality
The quality cost driver is multi-faceted, and emphasized in theory. Supplier quality for example is very important, and should be maintained via activities such as careful supplier selection, understanding supplier processes and maintaining supplier

74 Ibid
75 Woodward (1997), p.339
76 Ferrin & Plank (2002), p.24-25
77 Ellram & Siferd (1993), p.166
78 Ferrin & Plank (2002), p.25
79 Ellram & Siferd (1993), p.166
80 Ferrin & Plank (2002), p.25
81 Ellram & Siferd (1993), p.166
82 Ferrin & Plank (2002), p.25

relations[83]. Quality is of course also the quality of the product, affecting cost drivers like durability, customer downtime, rework, out of service costs, and customer returns[84].

Logistics

The aspect of cost arising with a logistics perspective is rather complex. The delivery terms from suppliers and activities like accepting deliveries, accepting partial shipments and arrange for correction of orders are all aspects that influence the total cost of a product.[85] How big these costs get depends on cost drivers as packaging, availability, tariffs and lead-time. Also the inventory and cost drivers like safety stock, storage and design/procurement for inventory reduction are important for an accurate total cost determination.[86]

Operations

In the operations cost driver category there are a number of cost drivers affecting the total cost of choosing a specific product or component; machine efficiency, production to schedule, labor savings, assembly cost and capacity utilization[87].

Service and Maintenance

In the service and maintenance section, there are activities like installing equipment and working with maintenance. There are also activities like ordering spare parts, customer training, maintaining spare parts inventory and responding to complaints.[88] Cost drivers affecting those activities are e.g. training, downtime, repair frequency, spare parts and labour[89].

Life cycle

There is also a life cycle aspect when identifying costs of a product, for example drivers like projected life cycle, life cycle stability, cost savings over life of product and redesign cost. Here there is also a technological category, including drivers like design obsolescence, suitability for intended use, changing technology and supplier ability to change technology.[90]

3.2.4 Supply Chain Costing

In the 1980s a new approach emerged, called Activity-Based Costing, (ABC). Unlike traditional cost accounting, ABC covers both direct and indirect costs. There is also a great difference from traditional cost accounting since ABC uses multiple drivers to assign costs.[91] The strength with ABC is that it shows which activities create value

[83] Ellram & Siferd (1993), p.166
[84] Ferrin & Plank (2002), p.25
[85] Ellram & Siferd (1993), p.166
[86] Ferrin & Plank (2002), p.25
[87] Ibid
[88] Ellram & Siferd (1993), p.166
[89] Ferrin & Plank (2002), p.25
[90] Ibid
[91] LaLonde & Pohlen (1996), p. 4

and which do not. In ABC, activities, resources and cost drivers are central concepts. The activity is what happens in the process, and resources are needed to carry out the activity. Finally, the consumption of resources in a specific activity can be calculated based on the cost drivers.[92]

The Supply Chain Costing (SSC) theory has been developed to analyze the activities involved in the key processes of a supply chain and is a further development of ABC. The main characteristic that distinguishes SCC from other costing techniques is that it focuses on costing activities that crosses the whole supply chain. The costs are divided into four different categories; *Transaction costs, Information costs, Physical cost* and *Inventory carrying costs*. The SCC-approach could be used to e.g. measure the performance of the overall effectiveness of a supply chain, identify areas with improvement potential or to analyze the performance of a single activity or process.[93] It can be thought of as a diagnostic tool for managers to evaluate performance and should be used as a complement to traditional cost accounting[94]. SCC is built up around a six-step methodology;

1. *Analyzing Supply Chain Processes*[95]: Determining the key processes in the Supply Chain, that is the design and manufacture of the product, delivery and sale. Output of this step is a flow diagram with supply chain participants and their major functions.

2. *Breaking Processes down into Activities*[96]: The functions identified in step 1 are broken down into specific activities. It is important to decide where to stop, when the activities have homogenous functions, low relative cost or is of low managerial interest, it is time to stop the decomposition and stay on that level of detail. The output is a flowchart illustrating the sequence of activities.

3. *Identifying the Resources required to perform an Activity*[97]: The resources (labor, facilities, utilities etc.) available in the supply chain are being split with regard to the activities consuming them. Output is a mapping where every traceable cost (resource) is assigned to a certain activity.

4. *Costing the activities*[98]: The cost of an activity is the total sum of all costs for performing that activity, cost of labor, material, administration and facilities. Helpful tools in costing activities are to use expert knowledge, work standards and cost estimates. Output is a picture of the costs, which can assist management in focusing on those activities consuming too much.

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[92] Paulsson et al (2000), p. 130-131
[93] LaLonde & Pohlen (1996), p. 5
[94] LaLonde & Pohlen (1996), p. 6
[95] Ibid
[96] Ibid
[97] LaLonde & Pohlen (1996), p. 7
[98] LaLonde & Pohlen (1996), p. 8

5. *Tracing Activity Costs to Supply Chain Output* [99]*:* By tracing each activity to the different products or customers it serves, the company obtains a comprehensive picture of profitability for each output and also a better view of what activities are value-adding and which are not.

6. *Analysis and Simulation*[100]*:* The usage of the SCC methodology provides a tool for further analysis of the cost drivers. For example specific activities, product and customers can be analyzed. By simulating possible changes in handling e.g. process reengineering and elimination of non-value-added activities, potential for cost savings could be calculated.

3.2.5 Limitations of Using Total Cost Analyses[101]

Using the term total cost is complex and difficult. First, there is a time aspect that needs to be considered, that is, for what time frame is the total cost being calculated? There could be substantial differences in calculating total cost for half a year or two years when comparing e.g. different products. For example, level of claims is not visible until after a certain period of time.

There is also a substantial challenge in deciding what costs should be involved and how they should be calculated. In the discussion of direct and indirect costs, it is for example debatable if Research and Development are costs that can be included in a single product cost. There are also problems involved in deciding, where the specific product chain start and stop?

The total cost of an item is also affected by the characteristics of the marketplace it is supposed to be offered in. The customer’s behavior varies on the market, for example different delivery terms could affect total cost substantially. Closely related to the total cost term, is customer value, a perhaps even better focus. By aiming to reduce total cost, higher customer value is offered.

[99] LaLonde & Pohlen (1996), p. 9
[100] LaLonde & Pohlen (1996), p.10
[101] Paulsson et. al (2000), p.52

4 Standardization at Alpha Box

This chapter presents the standardization work at Alpha Box. The Component Standardization department is presented as well as the current Product Groups.

Since January 2007, Alpha Box consists of three different business areas, Alpha Box Packaging Solutions, Alpha Box Technical Services and Alpha Box Processing Solutions. Packaging Solutions is a fusion between the two former companies Carton Chilled and Carton Ambient. It has the complete responsibility for the production of the filling- and distribution machines and for the packaging materials. Technical Services is the service organization, responsible for customer service and Processing Solutions is the business area responsible for the processing of food and beverages. An illustration of the organization and where CS is placed is shown in Figure 5.[102]

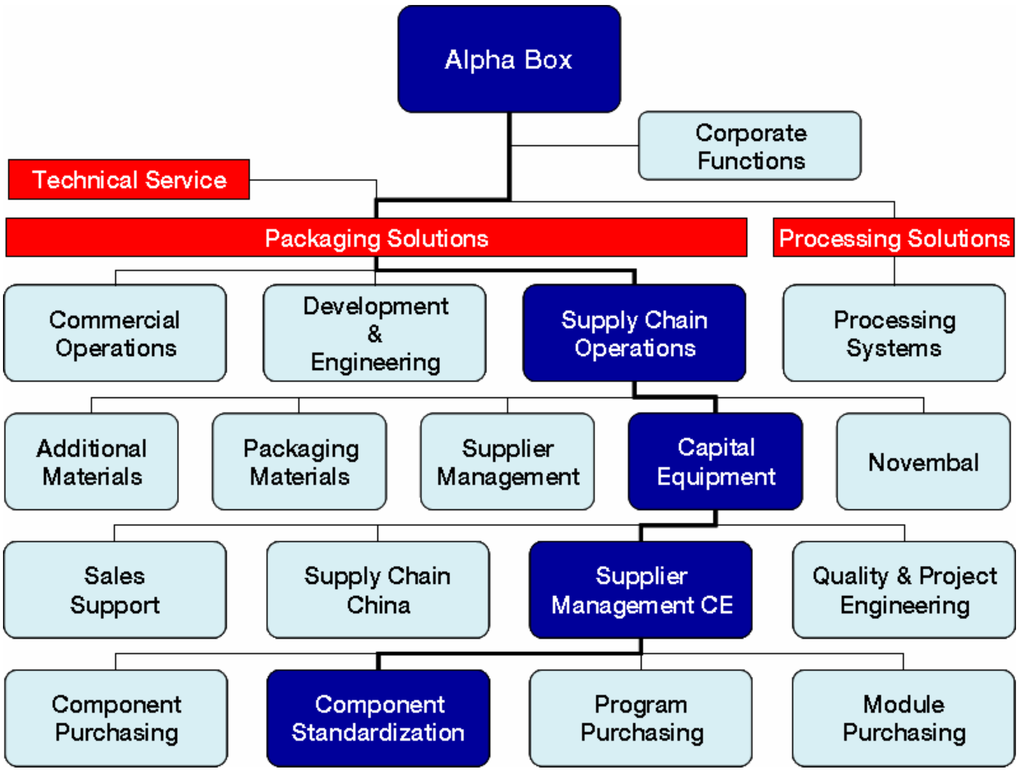

Figure 5: Organization chart, Alpha Box.

Within Alpha Box Packaging Solutions, Supply Chain Operations has the responsibility for all operations concerning the supply chain. Supplier Management Capital Equipment (SMCE) handles the purchasing of the components used in the machines, the capital equipment. SMCE consist of four departments; Component

[102] Alpha Box, Internal Material, 2007-03-12

Purchasing, Component Standardization, Program Purchasing, and Module Purchasing.[103] Component Standardization (CS) is responsible for developing and maintaining a standardized component assortment, in order to support cost effective and sustainable designs[104]. This is performed by tracing current and future technical requirements from the platforms. Appropriate suppliers that can fulfill these requirements are then chosen, in cooperation with Component Purchasing[105]. CS handles mechanical and electrical purchased components for the filling and distribution equipment. There are nine Product Managers at the CS department, each one of them responsible for 4-7 Product Groups.[106]

4.1 Standardization of Purchased Components

To develop and maintain a standardized component assortment is important at Alpha Box for several reasons. When it comes to product development of the machines, a standardized component assortment can prevent extra-work that does not add value. It can reduce the complexity and thereby decrease time to market. By assuring that preferred suppliers are being used the volume of purchased items from the same supplier will increase and this will potentially mean reduced costs. From the customer's point of view, using a standardized component assortment, aims to contribute to a common Alpha Box profile. The handling of spare parts will also be easier and the field of maintenance will be simplified. In the long run, the department of Component Standardization should reduce total costs for Alpha Box.[107]

The standardized assortment should be based on aligned technical requirements.[108] The Product Managers are responsible of continuously developing and maintaining the corporate standard component assortment, and also to introduce, change and phase out components as well as monitor and suggest potential suppliers. The responsibility also includes driving evaluation projects. The Product Managers should promote the use of the corporate standard assortment and preferred suppliers. To do this they need to keep the component data base, PCFinder, updated. The coordination of technical input and demands from Alpha Box towards preferred supplier are also within the Product Managers job description.[109]

4.1.1 Supplier Management

There are numerous suppliers delivering components to Alpha Box's filling and distribution machines. Almost half of them do not supply new machines with components, their products are only used as spare parts to the old machines at

[103] Ibid
[104] Alpha Box, Internal Material, 2007-03-12
[105] Nilsson, S., Mechanical Components, Component Purchasing, 2007-03-14
[106] Lindberg, A-C., Manager CS, 2007-03-15
[107] Alpha Box, Internal Material, 2007-03-15
[108] Ibid
[109] Ibid

customers' sites. The reason for the high amount of spare part suppliers is that the machines have a long lifetime and Alpha Box is obligated to assure spare parts.[110]

The introduction of a new supplier is a process with several steps. Often the need for a new component emerges in the design process and it is the Product Manager that sets the technical specifications. After this the Supply Manager and the Product Manager scans the market for suitable suppliers. A manageable amount is selected and they are investigated more carefully. The suppliers are rated on technical specification, quality, lead time and price. One of the suppliers is selected and the negotiation begins. When the parties agree a contract is set up.[111]

4.2 The Product Groups

There are 28 different Product Groups that the CS department handles today. These groups are further divided into two areas, mechanical components and electrical components. In the two areas the components are divided into Product Groups with respect to their technical function such as hydraulic, fasteners and control systems. These groups are further divided into subgroups called DC-classes, containing products within the same product category such as bushings, springs or cables.[112] A Product Group consists of between 3 and 117 DC-classes.

