Cost Breakdown Analysis

A study of product costs in kitchen appliances at IKEA of Sweden

by

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SUMMARY

IKEA's vision is to create a better everyday life for the many people by offering functional and well-designed home furnishing products at low prices. In order to achieve and retain low prices it is critical to monitor the product cost development. To monitor and lower costs it is necessary to have knowledge of what drives costs in a specific product. The purpose of this study is to increase the awareness of the costs by identifying and analyzing cost drivers for two product ranges within the kitchen appliances, hoods and induction hobs. The study will also expose cost saving potential within the product ranges. In a broader perspective this may result in a cost reduction and increased value for IKEA and its customers.

The authors of this study defined a product cost structure including costs for; material, manufacturing process, assembly, packaging, transport and other related costs for kitchen appliances. The result of the research showed that material cost accounts for a significant part of the total cost for both hoods and induction hobs. For hoods raw material is a much higher cost than for induction hobs, whereas induction hobs have much higher relative cost for semi-finished components. The research also showed that cost for assembly and transport account for a significant part of the total cost in some cases.

Conclusions made from the analysis indicated several cost saving potentials. IKEA should in the future consider using different type of steel for some products in the hood range. It is also recommended to consider how the design of the hood affects the performance, and thereby required motor choice. For the induction hobs the choice of ceramic glass and the solution for the printed circuit board should be considered. Using methodologies to decrease required assembly time and number of components in the hoods can reduce assembly cost. For some products there is also a substantial cost saving potential in sourcing assembly operations to low cost countries.

Keywords: Cost breakdown, cost driver, activity based costing, product cost structure, sourcing, hood, induction hob, kitchen appliances.

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Preface

This Master Thesis was carried out during the spring of 2011, concluding the master's programme in Production Engineering at Chalmers University of Technology. The thesis has been conducted at IKEA of Sweden AB in Älmhult.

The authors would like to dedicate a thank you to all personnel in the Home Furnishing area of Kitchen and Dining, at IKEA of Sweden, for an interesting and inspiring time. We would like to thank Anders Poulsen, category leader for appliances, for giving us the opportunity to perform this research and Mårten Wennersten, sourcing developer for appliances, for all your help and support.

Other people that have been of great importance in the project are Nicola Ossolo, product technician at IKEA trading in Milano, and Jan-Åke Gunnarsson, sourcing developer for steel and plastic. We thank you both for sharing your knowledge and for your support.

Finally we would like to thank our supervisor Peter Almström, at the department of Material and Manufacturing Technology, for your help and assistance.

After five very interesting months, with hard work, interesting insights into the area of product costs and IKEA of Sweden, we are happy to present this research. We hope it will be of value for IKEA of Sweden in their future work of providing functional and well-designed home furnishing products at low prices.

Göteborg, June 2011

Pontus Asking

Stefan Gustavsson

Most values have been altered and two appendices have been removed in this version due to confidentiality reasons. The unaltered version is available through IKEA of Sweden.

Abbreviations

ABC	Activity Based Costing
ABS	Acrylonitrile Butadiene Styrene
BTI	Breath Taking Item
CCE	Cold Continuous Extrusion
DC	Distribution Centre
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization
EPS	Expanded Polystyrene (Also named Cell Plastic)
FOB	Free On Board
IoS	IKEA of Sweden
PA	Polyamide
PC	Polycarbonate
PCB	Printed Circuit Board
PP	Polypropylene
R&D	Research & Development
SAN	Styrene-Acrylonitrile
VAT	Value-Added Tax

1 Introduction

To provide the reader with an understanding of the background and the approach of this thesis, this chapter will describe the problem background, the problem definition, the purpose, the objective and the delimitations. In the end the reading directives will be explained.

1.1 Problem background

The retail industry is constantly struggling with attracting new and existing customers by lowering prices and expanding the offer of appealing products. Globalization has also introduced more competitors on an already competitive market.

IKEA's vision is to create a better everyday life for the many people by offering functional and well-designed home furnishing products at low prices (Inter IKEA Systems B.V., 2011). In order to achieve and retain low prices it is critical to monitor the product cost development. By doing this it is also possible to lower the prices relative to the general price trend. IKEA have an apparent cost consciousness throughout the whole organization and puts efforts in offering high value for low prices. By doing so they will also achieve a financial stability, which allows IKEA to develop and grow in a long-term view. To monitor and lower costs it is necessary to have knowledge of what drives costs in a specific product.

IKEA have an appliances range included as a part of their kitchen range of products that they offer their customers. The kitchen appliances are considered as of high commercial importance for IKEA. Due to the complexity as well as the range variety, IKEA has until date not been able to analyze all cost-drivers in detail. A solid knowledge of the cost drivers is central for IKEA´s understanding and professional behaviour towards the appliances industry.