4.2.1 Component Classification

PCFinder is the database containing all articles in the standard component assortment. It is used by the designers to find an appropriate item. There is also information about the components, e.g. drawings and BoM (bill of materials).

The components in PCFinder are divided into first choice, second choice and local choice. First choice components are also referred to as corporate standard. Those components are owned by its PM and they are checked and controlled to meet specified criteria. They are also from a preferred supplier. Second choice components are owned by people outside CS, e.g. a designer at a platform. Second choice components come from a preferred supplier, but have not been approved by a PM. Local choice components are also owned by people outside CS and they are supplied by companies that are not approved by Component Purchasing.[113]

In order to find out the number of articles and the share of first, second and local choice components, a survey of PCFinder was performed. All Product Groups and DC-classes that had a responsible PM were gone through to achieve a wide understanding of the assortment.

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[110] Nilsson, S., Manager Mechanical Components, Component Purchasing, 2007-03-14
[111] Nilsson, S., Manager Mechanical Components, Component Purchasing, 2007-03-14
[112] Lindberg, A-C., Manager, CS, 2007-01-11
[113] Olandersson, T. Product Manger, CS, 2007-04-26

4.2.2 Volume Value

Statistics concerning volume value for all of the articles where studied. In all there were nearly 9000 articles in the database. The article numbers where not divided in DC-classes from the beginning. In order to arrange the articles in their DC-class information based on their article number was collected from PCFinder. When the article numbers where placed in a DC-class the total annual volume value was calculated. Due to confidentiality the statistics are only presented as relative numbers in the model.

4.2.3 Mechanical Components

The mechanical components are divided into 19 different Product Groups. The Product Groups are handled by 5 Product Managers. Unlike the electrical components, there are seldom natural shifts in generation due to suppliers introducing new components[114]. The mechanical components are presented in Table 1 below.

Table 1: The mechanical components.

Product Group	Description
Bearings and Bushings	*Bearings and bushings in different shapes* This group contains everything that is rotating. The suppliers in this segment compete on quality and not function and the assortment contains mainly bulk components. It is rather uncomplicated to switch among suppliers in this Product Group due to standardized dimensions.[115] Complexity rating: 6
Seals	*Scrapers, rod and piston seals* These components are considered strategic since some of the component helps to prevent food from coming in contact with the wrong elements. The situation today is that some seals are still in use, although they are not approved. The differences between the supplier's products lie mainly in material choice and quality, and they are mainly categorized as bulk. The level of technical development in this group is low.[116] Complexity rating: 8

[114] Gullberg, H., Product Manager, CS, 2007-02-08
[115] Sjöberg, S., Product Manager CS, 2007-02-07
[116] Ibid

Product Group	Description
Fasteners	*Inserts, nuts, pins and screws* A stable group with low technical speed and bulk components. Typical issues for these components are material choice, what kind of steel that is preferable for a screw inside a given location of the machine. Since the Product Group is considered to be bulk, it is difficult to get the constructors time and interest to discuss the problems.[117] Complexity rating: 3
Exterior Components	*Handles, wheels, ladders etc.* In this group the characteristics of the components differ heavily and there are many different suppliers. The group has a strategic importance in the sense that if the components are the same on every machine, this will create a recognition value for the customers.[118] Complexity rating: 4
Pneumatics	*Cylinders, valves, vacuum parts etc.* In the pneumatic case, there are representatives from the preferred supplier that works only with Alpha Box's products. This close cooperation means that the suppliers are aware of the product development projects and can thereby align their component development.[119] Complexity rating: 6
Noise reduction/ Dampers	*Vibration dampers and silencers* There are no ongoing projects in this group, only support is being performed.[120] Complexity rating: 5
Vacuum Parts	*Gauges, pumps and other vacuum accessories* There are no ongoing projects in this group, only support is being performed.[121] Complexity rating: 6

[117] Ibid
[118] Sjöberg, S., Product Manager CS, 2007-02-07
[119] Engström, S-Å., Product Manager CS, 2007-02-09
[120] Ibid
[121] Ibid

Product Group	Description
Hoses and Tubes	*High-pressure and food contact hoses, different material tubes* No particular projects are currently performed with Hoses and Tubes. The only job being done is to answer questions coming up, i.e. pure support work. [122] Complexity rating: 6
Pumps	*Food contact, peroxide and vacuum pumps* This group contains components that are more unique than bulk. [123] Complexity rating: 7
Valves	*Food contact, peroxide and pneumatic valves* The work inside this group is to a large extent similar with the Product Group pumps. [124] Complexity rating: 7
Meters and Instruments	*Level, food contact, flow equipment, gauges* Meters and Instruments is a small non-strategic Product Group with unique products but without specific ongoing projects. [125] This group shares some of its DC-classes with Sensors & Switches. Complexity rating: 5
Drives	*Brakes, chains, clutches and gears* This group includes the components making the machines drive. It is a Product Group with a good structure and solid supplier base, but there is still work to be done. Drives are a strategic Product Group in the sense that they are used in many applications. [126] Complexity rating: 6
Linear Units	*Linear units, slippers and sidebars, bearings* Typical issues are to search for possibilities to change suppliers. The new supplier should have lower prices, but with maintained, or at least sufficient quality. [127] Complexity rating: 6

[122] Ibid
[123] Olandersson, T., Product Manager CS, 2007-02-06
[124] Ibid
[125] Olandersson, T., Product Manager CS, 2007-02-06
[126] Grane, H., Product Manager CS, 2007-02-09
[127] Ibid

Product Group	Description
Springs and Dampers	*Gas springs, tension springs, vibration dampers etc.* Those components are adjusted to fit into a given system, and have to be dimensioned thereafter[128] Complexity rating: 4
Hydraulics	*Valves, fittings and gauges in hydraulics* The Product Group Hydraulics is special since the hydraulic solution is purchased with a given interface. The consequence is that these components are expensive. Complexity rating: 5
Lubrication	*Gauges, equipment and filters* This group does not need much effort to function properly.[129] Complexity rating: 4
Supply Systems	*E.g. pipe carts, cooling units, containers, steam appliances* This group has some common DC-classes with Pipe Components and Hoses & Tubes. Complexity rating: 3
Pipe components	*Pipe fittings and pipe tools* Pipe components have been neglected in the past. For example the assortment in PCFinder contains false information, e.g. corporate standard suggestions that are no longer able to purchase. [130] Complexity rating: 3
Supply Systems	*E.g. pipe carts, cooling units, containers, steam appliances* This group has some common DC-classes with Pipe Components and Hoses & Tubes. Complexity rating: 3

4.2.4 Electrical Components

The electrical components contain 19 Product Groups, of which 13 are being examined in this master thesis. The other groups currently lack a responsible Product

[128] Ibid
[129] Gullberg, H, Product Manager CS, 2007-02-08
[130] Gullberg, H, Product Manager CS, 2007-02-08

Manager, and therefore it is hard to examine them closer to achieve a correct view of the groups. Right now there are four Product Managers working with electrical components.

There has been a rather developed cooperation among the PM in the electrical components section. They have a common network, IAM, International Automation Meeting, where they together meet designers, suppliers and other key actors[131]. At IAM, issues concerning functions in the automation area are discussed and not questions on component level[132]. Generally, the standardization work has gone further among the electrical components than the mechanical, due to that it has been prioritized in the past.[133] The electrical components are presented in Table 2 below.

Table 2. The electrical components.

Product Group	Description
Safety Systems	*Safety relays, emergency stop, safety alerts* The safety systems (warning systems) products are to a large extent controlled by legislations and regulations.[134] Complexity rating: 7
Motor Drive Systems	*Motors, brake motors, frequency converters* The work within this group concerns mainly document handling and support.[135] Complexity rating: 9
EMC[136] Components	*Capacitors, potentiometers, diodes etc.* EMC Components is a fairly updated group, activities are mainly supportive.[137] Complexity rating: 4

[131] Ek, A., Product Manager, CS. 2007-02-13
[132] Månsson, B., Product Manager, CS. 2007-02-12
[133] Ibid
[134] Ek, A., Product Manager CS, 2007-02-13
[135] Ibid
[136] *EMC = electromagnetic compatibility*
[137] Ek, A., Product Manager CS, 2007-02-13

Product Group	Description
Operator panels	*Operator Panels and accessories* Panels is a prioritized group. An extensive project aiming to find a corporate standard that can be used in the majority of the machines is soon finished. Then only one supplier of panels will be needed. There was a great need for standardization due to earlier quality problems.[138] Complexity rating: 10
Buttons and Lamps	*Different kind of bulbs, switches and lamps.* This assortment will be decreased since when the new standardized generation of panels is introduced a majority of the components in this group will be integrated in the panel.[139] Complexity rating: 5
Instrumentation	*Recorders, transducers, counters etc.* A new updated version in one of the DC-classes from the suppliers two years ago requires an update of the assortment.[140] Complexity rating: 7
Transformers and Power Suppliers	*Transformers, power suppliers and power supply accessories* This is a strategic group that has been worked with a lot in the past. The components are considered unique.[141] Complexity rating: 6
Fuses and Circuit Protection	*Fuses, over voltage protection, miniature circuit breakers* A group that contains components with quality problems. The components are unique [142] Complexity rating: 5
Load Breakers	*Switches, accessories etc.* This group is included in Fuses and Circuit Protection.[143]
Relays and Contractors	*Contactors, relays and accessories* This group is included in Fuses and Circuit Protection.[144]

[138] Ibid
[139] Ibid
[140] Ibid
[141] Nilsson, P., Product Manager CS, 2007-02-12
[142] Ibid
[143] Ibid
[144] Ibid

Product Group	**Description**
Sensors and Switches	*Sensors, cables etc* A strategic group with non-bulk components, that has been worked with a lot in the past[145] Complexity rating: 7
Signs and Markings	*Signs, cable marking and terminal marking kit* The group Signs and Markings only requires basic handling due to its low-tech nature.[146] Complexity rating: 1
Panel Software	*Software for panels* Small group with mostly software for panels.[147] Complexity rating: 8
Automation Software	*Software* Software is a small group. It contains two main components, that is very complex and are in need of continuous updating.[148]

[145] Ibid
[146] Månsson, B., Product Manager, CS. 2007-02-12
[147] Ibid
[148] Lind, O., Product Manager CS, 2007-02-14

5 The Flow of Standard Components

This chapter aims to present the costs arising in the standard component flow. The three functions design, purchasing and service are presented together with the standard component activities performed.

A number of functions and departments are involved in the handling of purchased standard components used in the filling and distribution machines. They perform activities that generate costs for the company as a whole, but the handling costs for a Product Group can vary at the departments since there are different issues concerning the type of products. This means that there are different incentives and priority suggestions for standardization work of the Product Group. The identified functions involved in the component handling are; design/product development, purchasing and service/maintenance. The manufacturing is outsourced and performed by outside actors, called Module Suppliers[149]. This means that the component flow is varies from many other manufacturing organizations.

5.1 Product Development and Design

Alpha Box filling and distribution machines are built on platforms.[150] The platforms are responsible for the product development of their machines. This means that they have their own designers constructing the machines in their segment. Roughly speaking, designers involved in the mechanical design are ten times higher than the ones involved in the electrical design.[151]

5.1.1 Standard Component Activities

Standardization in the design phase could be performed in multiple ways. One example is that a platform chooses the same components or complete functions as another platform has already chosen, when possible. This implies that the cooperation with the Component Suppliers should be closer. They should develop functional solutions that can be used in as many machines as possible. The standardization work could also be that the designers are forced to always choose a standardized component. For example, if there are only three possible lengths of a screw and it is not aloud to choose anything else. If the designer still chooses another dimension, the budget of the project should get punished in some way.[152]

At one of the platforms, there is an ongoing project that aims to make improvements due to standardization in the machine design phase. The desired outcome of the project is rationalization in three ways. First, there is a wish to increase the overall use of standard components. Second; it would be desirable to lower the amount of components that has to be added when changing the capacity of the machine. Third,

[149] Nilsson, S., Manager Component Purchasing, 2007-03-14
[150] Alpha Box, Internal Material, 2007-04-10
[151] Månsson, B., Product Manager, CS. 2007-02-12
[152] Binder, L., Manager Concept Studies and Comp. Appl., D&E, 2007-04-03

there is a desire to lower the amount of components that are put into a machine in the project phase. [153] The result of the standardization efforts so far is for example a chart of guidelines for how the designers should choose among components at the platform. This should make the design in line with the standardization work. This has already been carried out for fasteners, but it will probably also be designed for pneumatics and small electrical components. It will possibly also be done with bearings and cylinders[154]. It can be rather difficult to convince the designers to choose from the standardized assortment since they are free to choose about anything. For example, screws are used in all possible lengths[155]. Working with standardization in the design phase is many times difficult, the designers, especially the experienced ones, often prefer to choose components like they always have done[156].

An increased standardization of the assortment would not ease the work for the designers right away according to Malmros (2007-03-20). What it principally contributes to is that cheaper and more appropriate components are chosen from the start. This is important, since once the components have been chosen, there is low probability that the components used will be changed once the machine design is completed.[157]

The product development department thinks that it would be an advantage if the Product Managers, product owners of standard components, will be more visible, and promote the preferred components. Binder (2007-04-03) mentions low cost country sourcing, as a coming issue for Component Standardization that should be handled in the future. A completely new business is to be built in a low cost country where even the components will be purchased from domestic suppliers. The question is if those should only be used there. It is possible that sourcing from this low cost country could be used in the worldwide assortment as well.[158]

5.1.2 Costs in the Design Phase

The fact that so many articles are chosen in the design phase is very costly. The costs are not mainly price differences, but the costs for handling and administration in later stages are noticeably increased. In handling activities like ordering, storing, and gathering are included. There is also a substantial increase in the risk of making mistakes. According to Johannesson (2007-04-02), the components most suitable for standardization efforts are the bulk ones with low complexity. There are however different ways of doing this. For example with bearings, the problem is not that there is a broad supplier base; the extensive assortment with many different dimensions is the problem[159]. One way of standardizing the component assortment is to include the

[153] Malmros, C., Master Data Maintainer, Specification and System, D&E, 2007-03-20
[154] Johannesson, L. Production Technology Specialist, 2007-04-02
[155] Ibid
[156] Ibid
[157] Malmros, C., Master Data Maintainer, Specification and System, 2007-03-20
[158] Binder, L., Manager Concept Studies and Comp. Appl., 2007-04-03
[159] Johannesson, L. Production Technology Specialist, 2007-04-02

component suppliers more; they are the experts in their area and can develop an assortment with dimensions that cover everything needed[160].

Malmros (2007-03-20) mentions Product Groups containing components with low complexity as the ones with the highest potential of cost saving due to standardization in the design phase. That is, components that are used in large volumes in the machines, e.g. fasteners (screws, nuts and washers) or small electrical components such as sensors[161]. Except the fact that it saves time for designers, this kind of standardization can save costs in assembling since the mechanics do not have to think about what size of screw should be assembled where. Time is saved and the risk of mistakes is decreased.[162]

The standardization among platforms could possibly save extensive amounts of money. The components best suited to this form of standardization are for example operator panels. That is because they are associated with a lot of costs introducing, programming the software, employment training (both Alpha Box & customer staff). Most of those costs only arise once, and thereby, noticeable amounts can be saved if the same items are used throughout Alpha Box.[163]

It is desirable that the designers in the development projects have standardized routines of cooperating with CS, then the standardized components would be used to a larger extent. One way of obtaining a better cooperation would be if a CS representative would join the project group.[164]

5.1.3 Sum Up: Standardization Effects on Design

Activities performed	Costs incurred when to many different components is chosen in the design phase	Product groups mentioned
Design and drawing	Personnel Costs (man-hours for the activities)	Fasteners
Choosing components	Life length cost of components	Sensors
	Administration	Operator panels
	Handling	Bearings
	Mistakes being made Price differences	*pneumatics*
		cylinders

5.2 Purchasing

Component Standardization is a part of the Supplier Management Capital Equipment (SMCE) that handles the purchasing part of the component flow. The other

[160] Binder, L., Manager Concept Studies and Comp. Appl., , 2007-04-03
[161] Malmros, C., Master Data Maintainer, Specification and System, 2007-03-20
[162] Binder, L., Manager Concept Studies and Comp. Appl., 2007-04-03
[163] Ibid
[164] Thelin, L., Manager Program Purchasing, 2007-03-23

departments are Program Purchasing, Module Purchasing and Component Purchasing. See Figure 5 for the organization chart.

Component Purchasing has the responsibility of sourcing and contracting component and technical consultant suppliers based on given technical specifications. They are also responsible for the maintenance and optimizing of the supplier relations. The measures for the supplier performance are quality, lead time and price (cost/1 000). Similar to CS their organization is divided into mechanical and electrical components, but the Supplier Managers are responsible for a number of suppliers instead of Product Groups. The targets for Component Purchasing are; improved supplier quality, reduced material cost, reduced complexity of the supply chain and reduced supplier lead time[165]. In the target "reduced material cost", the aim of reduced component cost, reduced module cost and a level of 100 % corporate standard is included, which refer back to the standardization work. The global agreements are used by the Parts Supply that handles spare parts, Program Purchasing and Module Purchasing. This means that the contracts are being used both direct by the platforms at Alpha Box and by the Module Suppliers.[166]

Program purchasing is responsible for purchasing items to the product development projects in the platforms Carton Bottle, Carton Economy and Gable Top Core in the US. Their tasks include; sourcing suppliers, writing project contracts, test the suitability of the different ingoing items in production, pricing of the production, quality assurance and production assurance.[167]

Module Purchasing is responsible for the commercial relation with the suppliers delivering assembled units or complete machines. The Module Suppliers are external companies that produce modules that are to be assembled to complete machines. The final assembly can be performed at a Alpha Box site, but in most cases it is outsourced to an external partner.[168] Module Purchasing decide what components should be used by the Module Suppliers, and in what volumes. They use the contracts prepared by Component Purchasing, and the technical directions from Component Standardization.[169] When sourced and contracted, the MP division is also responsible of maintaining and managing the Module Supplier base.[170]

5.2.1 Standard Component Activities

Component Purchasing is the commercial partner to CS. Hence, they should work for a standardized assortment, standardized components and standardized suppliers. Nilsson (2007-03-14) consider it a team responsibility of standardizing the supplier base, CS should identify technical needs and come up with technical specifications

[165] Nilsson, S., Manager Mechanical Components, Component Purchasing, 2007-03-14
[166] Ibid
[167] Thelin, L., Manager Program Purchasing, 2007-03-23
[168] Holmqvist, O. Manager Module Purchasing, 2007-03-20
[169] Lindberg, A-C., Manager, CS, 2007-03-15
[170] Holmqvist, O., Manager Module Purchasing, 2007-03-20

and Product Development (D&E) should redesign in order to make greater use of the standardized components.[171]

One way of standardizing the supplier base is to work towards single sourcing. Prerequisites for this kind of extended supplier relationship are[172];

- That there is enough volume value in the Product Group to make it worth the effort
- That there exist some interesting actors on the market to choose between
- That there exist suppliers that are big and stable enough to initiate a closer relationship with

Although there are risks involved in single sourcing, Bengtsson (2007-03-14) considers the fact that Alpha Box is not big enough to have several suppliers. They simple do not have the bargaining power. Although Alpha Box is a large and global company as a whole the production of filling and distribution machines is not a comparatively big business. Therefore, single sourcing is the most profitable alternative even when considering the risks involved.[173]

About 30-35% of the total volume value in a module is standardized components. The rest of the volume value is raw material and unique components. The prices of the components are those that have been negotiated via Component Purchasing. The Module Suppliers are supposed to always use those contracts, but sometimes they procure on their own, especially when it comes to low-tech components with high volumes. The reason for this is that the Module Suppliers are often big actors on their market, and they are sometimes larger customers than Alpha Box, which means that they can practice price pressure and benefit from larger economies of scale on their own. That is also the reason why Holmqvist (2007-03-20) thinks it is more important to focus on the critical strategic components than bulk when using resources for standardization. If the standardized components are not used by the outsourcing partners, practically, the entire job with standardizing will be of low practical worth. An increased standardization in the right Product Groups could mean fewer problems with delivery delays and also simplified internal handling.[174]

Module Purchasing is involved in two main ways in the standardized component flow. Firstly, when a new kind of component or technical characteristic is requested, MP is the first division to get to know about it, since they are the ones closest to one of the main users. Secondly, MP gets involved in the standardized components handling on a daily basis, when complaints and delivery problems are reported from the Module Suppliers. Typical problems are that the Component Supplier can not deliver, which means delivery delays for the Module Suppliers as well and as a result, increased costs for Alpha Box. The reason for why the Component Suppliers can not deliver vary, but one reason, that could highly be improved by standardization, is that

[171] Nilsson, S., Manager Component Purchasing, 2007-03-14
[172] Bengtsson, F., Supplier Manager, Component Purchasing, 2007-03-14
[173] Ibid
[174] Holmqvist, O., Manager Module Purchasing, 2007-03-20

the Module Suppliers request obsolete components, that are still registered as standard components in PCFinder.[175]

Two Module Suppliers were contacted to give their opinion on the standardization subject. They bought the majority of their purchased components on Alpha Box contracts; one Module Supplier mentions as much as 98 % in volume value. There are however some components were they use their own contract since they are more beneficial. Fasteners are examples of components that are not bought on Alpha Box contracts[176]. Fasteners is not a big group in volume value, but concerning volume it is an important group. Sometimes new components, used in the new designs, do not have a contract yet[177]. This is possibly costly both for Alpha Box and the Module Supplier[178]. There have been some delivery problems with the electrical cabinets, and quality issues with pneumatic modules[179]. There are also problems with some screws, with special material choices, that are not able to order, hence, they are obsolete. It also happens that electrical components are obsolete[180]. The problems most common for the Module Suppliers is delayed deliveries[181]. According to one Module Supplier, Alpha Box could benefit from economies of scale when standardizing coverings to a higher extent[182]. Quality problems come and go, and are difficult to specify to any certain Product Group[183]. Generally, the Module Suppliers are positive to more standardization, since it would ease communication and mean more attention from the Component Suppliers, since Alpha Box and the Module Suppliers would be a bigger customer[184].

5.2.2 Costs in the Purchasing Phase

When the Supplier Managers have too many actors supplying the same function, it is a waste of working hours. There is also not enough time for maintaining and controlling the quality when the Supply Managers are responsible for too many suppliers. Issues that could get extremely costly due to lack of time are destroyed production and sometimes even damage claims. Costs also incur in maintaining supplier records, obsolete suppliers are not disclosed and in “opportunity losses”. The opportunity losses lie in the fact that with fewer suppliers it would be time for developing closer relationships that could mean lower costs. Closer relationships would also open up for the suppliers to help optimizing their assortment, that is, they

[175] Ibid
[176] Söberg, H. , Module Supplier 1, 2007-04-24
[177] Ibid
[178] Söberg, H., Module Supplier 1, 2007-04-24
[179] Helgewall, M., Manager Business area Machine Systems, Module Supplier 2, 2007-04-11
[180] Söberg, H., Module Supplier 1, 2007-04-24
[181] Ibid
[182] Helgewall, M., Manager Business area Machine Systems, Module Supplier 2, 2007-04-11
[183] Söberg, H ., Module Supplier 1, 2007-04-24
[184] Ibid

can supply the exact components that Alpha Box needs.[185] It will also naturally, save costs due to economy of scale, since bigger amounts could be purchased[186].

A customer focused cost perspective is essential for Alpha Box to remain successful in the future, according to Nilsson (2007-03-14). More efficient functions in the machines provide the customer with a lower production cost. This in turn will give Alpha Box a better reputation. One example is better life-length of the components which will mean fewer operation stops.

Price fluctuations on the components for the modules suppliers are most often only communicated when the prices rise. It is not completely obvious that the cost savings being made due to standardization are visible when contracting the Module Suppliers. A framing agreement is written every second year with the Module Supplier, a product contract is then written every year, and quarterly pricing reviews are being made. This means that the contracting with the Module Suppliers is not synchronized with the contracts prepared by Component Purchasing.[187]

5.2.3 Sum Up: Standardization Effects on Purchasing

Activities performed	Costs incurred when to many different components and suppliers are in the system	Product groups mentioned
Contracting component suppliers	Wasted working hours	Exterior elements
Maintenance of supplier relations	Opportunity losses, (Lowered supplier costs when standardizing makes possibility for partnership)	Non-bulk
Component supplier quality control	Destroyed production (for customers)	Pipes
Contracting Module Suppliers	Component not used by Module Supplier	
Managing Module Supplier base	Obsolete components when Module Suppliers order Price reductions due to delivery delays	
Handling problems between component and Module Suppliers, e.g. delivery failures	Cost of non-quality	

5.3 Service and Maintenance

Technical Service is an independent organization inside Alpha Box and is responsible for service. Their tasks include pre-production services, production services, improvement services and training services.[188] One big responsibility of Technical

185 Nilsson, S., Manager Component Purchasing, 2007-03-14
186 Binder, L., Manager Concept Studies and Comp. Appl., D&E, 2007-04-03
187 Holmqvist, O., Manager Module Purchasing, 2007-03-20
188 Alpha Box, Internal Material, 2007-04-10

Service and the section Parts Supply Chain is to provide the customers with all the spare parts they need. This is managed from the site in Lund, where also the spare part warehouse is situated[189]. Alpha Box filling machine has a rather long life-length, and it is not unusual that 20 year old machines are still functioning properly out at the dairies. This leads to extensive service commitment for Alpha Box and it is important to serve those costumers since goodwill is a crucial measurement for the organization.[190]

5.3.1 Standard Component Activities

The Technical Service department is responsible for Parts Supply worldwide. They have their own warehouse, with 30 000 storage places and 33 000 mini loads, which means 60 000 storage places in all[191]. They deliver to customers all around the world and to regional distribution centers. They also perform the operational procurement for the parts, using the contracts from Component Purchasing. This is why they are the first to know from customers when something is not functioning properly with the components[192].