1.2 Problem definition

The sourcing structure and the product diversity within the kitchen appliances makes it complex to entirely comprehend all the costs involved. IKEA is therefore focusing on this area in order to get a more complete picture of the costs related to the appliance industry. By acquiring knowledge of the critical cost drivers IKEA can expose cost saving potentials, and in the end increase the value for both IKEA and its customers.

The main problem is to clarify the costs and what drives them in the range of hoods and induction hobs. Without this knowledge it is not possible to facilitate cost saving potential. The following questions reflect different steps in the research and will be answered during the progress of the project.

- *What costs can be assigned to the product ranges of hoods and induction hobs?*

- *What drives the cost for hoods and induction hobs?*

- *What are the cost saving potentials?*

1.3 Purpose

IKEA are sourcing the production of their kitchen appliances to producers of appliances that in their turn partly source their production, this forms a complex structure. To date IKEA have not defined and analyzed all the cost drivers for the kitchen appliances. Thereby they do not have a complete picture of the costs concerning the kitchen appliances products they are offering their customers.

In order for IKEA to stay competitive on the appliances market it is important to have knowledge of the appliance industry. To maximize the value for IKEA and their customers the understanding of processes and costs related to the appliances are a necessity. The purpose of this project is to increase the awareness of the costs by identifying and analyzing potential cost drivers for two product ranges within the kitchen appliances, hoods and induction hobs. In a broader perspective this may result in a cost reduction and increased value for IKEA and its customers.

1.4 Objective

To answer the stated questions the assignment need to undertake several activities throughout the project lifetime. Definitions of the costs involved in the product ranges require a complete cost breakdown of the products regarding the relevant cost unit areas. In addition a logical definition and structure of the cost areas is essential for this objective and has to be developed.

The question for definition of the potential cost drivers is an extension to the first query. To reach a realistic conclusion, an analysis of the results from a cost breakdown is required. Cost saving potentials is a possible conclusion from an analysis of the complete cost breakdown and the definition of the cost drivers.

1.5 Delimitations

To be able to reach the desired results the research has to be performed with a clear focus on the problem definition and the expected outcome. This requires several delimitations for the research, mainly due to the time constraints of the project.

- The project comprises two product ranges within the kitchen appliances, hoods and induction hobs, no other product ranges will be regarded within this assignment. Due to time constraints it is not possible to analyze all articles within each product range, thus a couple of samples will be chosen.

- Due to that IKEA was interested in comparing several products in both ranges, a high number of products were selected, with the trade-off in a lower level of detail for some cost categories. The research focus was set on keeping a high level of detail on the material and manufacturing process categories.

- To what extent the samples are disassembled are dependent on assumptions of potential cost drivers, practicality and the modularity in the production.

- Regarding the analysis of the product cost it will only include activities performed by the principal supplier of the product, see Figure 1.

- Regarding the logistic costs the research will only cover the expenses for external transportation, i.e. the cost for transportation of material and finished products.

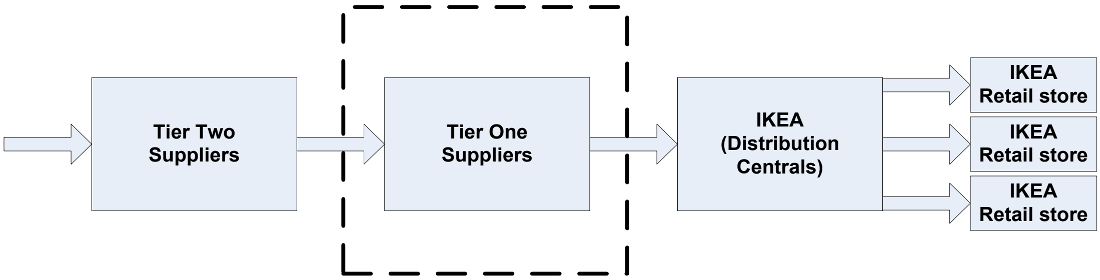

Figure 1 - Tier one perspective

1.6 Reading directives

To give the reader a short introduction to the different parts in this research the following section will explain the content in each chapter. The thesis report is divided into four phases, each including two chapters, see Figure 2.

Figure 2 - Reading directives

Chapter 1 - Introduction

To provide the reader with an understanding of the background and the approach of this thesis, this chapter will describe the problem background, the problem definition, the purpose, the objective and the delimitations. In the end the reading directives will be explained.

Chapter 2 – Company & product overview

The first part of this chapter will give the reader an introduction to the company IKEA and its organization. The second part will cover an introduction to the market characteristics of home appliances, including a short description of the suppliers included in this research. Finally the sample products included in the reference group will be introduced.