Safety stock volume for the different components is calculated depending on their characteristics. There are 8 different classes for categorization. Category 1 is for maintenance, that is, spare parts. Category 2 is consuming products, that is, they have to be replaced after a certain number of hours. Category 5 is components that are important on a safety basis. Category 6-8 is non-critical components.[193]

5.3.2 Costs in the Service and Maintenance Phase

Axwik (2007-04-02) is responsible for the *Exchange Component Requests, ECR*. An ECR can evolve for many different reasons, e.g. that a component is impossible to order, that a supplier changes article number, that a supplier replaces the component with another, that there are doubles or that something is wrongly constructed. The ECRs can come from procurement, when they are unable to finish an order, or sometimes from the Technical Service department themselves. It is very important to contact the person who is technical responsible, e.g. the Product Manager before choosing a replacement component. For example there is a black list of suppliers that should be avoided. When one piece of the order is missing, e.g. a component, the complete order is on hold until it is completed.[194] According to Thelin (2007-03-23), not keeping a standardized assortment means a lot of additional costs. The maintenance phase will be more costly, in terms of storing, handling obsolete components and to keep up systems and databases.[195]

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[189] Axwik, U., Quality Investigator, Technical Service, 2007-04-02
[190] Binder, L., Manager Concept Studies and Comp. Appl., D&E, 2007-04-03
[191] Axwik, U., Quality Investigator, Technical Service, 2007-04-02
[192] Ibid
[193] Engman, J. Manager Stock Management, Technical Service, 2007-04-24
[194] Axwik, U., Quality Investigator, Technical Service, 2007-04-02
[195] Thelin, L., Manager Program Purchasing, 2007-03-23

The ECR work is highly prioritized at Alpha Box. When the process has gone so far as to ordering, the customer is very close. And not to be able to deliver, can be extremely expensive, since the goodwill of the whole company is at risk. Lost goodwill due to a service level that is not sufficient to important customers that are global actors, could get extremely expensive [196] Malmros (2007-03-20) stresses the fact that from the customer's point of view the cost for running the machine is important. The size of this cost is affected by the chosen components since they have different life length and differs in complexity which means that maintenance costs differ due to what kind of service is needed and what qualifications needed by the mechanics to perform it.[197]

5.3.3 Sum Up: Standardization Effects on Service and Maintenance

Activities performed	Costs incurred when to many different components and suppliers are in the system	Product groups mentioned
Procurement	Lost Goodwill	Low-volume products with small suppliers
Storing	Storing	
Writing ECR	Orders on hold: Administration costs Personnel costs	
	Obsolete components and systems keep up	

[196] Axwik, U., Quality Investigator, Technical Service, 2007-04-02
[197] Malmros, C., Master Data Maintainer, Specification and System, 2007-03-20

6 Synthesis of Theories

This synthesis chapter is used to describe how the theories presented in chapter three have been used in order to analyze the costs identified in the empirical section.

The main focus of the empirical work has been to investigate the cost structure of the standard component handling and thereby find emerging costs behind the initial price. To track the costs drivers via activities the methodology from SCC, Supply Chain Costing was used. The output was a cost structure map of the component flow.

6.1 Total Cost Analysis and Standardization Theory

The Total Cost of Ownership and Life Cycle Costing theories were used to find the theoretical cost drivers. The categorization of cost drivers discussed in the analysis emerges from the different categories in the theories. The theory was compared to the cost drivers found in the empirical study where the SCC methodology was used, and then categorized with respect to what company function they arise in; *service*, *purchasing* or *design*. This was made with the aim to achieve a better overview and to have some help in translating, e.g. interview answers, into usable cost drivers. Through this comparison it was easier to understand if and why the same kind of costs occurred in different functions. This was important since costs arising in several functions influence the cost structure of a Product Group to a great extent. Using total cost theory was also helpful since it offers the comprehensive picture requested, in order not to neglect any important cost factors.

Since the model should be based on costs that can be influenced by the CS department the costs were subsequently evaluated with respect to standardization theory. Just because a cost driver is not mentioned in standardization theory does not mean that it could not be affected by CS. However, the cost driver in that case deserves a discussion why it is not mentioned in theory. For example, it could be that prerequisites at Tetra Pak make this cost driver important, but it is not a general cost. The output of this discussion is a collection of cost drivers that CS can influence. These cost drivers are then made quantifiable in order to be used in the model. They were also categorized. The categories chosen were *design*, *purchasing* and *service*. The reason for choosing these categories is that these are the main functions involved in components handling. By using them, a comprehensive cost map is achieved. The chosen dimensions will also make it easy for uninitiated to understand and follow the total cost mapping. Inside each dimension, parameters connected to the identified cost drivers, were chosen.

Some of the cost drivers found, e.g. costs due to bad quality, are not possible to quantify right away without translation. The work in this last part was carried out by finding parameters that would give the cost drivers an as accurate picture of the cost significance as possible. This means finding parameters that are assigned to a certain parameter, weight them, and put them into the model.

Figure 6 illustrates the cost driver finding process.

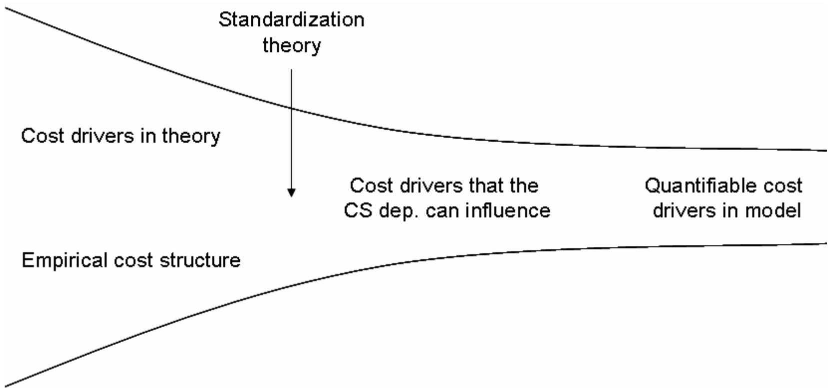

Figure 6: The cost driver finding process.

6.2 Supply Chain Costing - Practical Usage

When collecting information concerning the costs in the flow of standard components, the SCC-methodology[198], presented in the theoretical framework section, was used;

1. *Analyzing Supply Chain Processes*:
The word supply chain can in this case perhaps seem misleading, since the flow analyzed is mainly inside the organization. However, other actors influencing costs of components where also discussed, Components Suppliers, Module Suppliers and customers. However, the main purpose with using this methodology was to observe the different functions and departments inside the organization as independent actors, in order to get their view of the situation. Three functions inside the organization where identified as key actors; Product Design (Development and Engineering), Purchasing (Component, Module and Program Purchasing) and Service/Maintenance (Technical Service).

2. *Breaking Processes down into Activities*:
The interviewees were asked to describe activities carried out inside their specific function that were related to the components. An example from design was "choosing components", from purchasing "maintaining supplier relation" and from service "supplying customers with spare parts. Some of the activities identified were the activities performed by CS, e.g. updating product groups in PCFinder.

3. *Identifying the Resources required to perform an Activity*:
The resources in question in this study are mainly personnel. Two factors were of interest, time required for an employee to perform an activity, and what conditions of a component affecting the time required. However the amount of

[198] LaLonde & Pohlen (1996), pp. 6-10

resources needed was not investigated in detail, only general estimations were made.

4. *Costing the activities*:
The costing of the activities is used relatively in the model. The Product Groups were compared to each other with respect to how much time an activity takes, given the conditions of the Product Groups. For example; choosing an item in the design phase is dependent on the number of choices possible and if there is a first choice component. The activity of choosing a component is also dependent on the technical complexity. The output of this step is the model for prioritizing among the product groups.

5. *Tracing Activity Costs to Supply Chain Output:*
This step was not carried out in this master thesis. It can be a useful complementary study in the future. By investigating e.g. quality of the components a more comprehensive picture can be created regarding standardization value for customers.

6. *Analysis and Simulation:*
It would be desirable to build on the model result. One suggestion is to build a business case, quantifying cost savings being made when standardizing the top scoring Product Groups. It would also be of interest to in detail investigate the effects of standardization. This could be carried out through simulations, determining e.g. quality improvements, price reductions or design simplifications.

7 Standardization and Cost Driver Analysis

This first analysis chapter presents the costs identified arising in the component flow. They will be presented according to which function they arise in and discussed with respect to how those costs are presented in theory.

The future for Alpha Box is characterized by intensified competition. For decades, Alpha Box has been one of the market leaders, with good margins in their business. This has lead to a mentality without emphasize on cost reductions. To keep this mentality could be devastating for the company's existence. Alpha Box must more than ever try to reduce costs in order to face the intensified competition. One way of doing this is to extend the standardizing work. Standardizing at component level is important since they historically have used a huge amount of components and the database is overflowed with components.

One challenge with the standardization work is to find the time and resources to perform it. Today nine people are involved in standardizing the component assortment. The Product Groups consist of about 30 000 articles that are registered in the database PCFinder. The survey performed in this master thesis regarding the database shows that only 24 % of the components in the total assortment are first choice components. This means that they are controlled by the PM, and have the proper quality and characteristics. The rest are either second choice or local choice. The local choice components stand for 48 % of the total amount of components. They are chosen by a designer or a market company and could be all kind of components. This of course has huge implications on quality control and price levels. There is another important issue in the standardization work beside time and resources: How can it be assured that the standardization work will be adding value to Alpha Box in the long run? For example issues like assuring that the designers use the standardized assortment and that Module Suppliers buy on the contracts. To achieve a standardized component assortment that is accepted and used, the different functions in the company need to get more involved. If CS could obtain more resources, they could get more involved, e.g. in product development projects.

In this section the definition of *standardization*, and in what different forms standardization could be performed, is discussed. This is important as a background, in order to understand how the costs mentioned later on are affected by standardization.

7.1 Standardization Approaches

The standardization work can, and should, be performed on different levels. The first way is to diminish the number of articles by replacing some of the present articles with one generic component, hence, the theoretical definition. This is done by cleaning up in the local choice assortment and assuring that there is first choice available for all components. This can also be performed by initiating an investigation in cooperation with the designers. What components are alike in their technical function, and could thereby be standardized? When the technical knowledge among the PM and designers is not enough, the Component Suppliers should be contacted, since they are the real experts on their components. This leads to another important approach in the standardization work, the job of standardizing among dimensions. This work will also have to involve the designers, at an early stage in the product development process. The expression 'dimension' should be widely interpreted; it could involve e.g. material choice, resistance or other features among small components, which today come in many different versions. The best result would be achieved if all platforms were involved in the work and together could agree on standard dimensions and features that are companywide.

There is also a standardization approach that aims to lower the number of suppliers. This should be done in cooperation with Component Purchasing. The work here is to investigate present first choice suppliers; could they widen their assortment of articles that they deliver to Alpha Box, with sufficient quality and good price levels? This is also a question of how close relationships could be developed with the suppliers. E.g. for a single sourcing involvement, the PM must be able to have enough time to thoroughly evaluate the supplier and the quality aspects on its products. When a first choice assortment is developed it has to be promoted towards the designers. If not, the designers will find their components on their own and introduce them as local choice.

7.2 Cost Drivers in the Component Flow

Here the cost structure in the different company functions along the component flow is discussed. This discussion emerges from the empirical studies and the total cost analysis theories. The focus is on the costs that can be influenced by the CS department through their standardization work.

7.2.1 Design and Product Development Costs

In the design phase, the activities performed that include components are simply to choose what component to use. The time it takes to choose a component is dependent on the technical complexity and on how many different items there are to choose between. If there is an updated component assortment, with a first choice that fits into the design, the choice will hardly take any time at all. The cost of choosing a component is not mentioned as a cost driver in TCO theory. The reason for this could either be that for most companies it is not a cost, since they have an updated assortment. It could also be because it is a well hidden cost driver that is not found until asking the designers in detail what activities are time consuming in their job. In standardization theory however the eased design work is a fairly discussed topic, probably since it is an area where standardization has big implications.

There are numerous consequences on the cost structure of the company as a whole involved in the choice of components in the design phase, beyond the operative costs described above. There are for example costs that only occur once, that is, when the component is introduced. These costs are emphasized in Life Cycle Costing, including e.g. installation and training costs. Those costs include training for customers and technicians, and adaptation to functionality solutions. These costs are at Alpha Box normally added on individual platforms. A more comprehensive standardization among the platforms would mean reduced costs for the company as a whole. The mechanics and technician job will be easier with a standardized assortment. In standardization theory, this effect is discussed as a manufacturing effect, since that is the area where the improvements will be visible. To standardize among platforms at Alpha Box requires a proactive approach, and a closer cooperation between the platforms as well as the product owners. The closest correspondence to this discussion in TCO theory is in the category *Miscellaneous* (installation), but there is no perfect match. In standardization theory this is perhaps the most discussed area, the module and group technology thinking, and platform development are very important. However, this topic lies a bit beyond the subject of this master thesis, since it concerns many components in combination. It can probably not be on the agenda until the component assortment has been further standardized.

There is also a more implicit effect that a higher level of standardization in the design phase could offer, possibly the most valuable one. That is the effect of less replaces. An improved efficiency concerning this topic is very important, since having to re-design is costly and a waste of resources. In TCO theory, those costs are categorized in *Life cycle costs*, which could be interpreted as an emphasis on the importance of choosing the right items from the beginning, and that wrong choices could affect the organization for a long time. Those kinds of costs are also mentioned in the categories *Customer-Related* and *Quality*. In a large perspective, the most important improvement is that less components with insufficient quality is put into the machines, which means less problems and product break downs for the customers. This improves the reputation among customers, a highly important issue for an international company like Alpha Box, with large and important customers worldwide. For this standardization effect to be true, it is very important that the standardization work is well performed, and that first choice components always have sufficient quality. In standardization theory the quality improvement effects are not emphasized, but it is not very improbable that it is one of the biggest improvement effects of standardization.

From a design phase perspective, it is interesting to investigate what Product Groups have the highest level of claims. It is also interesting to compare level of complexity among the components in a Product Group.

7.2.2 Purchasing and Supplier Relation Costs

In the purchasing function there are a number of activities that needs to be considered since they can be affected by standardization. However implicitly, the reduced number of suppliers is of interest here, and not the number of different components. It is likely that a reduced component assortment would also mean a reduced supplier base. This means that it is important for the Product Managers to reduce the first choice and second choice assortment, in those Product Groups where there are several suppliers listed. This is because the first choice suppliers are managed by Component Purchasing. Managing supplier relations mean operative costs, resources needed for developing and maintaining supplier relations. It is very important that this is done thoroughly, since it includes quality and delivery condition follow-ups on suppliers, issues that directly affect customer satisfaction. Hence, with this perspective, the Product Groups with largest cost saving potential are those with many different suppliers listed and a parameter that measures number of suppliers is of interest.

Another cost directly affected by the level of standardization among suppliers is the price of components. Fewer suppliers mean greater volumes and lower prices due to economies of scale. Fewer suppliers also enable closer relationships, which in turn could mean other benefits, such as R&D cooperation and in some cases may even the supplier perform some of the operative work. This should of course be weighted against the pros and cons of single sourcing. As mentioned, since Alpha Box is a small customer for global suppliers, it is likely that they could benefit from closer relationships, offering them more attention from the suppliers. To put effort into a single sourcing relationship, there should be interesting potential partners and the volume value of the components should be considerable.

In TCO theory, the cost driver category *Supplier Reliability and Capability*, including cost drivers like supplier capabilities, supplier support and service by supplier, are well corresponding to the costs discussed in this section. Also the *Initial Price* category, (unit cost, initial purchase price) is of interest here. In standardization theory, price reductions, less administration as well as less handling are discussed. Price reduction potential could be measured by comparing first choice and local choice component prices.

There is possibly a need for a more frequent investigation of what contracts are actually used by the Module Suppliers. Contracts not used by Module Suppliers are only used for spare part purchasing. This means that it should not be put as much effort into those contracts. It would also be of interest asking the customers; do they always use the service agreements from Alpha Box? And if not, why is that? Level of standard component usage in development projects would also be interesting to investigate. This implies that one parameter should be share of platforms using the components in the Product Group.

7.2.3 Service and Maintenance Costs

Several cost drivers found in TCO theory appears in the service function, *Inventory cost*, *Transaction cost*, *Customer-related*, *Quality, Logistics* and *Maintenance*. LCC emphasizes the *life of the asset* in functional, physical and technological terms. The operative work performed, warehousing, storing and supplying customers with spare parts are costs dependent on the cost drivers mainly in Maintenance, Inventory cost and Logistics. In Alpha Box's case this is directly related to customer satisfaction, since the spare part handling mainly is for customer production. The Logistics section, including cost drivers like availability, lead-time and tariffs, are much dependent on the suppliers of the components. Standardization theory emphasizes the effect of lowered warehousing and storing costs, but also the fact that labor efficiency in service will be higher when working with a standardized assortment. With this perspective, Product Groups with many local choices, or with suppliers with delivery uncertainties, are prioritized. Customer satisfaction is at stake, and lessened delivery problems are definitely an important issue. Reduced level of local choice components would probably decrease those problems.

How expensive different spare parts are is dependent on their calculated safety stock size need, which is calculated with respect to their level of quality problems and their strategic importance for avoiding break downs in customer production. It is likely that the biggest cost saving potential are in Product Groups with many high classification components, especially if the volume value is high.

8 The Model for Identifying Cost Saving Potential

This is the second analysis chapter and here the model for prioritizing among Product Groups is presented. The ingoing parameters and the characteristics of the Product Groups are described.

The aim of the model is to compare the Products Groups with each other so that a prioritization for how to work with them can be made. The Product Groups are evaluated with respect to how great savings can be made when standardizing the assortment. Each Product Group is illustrated by a three dimensional vector. The dimensions (x, y, z) represents the three different functions mentioned in earlier chapters; *service*, *purchasing*, and *design*. Each Product Group obtains a value in each dimension between 0 and 1 that represents how great the cost saving potential is in that dimension. This gives a vector with values in each dimension, e.g. $PG_1 = (x_1, y_1, z_1)$, illustrated in Figure 7. A background to the basics of linear algebra is given in Appendix 1.

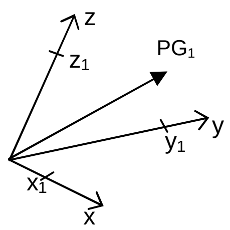

Figure 7: Example of a Product Group vector.

8.1 The Parameters in the Model

The values in each dimension are determined through different cost driver parameters. The Product Group is then evaluated with respect to these parameters and given a value between 1 and 10, where 10 represent the highest potential for cost saving due to standardization. The input value for the parameters for each Product Group has been determined through the investigations in the empirical study. For each parameter, the values are relative; the Product Groups are compared to each other. The determination of what parameters to use has its background in the interviews performed. Then the actual values were found through the quantitative PCFinder survey and volume value survey, complemented with previous qualitative surveys at CS. The Product Managers were asked to rank all Product Groups with respect to complexity.

Table 3 Cost Driver Parameters with Explanation

	Parameter	Discussion
Service	Claims cost	The cost of claims often arises in quality issues. If the standardization is increased it can be assumed that these costs will be reduced through better quality control. This means that if a Product Group has a high amount of claim costs there is more savings to be made through standardization.
	Broken component impact on machine performance	From the customer's point of view, components that have the highest impact on machine performance are the ones causing the highest costs when breaking down. This is important for Alpha Box to consider in order to improve customer satisfaction. The Product Groups that have the highest impact on machine performance should be prioritized.
	Exposure of component	This means that the component is visible, for example a component that the user touches. A high exposure indicates that the component is of strategic interest and therefore it is important to standardize.
Purchasing	Number of suppliers	A high amount of suppliers is associated with costs such as not enough quality control, not obtaining the desired supplier relation, and administrative costs. This means that if the amount of suppliers is high there is a high potential for cost saving.
	Years between new generations	A Product Group that has short time between product generations is harder to standardize and the standardized assortment is valid for a shorter period. This suggests that the saving potential is higher for a Product Group with long time between generations.
	Share of articles	This measurement shows the number of articles, the size, of a Product Group in relation to all Product Groups. If this number is high, there are possibly more components that can be replaced.

Design	**Share of article number per supplier**	If the suppliers only deliver few article numbers it indicates that the supplier base is fragmented. This makes the standardization work more profitable. The actual share is confidential and the relation is described as low/high. If the share is low the saving potential is high.
	Volume value	If the volume value is high there is a high potential for savings when standardizing.
	Complexity	The more complex components the Product Group contains, the harder it is to standardize. It will be more time consuming and require more cooperation with other functions
	Share of DC-classes without first choice	If there is a lack of a first choice assortment the local choice assortment can be assumed to expand. This gives a more fragmented assortment and more and smaller suppliers that arises more costs. Consequently, a higher amount of DC-classes without first choice indicates that the potential for cost savings is higher.
	Share of local choice	Here the amount of local choice components is compared to the total assortment. If the local choice assortment is lowered the handling costs are reduced. A high amount of local choice indicates that there are savings to be made.
	Usage in platforms	The more platforms a component is used in, the greater impact will standardization have. Consequently, the potential for cost savings is higher.
	Usage in strategic development projects	Strategic development projects are important for the future of Alpha Box. If used in the future, the potential for cost savings due to the usage of standard components is high.

In order to assure that the parameters have appropriate impact they are weighted with respect to each other. To receive a value between 0 and 1 the values in each dimension is regulated. In Table 4 the design of the model, with the weightings and explanation to how the parameters are given values, is shown. The complete model is visualized in Appendix 2.

Table 4: Model Dimensions and Cost Driver Parameters

			Weight	Product Group
X Service	**Claims cost**	1: No costs 5: Small amount of claims with low costs 10: Claims with high costs	8	
	Broken component impact on machine performance	1: No impact and low probability 5: Smaller impact that would not affect the costumer economically and medium probability 10: The economic impact will be huge and high probability.	10	
	Exposure of component	1: No exposure of component 5: Component are exposed (but not eye-catchers). 10. The component is visible and intended to be touched.	2	
Y Purchasing	**Number of suppliers**	1: <10 5: 50 10: >100	8	
	Years between new generations	1: Yearly 5: 10 years 10: > 20 years	5	
	Share of articles	0: <1% 5: >5% 10: >10%	1	
	Share of article number per supplier	1: high 10: low	9	
	Volume value	1: low 10: high	8	
Z Design	**Complexity of component**	1: very complex 10: not complex at all	8	
	Share of DC-classes without first choice	0: 0% 5: >50% 10: 100%	10	
	Share of local choice	1: <10% 5: 50% 10: 100%	6	
	Usage in platform	1: No usage 5: Half the MS 10: All MS	7	
	Usage in strategic development projects	1: No usage in SP 5: Used in one SP 10: Used in all SP	6	

8.2 Product Group Characteristics

A background to the input values of the Product Groups is given in the section below. Characteristics such as annual volume value of the purchased components, complexity, and size of the group are discussed.

8.2.1 Mechanical components

Bearings and bushings
These components are not very complex and the dimensions are standardized. 29 % first choice and 31 % local choice is not that bad, however a lot of work could still be done. It is a large group, containing 7 % of the total number of articles and with a somewhat high volume value.

Drives
Drives is one of the biggest groups, with a high volume value, 12% of all articles are in this group. It is also used in many different applications, which makes the assortment structure important. 33 % first choice is very good concerning the size of the group, but among the 33 % local choice articles, some clean up is desirable.

Exterior components
This is a differentiated group with many different components, the DC-classes includes many different articles. First choice share is very low, 9 % and local choice is high, 67 %. Technical complexity is not that high, which makes it hard to gain designer involvement. There is an extra dimension to standardizing this group since the customer will recognize it. Once the assortment has been standardized it will probably last for a long time. Volume value is middle-high, compared to other Product Groups.

Fasteners
A bulk group with low pace in generation shifts. It is a big group with 11 % of all articles. There is a lot of local choice, 62 % to clean up, but there is a rather good, 32 % first choice assortment. One way of reducing the assortment is to reduce the number of different components. Some of the module suppliers do not use the Alpha Box assortment, which lower the importance of standardizing the group. With screws, one module supplier has experienced some quality problems. The volume value is rather high, and technical complexity is very low.

Hoses and tubes
This group contains middle-tech components. It is a small group with only 9 DC-classes with a rather low volume value. There is a lot of work to be done in order to achieve a standardized assortment, today there are only 15 % first choice components but 70 % local choice.

Hydraulics
Hydraulics is one of few groups without any first choice components at all, and with 85 % local choice. From a standardization perspective, this could only indicate that

there is work to do. One reason for the assortment being as it is, could be that hydraulics is bought as a whole solution with a given interface, which makes it difficult to act on component level. The volume value is quite low.

Linear units

In the linear units group, the majority of the DC-classes, 75 %, lack first choice components. There is a desire to change suppliers, so when a proper supplier is found, effort should be put into making them deliver to a majority of the assortment. The volume value is rather low and the components are not very complex.

Lubrication

Lubricants are not highly prioritized today. The statistics could be better, 61 % of the assortment is local choice, but despite this as much as 78 % of the DC-classes have a first choice, which is rather good.

Meters and Instruments

Meters and Instruments has almost no DC-Classes with first choice components, and an as high share as 83 % of the components are local choice. The complexity is not very high and volume value is low. The group has not been prioritized, which explains the bad figures and indicates that standardization effort pays off.

Noise reduction/ Dampers

This is a small group and all DC-classes have a first choice assortment.

Pipe components

Pipe Components is a big Product Group, containing 11 % of total assortment, however, the volume value is not very high. There is a lot of work to do since some of the information in PCFinder is false. This could also mean that the 36 % first choice and 44 % local choice is not as good as it seems. This group should be standardized together with other groups, since it is important that the component dimensions fit together.

Pneumatics

Pneumatics is a Product Group with one of the closest supplier relationships, including cooperative product development. It is a large group, 11 % of total assortment is pneumatic-articles and the volume value is high. There is still some work to be done, 38 % of the articles are local choice according to PCFinder. This could however be misleading figures since the supplier with whom Alpha Box cooperates, are not allowed to put new components in the system as first choice.

Pumps

Pumps can to some extent be characterized as complex components. There is work to be done in order to update PCFinder. This is strengthened by the fact that there are no first choice components at all, and 86 % of the articles are local choice. Pumps are complex products and volume value is rather high.

Seals
Seals deserve attention due to their technical importance in the machines; they prevent the food of coming in contact with the wrong elements. Half of the DC-classes lack a first choice, but only 24 % of total assortment is local choice, which is good. Seals is not a very big group considered volume value.

Springs and dampers
This group has 86 % local choice and 88 % of the DC-classes lack a first choice. The components are non-complex with low volume value.

Supply systems
Supply systems are different small non-complex components. They should probably be standardized along with other groups since they are to be used with e.g. pneumatics, lubricants, pipes and hoses. Concerning the number of articles, it is the largest group, but the volume value is rather high. Half of the articles are local choice, which means that there is work to be done.

Vacuum parts
Vacuum parts is a very small group with only 106 articles in total and the volume value is low. The components are of middle complexity. It should not take that much effort to create a first choice assortment. Today there are no first choice components at all.

Valves
Valves is important since it contains for example food contact valves. It is also a group with a rather high volume value. The technical complexity is quite high. Today the first choice assortment only covers 25 % of the DC-classes and 8 % of total number of articles.

8.2.2 Electrical Components

Buttons & Lamps
Buttons and lamps are characterized as a group with middle technical complexity components. A low volume value is purchased each year. It is a group with a very high share local choice, and very low share first choice components. However this group will be integrated with panels, where a new standardized generation is going to be introduced, and thereby the number of components in the system will be reduced drastically.

Electronic and EMC Components
This group has 70 suppliers supplying 228 articles, which implies that the number of suppliers could be heavily reduced. 4 % first choice components is the lowest share of groups having any first choice components. The components in this group are small, non-complex items like resistors, capacitors and filters. The volume value is rather low.

Fuses and Circuit Protection

This group has 25 suppliers to 11 DC-classes, which is not that high. Only 8 % of the articles are first choice, but in all 60 % comes from preferred suppliers, which should assure sufficient delivery terms and quality level. The components in this group are small and not middle-complex technically. A rather low volume value is purchased each year.

Instrumentation

Instrumentation includes 57 suppliers for 11 DC-classes, which is too many. Hence, there is also a high level of local choice components, 75 %. There is also pressure from the preferred suppliers to update the assortment and adapt to the new generation. The volume value is quite low. The complexity in the components is rather high.

Motor drive systems

Motor drive system has 61 suppliers supplying 22 DC-classes, this is somewhere in between, not very good or bad. The same goes for the share of first, second and local choice share. The volume value is very high in this group. The Product Group contains complex products.

Operator panels

There is extensive work going on in this group, finding one preferred supplier that will deliver to all platforms. Today there is 61 % local choice, probably because this group contains a lot of different components, such as installation tools and accessories. The volume value in this group is low.

Safety systems

The assortment in this group is ruled by laws and legislations, which possibly forces a standardized assortment, the designers can not choose for themselves. 35 % of the assortment is local choice, and although it is not that much, it should be lowered due to the nature of the Product Group.

Sensors and switches

This group has been considered strategic and the components are somewhat complex. Despite this fact there is some work to be done. 74 % of the DC-classes lack First choice components, and 39% is categorized as local choice. It is the biggest electrical group containing 3 % of all articles, and volume value is high.

Transformers and power supplies

This group is well structured. It is one of the groups with the lowest share of local choice, only 29 %, and almost all DC-classes have a first choice. The components are middle complex, with low volume value.

Excluded Product Groups

The Product Groups *Cables*, *Communications, Control Systems, Installation Materials, Sterilization systems* and *Sealing systems* are not included in the study, since they currently lack a responsible Product Manager. *Load Breakers* and *Relays and contactors* are small groups that have been included in the Product Group *Fuses* *and Circuit Protection.* The group *Signs and markings* is also excluded from the study. It is a very low tech group with hardly any product development. It will also not be of interest to develop close supplier relationships. From a standardization perspective, this group is not very suitable. *Automation Software* has also been excluded from the study. Like signs and markings, its distinguishing features make it unsuitable for studying standardization with the chosen perspective. The importance of standardized software can not be enough emphasized, but since maintenance, storing, purchasing and other activities is so very distinguished from the other groups, the group can not be used in this study

9 Model Result Analysis

This chapter presents the result of the model. The Product Groups' scoring in different dimensions is discussed as well as improvement potential of the model.

The model evaluates the cost saving potential among the Product Groups. This gives an indication of where the greatest savings can be made through standardization work and which Product Groups to prioritize. The model also gives information of similarities and differences between the Product Groups. This gives an indication of how the CS department should organize the Product Groups among the Product Managers. The results are presented in the two sections below.

9.1 Cost Saving Potential

The length of a vector is used as a measurement of the cost saving potential due to standardization. Therefore the lengths of all Product Group vectors were calculated and compared to decide where the potential is the highest. It is not only important to look at the length of the vector. The direction is also essential. The potential is a combination of the length of the vector and the spread in each dimension. The spread of the values can also give information on how the standardization work best can be performed. For example, if the Product Group scores high in the purchasing dimension the standardization work should focus on the activities in that area.

The prioritizing result is found in
Table 5 and the result from sorting the Product Groups on the different dimensions; *design*, *purchasing,* and *service* are found in Table 6, Table 7, and Table 8 respectively.

When considering the Product Groups with the highest score in
Table 5 it is clear that the mechanical components have the highest prioritization value. Of the ten Product Groups with the highest score eight groups are mechanical and two groups are electrical components. This can be explained by the fact that the CS department has worked with the electrical components during a longer period of time and also because the filling and distribution machines consist of more mechanical components. It is important to keep in mind that it is not useless to standardize the assortment of those Product Groups that have a low score.

Table 5: The prioritization of the Product Groups.

Product group	|PG|
Pumps	1,41
Valves	1,25
Exterior components	1,22
Sensors & Switches	1,22
Drives	1,18
Meters & Instruments	1,15
Supply Systems	1,14
Springs & dampers	1,11
Hoses & Tubes	1,08
Operator Panels	1,07
Hydraulics	1,06
Linear units	1,05
Instrumentation	1,04
Pneumatics	1,02
Seals	1,01
Fuses & Circuit protection	0,97
Lubrication	0,96
Buttons & Lamps	0,96
Motor Drive Systems	0,95
Vacuum Parts	0,94
Pipe components	0,94
Bearings & Bushings	0,93
Safety systems	0,84
Noise reduction/Dampers	0,78
Fasteners	0,78
Transformers & Power Supplies	0,76
Electronic & EMC components	0,74
Panel Software	0,70

The group that has the highest potential for cost savings are *Pumps*. This group consists of components with a relatively high initial price and they can be seen as rather complex. It scores significantly high in all dimensions especially the *service* and *design* dimension. Because of the total lack of a first choice assortment the selection of component in the design phase is hard and has led to a fragmented assortment which is illustrated by the high amount of local choice components, 86 %

of the total assortment. This fact in combination with the complexity indicates that the communication with the designers is an important part of the Product Mangers responsibility.

Valves is the group with the second highest score. It scores high in the *service* and *purchasing* dimension. It is a group with a high volume value since it used to a great extent in the machines. It also consists of an assortment that has a low level of first choice with many suppliers. The suppliers only deliver a few components each which, according to earlier discussions, indicate that the supplier management costs are high. There are savings to be made if the amount of suppliers is lowered so that they deliver a wider assortment each. First of all it is important to develop a first choice assortment.

Exterior Components and *Sensors & Switches* are the groups that have the third highest score. Exterior Components is a group that has a middle high score in all dimensions. Due to its low-tech nature it does not require a high amount of technical guidance in the design phase. The main issue of this group is that it has a low share of first choice components and several different suppliers. The Product Group has not been prioritized and is therefore in need of clean-up. It is one of the most important groups when it comes to designing machines that the customers recognize. If Alpha Box wants to produce machines that is recognizable for the customers this is where the standardizing work should start. Sensors & Switches is the only electrical group that scored high. This is the largest electrical group which makes it more fragmented than the others. It scored high in the purchasing dimension due to the high amount of suppliers and the fact that each supplier delivers few articles. The standardization work should therefore focus on lowering the amount of suppliers.

In Table 6 the results of the design dimension is shown. The parameters involved are connected to the operations in the design phase. The dimension describes the structure of PCFinder, the tool that the designers use when choosing a component. It also evaluates the complexity of the components and in what platforms they are used. *Pumps* is the group with the highest score, it has already been discussed above. The groups with the second highest score are *Meters & Instruments* and *Springs & Dampers*. They are both middle-tech groups and are in a need of a first choice assortment. They are also represented in all of the platforms and in the strategic development projects.

Table 6: The result of the design dimension

Product group	Score
Pumps	0,92
Meters & Instruments	0,83
Springs & Dampers	0,83
Hydraulics	0,80

In Table 7 the result of the purchasing dimension is illustrated. The parameters affecting the dimension concern the purchasing activities and mainly describe the supplier base. If a group scores high, the work should be focused on lowering the number of suppliers and on achieving a cost-effective relation with the suppliers. The work needs to start with developing a first choice assortment. The group with the highest score is *Drives*, this is one of the biggest groups, 12 % of the total number of articles is found in this group. The first choice assortment share is high compared to other groups but since the volume value of the group is high it is crucial to develop this group further. Because of the size of the group, a higher amount of suppliers may be necessary compared to other smaller groups. But since the amount of article numbers per supplier is low there is a high potential for lowering the number of suppliers.

Table 7: The result of the purchasing dimension.

Product group	Score
Drives	0,79
Sensors & Switches	0,78
Supply Systems	0,76
Valves	0,73

In Table 8 the Product Groups that scored highest in the service dimension is shown. The parameters concerned are from a customer's point of view and the dimension measures how important it is that the service function is working well. The group with the highest score is *Operator Panels*. The reason for this is that the group is the one that the customers interact with and that a broken component has a significant impact on machine performance. However, the standardization work within Operator panels has, because of a major project that is just about to finish, come a long way. The project has standardized the panels so that they can be used in all platforms. Therefore the main activities in the group are to evaluate the project and then continue to support the result of the project.

Table 8: The result of the service dimension.

Product group	Score
Operator Panels	0,82
Pumps	0,80
Valves	0,71
Supply Systems	0,70

9.2 Weaknesses of the Model

The component database PCFinder that has been used to find information and quantitative facts is not 100 % correct. For example, it is not certain that first choice components are supposed to be first choice. They can in some cases be obsolete. However, it is still the database being used within Alpha Box today. The investigations made in PCFinder and with statistical material have also been complicated to handle since they involve so many article numbers. Because of this, some errors may have emerged.

In the volume value study, 20 % of the volume value of spare parts purchased is not included in the statistics. However, this error is likely to be spread among most Product Groups. There is also a problem with a few DC-classes since they are appearing in several Product Groups, e.g. *Supply Systems* share many DC-classes with *Pipe Components* and *Hoses and Tubes*. Handling these problems is one important issue when updating PCFinder.

When designing the model, trust has been put into the Product Managers skills and knowledge of the components. A possible source of error in this case is that the Product Managers do not estimate the impact of their groups the same compared to each other. To avoid this problem we have evaluated the answers and made some corrections. For some Product Groups the complexity estimation is the result of the authors' owns minds.

The fact that the model is divided into three dimensions is also an issue. The parameters involved represent the dimension where they are best suited. They can also influence the other dimensions; they have been placed where they have the greatest impact. The weighting of the different parameters is also the author's opinion, and should be interpreted thereafter. The parameters are not completely non-correlated; they can influence each other. This has been taken into account when the weighting of the parameters was conducted.

10 Standardization and Cost Saving Potential Modeling

This chapter aims to broaden the analysis from the case study perspective to a more general view. Both how Alpha Box should work with standardization from a broader perspective and standardization effect on cost structure on a general level are discussed.

First, the situation at Alpha Box today and possible future considerations are discussed. Topics beyond the model are discussed, and then the general usage of the model is discussed, how, and with what prerequisites could it be used by other companies. This discussion is complemented with thoughts on the costs that are affected the most by standardization generally.

10.1 Standardization considerations for Alpha Box

There are a number of standardization issues that our model does not cover. The model is based on current conditions, changes can occur in the future. For example, Alpha Box is exploring the possibilities in low cost countries. To source components from low cost countries to be used worldwide in the machines could radically change the standardization work. Our focus has been the Lund site and since the Component Standardization department is responsible for standard components for Alpha Box globally, maybe employees from other sites would have important input.

This master thesis focuses on standardizing on the component level. In the future there might be even greater savings to be made if standardizing on a higher level. Alpha Box has during developed the different platforms as more or less isolated projects. This might have resulted in various solutions to the same kind of problems. The intensified competition now stresses the need for a closer cooperation between the projects. When focusing on modularity and standardizing functions the possibility for greater savings will increase. A less detailed level will make it easier to gain involvement from all platforms. Costs could be lowered significantly since higher volumes of the same modules are purchased. The standardization on component level will also be easier to work with. If the functions are already standardized, components are chosen within the functional solution. Thereby, it is much more likely that the designers will stick to those chosen solutions and not choose components on their own.

Also the attitude among the designers needs to be changed, the freedom to introduce new articles as easy as today can no longer be an option. This behaviour has led to a fragmented database where many of the article numbers only have one application. This behavior gives a supplier base where some suppliers deliver components to very small amounts each year. According to the theories on total cost analysis, purchasing price is only a fragment of the real cost. Every single supplier contributes to the administration costs. This emphasizes the need for standardizing through lowering the number of suppliers. The risk of single sourcing is important to keep in mind. But due to the characteristics of the components this is not a valid reason for not lowering the number of suppliers. To keep up two parallel supplier relations delivering the same components is not possible, and to have a supplier delivering more kinds of components does not substantially higher the risk.

One important issue for Alpha Box in order to perform effective standardization work in the future is the information availability. According to Life Cycle Costing theory, it is important to keep the potential cost savings in proportion to the costs of collecting data and analyze the information. In the Alpha Box case, it is likely that they would benefit from putting more effort into information collection. The standardization work would then not be dependent on estimations and assumptions. For example, it would be an advantage if the Product Managers and Supplier Managers could share the same information. It would also be an improvement if the designers had more information helping them to choose the appropriate components. Finally, the information about quality issues from Module Suppliers and customers should be emphasized and made visible for the functions mentioned in this master thesis.

10.2 The Possibility to use the Model in Other Organizations

The model designed in the previous chapter is constructed with the aim to be general so that it can be used by other companies in a similar situation as Alpha Box. It can be difficult for a company to know how to prioritize the standardization work when everything seems to be equally important. That is why our model can be helpful; it helps prioritizing here and now. However, the chosen dimensions and parameters in our example can not be used without concerning the particular situation at the contemporary organization. Consequently, it is also no good to use the weighting from the example without consideration.

The actions to take in order to apply the model on another organization are to achieve an as broad perspective as possible of the situation at the company. This is appropriate to do by mapping out the value adding flow. When this is done, each function involved should be investigated thoroughly. We recommend using the different functions as dimensions, since by this, all functions will get represented and will be treated fairly. It is likely that *manufacturing* is a possible dimension for many companies. When tracing the costs, the usage of a standardized management tool e.g. Activity Based Costing, can be helpful so that important cost drivers not are left out. Once the cost drivers have been found, they should be translated into parameters that are possible to quantify. Here our model could be used as a guideline. Most of the parameters can probably be used with smaller adjustments. However, the parameters can possibly be complemented in most cases, with measurements that are important for the particular organization investigated. Examples of areas that could be more covered are quality aspects and storage measures. When estimating the value of the chosen parameters all sorts of structured information and statistics are valuable. However, it is often a very time consuming work, and the effort should be weighted against the benefit. One effect from this work can be that the organization discovers gaps in their information databases that would be useful to have. As the parameters have been chosen, they should be weighted. Also here, the model could be used as a basis and as inspiration. Generally, parameters concerning quality aspects should be weighted high, since they affect the whole organization as well as their customers. Finally, when analyzing the results, it is a good idea to look for component groups with high volume value, since they indicate higher potential savings.

It is not unlikely that an adjusted version of the model can be used to investigate cost saving potential on other levels than at component level, e.g. at a functional level. One challenge is if the company does not have a Product Group dividing like Alpha Box to prioritize among. Then the people investigating will have to work out their own divide.

10.3 Cost Structure Effects when Standardizing

Standardization and Total Cost Analysis fit well together since both theories focuses on how an organization as a whole can change its operations and how that will make the company more profitable. Combining the two theoretical areas gives a more management-focused perspective on standardization, complementing more technical concerns like modularity.

The cost parameter from TCO theory, perhaps most important to consider in a standardization perspective, is the *cost of non-quality*. Improved quality save costs in terms of less production stops, less re-work, less destroyed production, etc. Since we consider increased control as one of the main effects of standardization, it is likely that quality costs can be reduced. Standardization work can reduce quality problem costs in two ways. The components used, and their characteristics and features will be better controlled. Also the supplier, and its ability to deliver the same quality every time, can be easier to control and manage. The costs caused by quality problems are important to eliminate because they affect the company on various levels. It is likely that other companies will benefit, even more than Alpha Box, from standardization viewed from a quality cost perspective. Since Alpha Box does not have their own production, they do not have to take these quality problems and production stops into account, at least not explicitly.

The *logistics costs* are associated with the cost of non-quality. With fewer suppliers and components the supply chain will be less complicated and easier to manage. This will make the supply chain less expensive and the risk of making mistakes will be reduced. A better quality on the products will also reduce the need of spare parts transport and handling. This leads to another of the potential highest cost saving potential areas; reduced storage volume value for spare parts.

Another cost that can be reduced due to standardization is the *purchasing price*. The reduction of the purchasing price can be performed in two ways. First, by standardizing components, it will be possible to reduce overall prices. This despite that, some articles in the standardized assortment have higher initial price. Overall total cost will however be reduced almost every time, according to standardization theory. The other way of reducing prices due to standardization is to achieve a better negotiation position with suppliers. Here both economies of scale and relation building play an important role.

11 Conclusions

The conclusions discuss the main topics from the model building and the general findings on how standardization can work as a method for making cost savings

The purpose of this master thesis has been to identify parameters affecting the potential of cost savings due to standardization of components. This was accomplished through different approaches in the empirical study. A starting point was the interviews with representatives both from CS and other departments at Alpha Box. Based on these interviews, quantifiable parameters were decided. A parameter is a cost driver that can be affected by standardization work. The set of parameters aimed to give an as broad picture of the cost structure as possible.

The purpose also includes the use of the identified parameters in a model that prioritizes among the Product Groups at Alpha Box. The model was made three-dimensional, with the dimensions representing the three identified main functions involved in component handling at Alpha Box; *design*, *purchasing* and *service*.

11.1 Model Conclusions

From the analysis of the model result it is apparent that some aspects are more important when finding potential savings due to standardization. Both *a high volume value* and the *lack of first choice components* in PCFinder are important parameters when prioritizing. The high volume value has possibly a considerable impact on prioritization since a high volume value enables greater savings. The lack of a first choice assortment is a problem that leads to bad effects. For example that new local choice components continuously will be introduced and that those components do not undergo the same quality control. The importance of a first choice assortment is essential, since a first choice component is basically the result of the standardization work at Alpha Box.

The four groups that have the highest score in the model all have high volume values and a low share of first choice components. *Pumps* scored at a very high prioritizing value compared to the other groups, lacking first choice assortment and with a high volume value. Although pumps have some technical complexity, this complexity should not be overemphasized, and the standardization work should be prioritized right away. *Valves* scored second highest. It is very similar to pumps in its characteristics, a big mechanical group with high volume value, although with some first choice. *Exterior Components* and *Sensors and Switches* scored third highest. Exterior Components will require special attention due to its fragmented character, but the standardization will be rather easy due to low complexity, it will probably last for a long time, and standardization will contribute to customer recognition. Due to the low complexity the main problem when standardizing the Exterior Components may be the lack of interest within the organization. Sensors and Switches is the only electrical group scoring high. It is a big group, which might be the reason for it not being as updated in the assortment as other electrical groups.

The model only shows where the potential savings due to standardization will be high. This means that today the activities performed are costly due to a fragmented assortment in the Product Groups. However it should be kept in mind that the Product Groups that scores the lowest is not necessarily the most structured and standardized groups but there is not a high potential for making savings within these groups. This probably since, small and non-strategic groups are enabled to reduce costs trough standardization.

The third part of the purpose included the fact that the model should be used as a tool for Alpha Box and as a general guideline for similar companies that wants to structure their standardization work. Alpha Box can, as mentioned, use the model for prioritizing, but also in order to structure the work with the groups. Here the model can be helpful since it is possible to see if the Product Group needs to be further structured in order to reduce the supplier base (purchasing dimension) or to reduce number of local choice components (design dimension). Other companies can use the model with smaller adjustments, for example to take in one new dimension (manufacturing) and add more parameters that affect the performance, e.g. quality aspects.

11.2 Conclusions of the Work and the Empirical Study

After spending about four months at Alpha Box, we have realized that the complicated structure in a large organization creates challenges in terms of information sharing and the formation of functions. It is difficult to comprehend where the department of Component Standardization fits into the whole. Several interviews have been conducted and each time it has been apparent that different people have a different view of the situation and opinion on what to prioritize, even though they work towards the same goal and for the same organization. Everything seems to be important at the same time. That is why our model can be helpful at CS, since it helps prioritizing here and now. When interviewing the Product Managers, they were asked to classify the Product Groups they are responsible for as “bulk or unique”. The result was that almost all of the Product Groups were classified as unique. To benefit from standardization and for the CS department to fulfill the aim of providing a standardized component assortment it is not possible to have 30 000 unique components!

As interpreted, the co-operation between the Component Standardization department and the designers needs to get closer. CS needs to be more visible and market the department within the company. The company as a whole needs a clear goal of the standardization work, not just to provide a standardized component assortment. The standardized assortment should be developed in order to make savings throughout the company.

11.3 General Conclusions of Standardization

To perform efficient standardization work the whole organization needs to be involved. Without participation and engagement from the department supposed to use the standardized assortment, the full saving potential can never be reached. The reason for this is that a lot of the cost saving effects due to standardization is obtained when tasks are eased for other departments such as design or service. Making everyone in the organization involved in the standardization work is essential. Forcing them to use the assortment should be achieved through a combination of understanding of the improvements being made and regulations. Examples of regulations could be that designers are punished when not using the standardized items in a construction, or a procurer reprimand when buying from a non-preferred supplier. The practical approach for involving the whole organization is to create networks and project groups with representatives all involved functions.

It could be a topic for discussion if standardization on component level is worth the effort. It is often a complex job, with countless article numbers to work through. However, this is also the reason why it is important. It is not unlikely that many organizations have old items in their databases. By cleaning up, there are probably considerable amounts to be saved. But if the organization wants to work more proactive, component standardization might not be the most efficient strategy. Then it is better to focus resources on standardization in terms of module building and standardized working processes. Component standardization is a good start to make the future standardization efforts on a higher level more likely to succeed.

12 Further Research

Further research is the authors' own suggestions for how the topic from this master thesis can be a further developed studying area in the future.

12.1 Model Development

There are improvements and further development that can be made in the model. To widen the *service* dimension, statistics concerning storage and logistic costs can be added as parameters. Interesting parameters for Alpha Box when comparing the Product Groups could be share of components with high volume value in storage. This parameter is somewhat related to level of quality problems for the components in different product groups, the perhaps most important parameter. It is difficult to acquire reliable statistics that are usable to investigate these parameters. One reason for this is that CS is perhaps the only department at Alpha Box using the Product Group dividing. However, giving the Product Managers access quality problem information would be valuable. More parameters can also be added in the other dimensions in order to strengthen the result.

12.2 Standardization Research

An interesting field of study is to combine the total cost analysis and standardization theory even further. The standardization theories seem to often concern technical issues like modularity and group technology thinking in production. By using a total cost perspective and thoroughly investigate what standardization can actually save in terms of resources, a more management focused perspective is obtained. This research can be performed in many ways, but to achieve knowledge deep enough, each function of an organization should probably be studied individually.

More research should also be put into the field of how to introduce standardization work in an organization. How should a company work with standardization, and how does the company develop the necessary networks to gain approval for the standardized efforts in the organization? How does a company integrate the standardization approach throughout the organization such as in the design phase or in the maintenance phase?

It would also be interesting to examine how to best organize the standardization work. Should the work be performed by a department or a network? If a department is responsible it should be investigated where in an organization it should be located.

At Alpha Box it will be of interest to investigate the possibilities for standardizing on a higher level. That is, to standardize on functions so that the same technical solutions are used throughout the platforms. Empirical information supporting the work can be found in the car industry where the platform thinking has been developed during a long time.

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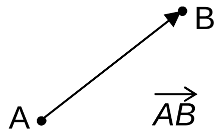
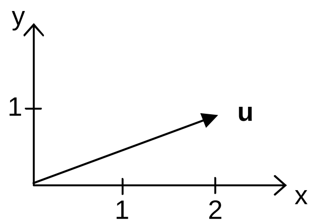
Appendix 1

Geometric Vectors

A vector is a geometric quantity that has a magnitude just as a scalar, but it also has a direction. The difference can be illustrated by the difference between speed and velocity. Speed has a magnitude but velocity also keeps track on direction. Hence, it is necessary to determine both the direction and the size (length). The vector also has a starting (A) and an end point (B).[199]

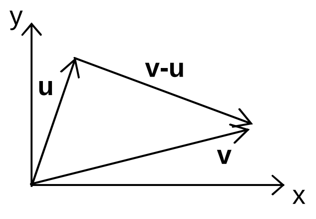


The vector in the coordinate system below to the left is written; **u** = (2, 1). If a vector, **u**, is multiplied by a scalar, λ, the outcome is a vector with the length |λ||**u**| and with the same direction as **u** if λ > 0, the opposite direction if λ < 0. If λ = 0, λ**u** = 0.[200] The length of vector, **u** = (x_1, x_2, x_3) is calculated as below in equation 1. The outcome is a scalar.[201]



$$|\mathbf{u}| = \sqrt{x_1^2 + x_2^2 + x_3^2} \qquad (1)$$

The sum of to vectors is defined as shown in the figure below. **u** = (x_1, x_2) and **v** = (y_1, y_2), illustrated in a two dimension coordinate system below to the left. The vector connecting them (**v**-u) is also shown. To calculate the length of the connecting vector the equation 3.2 is used.



$$|\mathbf{v} - \mathbf{u}| = \sqrt{y_1^2 - x_1^2 + y_2^2 - x_2^2} \qquad (2)$$

[199] Sparr, G. (1994), pp. 18-19
[200] Sparr, G. (1994), p. 20
[201] Sparr, G. (1994), p. 70

Appendix 2

Below follows a description of the model and the results from Alpha Box.

			Weight	10*Weight	Value	Value*Weight	
X Dimension	**Parameter 1**	1: condition 1 5: condition 2 10: condition 3	8	80	3	24	
	Parameter 2	1: condition 1 5: condition 2 10: condition 3	10	100	6	60	
	Parameter 3	1: condition 1 5: condition 2 10: condition 3	2	20	2	4	
				200,0	11,0	88,0	0,4

Figure 8: Shows how the model is designed

In Figure 8 the calculations in the model are shown. The weighting of the impact of the parameters are estimated by the authors. The column called 10*Weight is maximum value for a specific parameter. The column Value in the figure is the estimated value given the conditions. The number in the orange box is regulated, it is the quotient of the Value*Weight and the 10*Weight. In this case this value is the x value in the vector.

			Weight
X Service	**Claims cost**	1: No costs 5: Small amount of claims with low costs 10: Claims with high costs	8
	Broken component impact on machine performance	1: No impact and low probability 5: Smaller impact that would not affect the costumer economically and medium probability 10: The economic impact will be huge and high probability.	10
	Exposure of component	1: No exposure of component 5: Component are exposed (but not eye-catchers). 10. The component is visible and intended to be touched.	2
Y Purchasing	**Number of suppliers**	1: <10 5: 50 10: >100	8
	Years between new generations	1: Yearly 5: 10 years 10: > 20 years	5
	Share of articles	0: <1% 5: >5% 10: >10%	1
	Share of article number per supplier	1: high 10: low	9
	Volume value	1: low 10: high	8
Z Design	**Complexity of component**	1: very complex 10: not complex at all	8
	Share of DC-classes without FC	0: 0% 5: >50% 10: 100%	10
	Share of LC	1: <10% 5: 50% 10: 100%	6
	Usage in platform	1: No usage 5: Half the MS 10: All MS	7
	Usage in strategic development projects	1: No usage in SP 5: Used in one SP 10: Used in all SP	6

Bearings & Bushings			Drives			Hoses & Tubes			Seals			Fasteners			Exterior components			Hydraulics		
3	24		5	40		5	40		2	16		2	16		10	80		5	40	
6	60		7	70		6	60		10	100		2	20		2	20		5	50	
2	4		5	10		5	10		1	2		5	10		10	20		1	2	
11	88	0,4	17	120	0,6	16	110	0,6	13	118	0,6	9	46	0,2	22	120	0,6	11	92	0,5
8	64		10	80		5	40		10	80		5	40		10	80		7	56	
4	20		4	20		7	35		5	25		8	40		5	25		5	25	
7	7		10	10		1	1		7	7		10	10		4	4		2	2	
3	27		8	72		9	81		3	27		1	9		8	72		5	45	
7	56		8	64		2	16		5	40		4	32		5	40		4	32	
29	174	0,6	40	246	0,8	19	173	0,6	30	179	0,6	28	91	0,3	32	221	0,7	23	160	0,5
4	32		4	32		4	32		2	16		7	56		6	48		5	40	
4	40		7	70		7	70		6	60		3	30		7	70		10	100	
3	18		3	18		7	42		2	12		6	36		7	42		9	54	
10	70		8	56		10	70		10	70		10	70		10	70		6	42	
10	60		10	60		10	60		10	60		10	60		10	60		10	60	
31	220	0,6	32	236	0,6	38	274	0,7	30	218	0,6	36	252	0,7	40	290	0,8	40	296	0,8

Linear units			Lubrication			Meters & Instruments			Noise reduction / Dampers			Pipe components			Pneumatics		
5	40		5	40		2	16		4	32		2	16		6	48	
7	70		7	70		4	40		4	40		5	50		6	60	
5	10		4	8		8	16		2	4		7	14		5	10	
17	120	0,6	16	118	0,6	14	72	0,4	10	76	0,4	14	80	0,4	17	118	0,6
4	32		3	24		8	64		4	32		10	80		5	40	
5	25		5	25		5	25		6	30		8	40		6	30	
1	1		1	1		1	1		0	0		10	10		10	10	
9	81		9	81		10	90		5	45		4	36		1	9	
3	24		1	8		5	40		1	8		5	40		8	64	
22	163	0,5	19	139	0,4	29	220	0,7	16	115	0,4	37	206	0,7	30	153	0,5
4	32		4	32		5	40		5	40		4	32		4	32	
8	80		3	30		9	90		0	0		1	10		6	60	
4	24		6	36		8	48		7	42		4	24		4	24	
8	56		10	70		10	70		10	70		10	70		10	70	
10	60		10	60		10	60		10	60		10	60		10	60	
34	252	0,7	33	228	0,6	42	308	0,8	32	212	0,6	29	196	0,5	34	246	0,7

Pumps			Springs & dampers			Supply Systems			Vacuum Parts			Valves			Buttons & Lamps		
8	64		5	40		7	56		4	32		6	48		2	16	
9	90		4	40		8	80		6	60		9	90		4	40	
3	6		4	8		2	4		3	6		2	4		10	20	
20	160	0,8	13	88	0,4	17	140	0,7	13	98	0,5	17	142	0,7	16	76	0,4
4	32		8	64		10	80		2	16		10	80		3	24	
5	25		7	35		3	15		6	30		3	15		5	25	
0	0		2	2		10	10		0	0		4	4		1	1	
10	90		7	63		10	90		9	81		8	72		10	90	
9	72		2	16		5	40		1	8		7	56		1	8	
28	219	0,7	26	180	0,6	38	235	0,8	18	135	0,4	32	227	0,7	20	148	0,5
7	56		6	48		3	24		4	32		3	24		5	40	
10	100		9	90		3	30		10	100		8	80		5	50	
9	54		9	54		5	30		7	42		6	36		9	54	
10	70		8	56		5	35		5	35		10	70		10	70	
10	60		10	60		10	60		7	42		10	60		10	60	
46	340	0,9	42	308	0,8	26	179	0,5	33	251	0,7	37	270	0,7	39	274	0,7

Buttons & Lamps			Electronic & EMC components			Fuses & Circuit protections			Instrumentation			Motor Drive Systems		
2	16		0	0		5	40		6	48		4	32	
4	40		0	0		6	60		5	50		4	40	
10	20		0	0		1	2		9	18		2	4	
16	76	0,4	0	0	0,0	12	102	0,5	20	116	0,6	10	76	0,4
3	24		7	56		3	24		6	48		6	48	
5	25		0	0		4	20		2	10		2	10	
1	1		1	1		1	1		0	0		2	2	
10	90		9	81		5	45		10	90		8	72	
1	8		3	24		3	24		4	32		10	80	
20	148	0,5	20	162	0,5	16	114	0,4	22	180	0,6	28	212	0,7
5	40		6	48		5	40		3	24		1	8	
5	50		6	60		8	80		7	70		6	60	
9	54		9	54		4	24		8	48		3	18	
10	70		3	21		10	70		5	35		9	63	
10	60		2	12		10	60		10	60		8	48	
39	274	0,7	26	195	0,5	37	274	0,7	33	237	0,6	27	197	0,5

Operator Panels			Safty systems			Sensors & Switches			Software			Transformers & Power Supplies		
8	64		4	32		6	48		2	16		3	24	
8	80		7	70		7	70		3	30		5	50	
10	20		7	14		6	12		1	2		2	4	
26	164	0,8	18	116	0,6	19	130	0,7	6	48	0,2	10	78	0,4
4	32		2	16		10	80		1	8		2	16	
2	10		2	10		3	15		1	5		5	25	
1	1		1	1		3	3		0	0		0	0	
4	36		9	81		8	72		2	18		10	90	
4	32		1	8		9	72		0	0		2	16	
15	111	0,4	15	116	0,4	33	242	0,8	4	31	0,1	19	147	0,5
1	8		3	24		3	24		2	16		4	32	
4	40		0	0		7	70		7	70		1	10	
6	36		4	24		4	24		4	24		3	18	
10	70		10	70		10	70		10	70		10	70	
10	60		10	60		10	60		10	60		6	36	
31	214	0,6	27	178	0,5	34	248	0,7	33	240	0,6	24	166	0,4

Product group		X	X^2	Y	Y^2	Z	Z^2	|PG|
Bearings & Bushings	PG^{1}	0,44	0,19	0,56	0,32	0,59	0,35	0,93
Drives	PG^{2}	0,60	0,36	0,79	0,63	0,64	0,41	1,18
Exterior components	PG^{3}	0,60	0,36	0,71	0,51	0,78	0,61	1,22
Fasteners	PG^{4}	0,23	0,05	0,29	0,09	0,68	0,46	0,78
Hoses & Tubes	PG^{5}	0,55	0,30	0,56	0,31	0,74	0,55	1,08
Hydraulics	PG^{6}	0,46	0,21	0,52	0,27	0,80	0,64	1,06
Linear units	PG^{7}	0,60	0,36	0,53	0,28	0,68	0,46	1,05
Lubrication	PG^{8}	0,59	0,35	0,45	0,20	0,62	0,38	0,96
Meters & Instruments	PG^{9}	0,36	0,13	0,71	0,50	0,83	0,69	1,15
Noise reduction / Dampers	PG^{10}	0,38	0,14	0,37	0,14	0,57	0,33	0,78
Pipe components	PG^{11}	0,40	0,16	0,66	0,44	0,53	0,28	0,94
Pneumatics	PG^{12}	0,59	0,35	0,49	0,24	0,66	0,44	1,02
Pumps	PG^{13}	0,80	0,64	0,71	0,50	0,92	0,84	1,41
Seals	PG^{14}	0,59	0,35	0,58	0,33	0,59	0,35	1,01
Springs & dampers	PG^{15}	0,44	0,19	0,58	0,34	0,83	0,69	1,11
Supply Systems[2]	PG^{16}	0,70	0,49	0,76	0,57	0,48	0,23	1,14
Vacuum Parts[3]	PG^{17}	0,49	0,24	0,44	0,19	0,68	0,46	0,94
Valves	PG^{18}	0,71	0,50	0,73	0,54	0,73	0,53	1,25
Buttons & Lamps	PG^{19}	0,38	0,14	0,48	0,23	0,74	0,55	0,96
Electronic & EMC components	PG^{20}	0,00	0,00	0,52	0,27	0,53	0,28	0,74
Fuses & Circuit protection	PG^{21}	0,51	0,26	0,37	0,14	0,74	0,55	0,97
Instrumentation	PG^{22}	0,58	0,34	0,58	0,34	0,64	0,41	1,04
Motor Drive Systems	PG^{23}	0,38	0,14	0,68	0,47	0,53	0,28	0,95
Operator Panels	PG^{24}	0,82	0,67	0,36	0,13	0,58	0,33	1,07
Safety systems	PG^{25}	0,58	0,34	0,37	0,14	0,48	0,23	0,84
Sensors & Switches	PG^{26}	0,65	0,42	0,78	0,61	0,67	0,45	1,22
Panel Software	PG^{27}	0,24	0,06	0,10	0,01	0,65	0,42	0,70
Transformers & Power Supplies	PG^{28}	0,39	0,15	0,47	0,22	0,45	0,20	0,76