Chapter 3 – Methodology

The following chapter will give a deeper understanding of the research methods used in this project. It covers the methods used for the progress of the project as well as methods used for the gathering and processing of data. It will also explain the chronological order in which the project was carried out.

Chapter 4 – Theoretical framework

In this chapter the theoretical framework that is the basis of this thesis is explained. The chapter introduces the reader to the concept of product cost lifecycle. It explains the basics of activity based costing and how the authors defined the activities suitable for this research. Finally the method used to estimate the costs for each activity will be described.

Chapter 5 – Empirical results

The following section presents the empirical data and the final results of the cost breakdown research, i.e. it will answer the stated question: What costs can be assigned to the product ranges of hoods and induction hobs?

Chapter 6 – Analysis

This chapter explains the analysis of the results performed by the authors of this thesis. First the total cost for the products will be compared to give the reader a range perspective and an overview of the product costs. Secondly each category will be further analyzed to understand the cost drivers and the cost saving potentials.

Chapter 7 – Discussion

In this chapter the process and outcome of the research will be discussed to give the reader insight in considerations and issues that may have affected the final result. First the methodology approach will be discussed and the credibility of the outcome will be considered. This chapter also reflects over the theoretical approach and the last section discusses the results and analysis of the project

Chapter 8 – Conclusion

In the introduction of this thesis three questions were defined. The answer to the first question can be found in Chapter 5 and Appendix I. The answer to the second and third question are based upon the answer of the first, derived from the results and analysis of the research and finally presented in this chapter.

2 Company & product overview

The first part of this chapter will give the reader an introduction to the company IKEA and its organization. The second part will cover an introduction to the market characteristics of home appliances, including a short description of the suppliers included in this research. Finally the sample products included in the reference group will be introduced.

2.1 IKEA

In 1943 Ingvar Kamprad founded IKEA, the name is an abbreviation for Ingvar Kamprad Elmtaryd Agunnarryd (Inter IKEA Systems B.V., 2011). During the past 68 years IKEA has grown from a small mail ordering firm outside the small village of Älmhult in Sweden, to one of the world's leading home furnishing companies with global presence. The vision and business idea of IKEA are, (Inter IKEA Systems B.V., 2011):

"To create a better everyday life for the many people."
(Vision)

"To offer a wide range of well-designed, functional home furnishing products at prices so low that as many people as possible will be able to afford them."
(Business idea)

The organization of IKEA consists of the IKEA group, INGKA Holding B.V. and two foundations, Stichting INGKA foundation and Stichting IKEA foundation, see Figure 3.

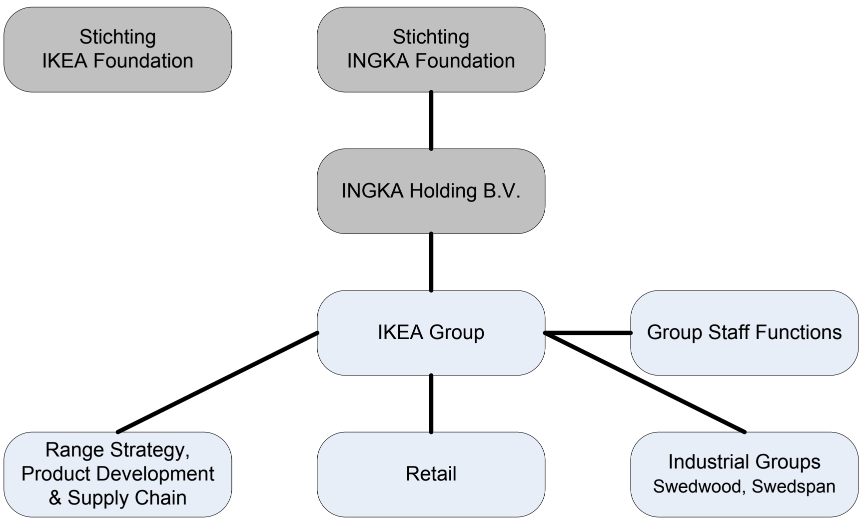

Figure 3 - IKEA Organization

The reasons behind this setup are explained by IKEA in the following way, (Inter IKEA Systems B.V., 2011).

"The Stichting INGKA foundation was established in 1982 by the founder of IKEA, Ingvar Kamprad, to create an ownership structure and organization that stand for independence and taking a long-term approach. It has two purposes – to reinvest in the IKEA Group and to fund charity through the Stichting IKEA foundation."

2.1.1 The IKEA Group

There are four basic areas of responsibility for the IKEA group; range strategy & product development, production, supply and retail. In 2010 the IKEA group had 127 000 employees in 41 countries with a total of 280 stores. The annual sales of 2010 reached 23,1 billion EUR with a steady growth during the last years, see Figure 4. Europe is the largest market with 79 percent of the sales, (Inter IKEA Systems B.V., 2011).

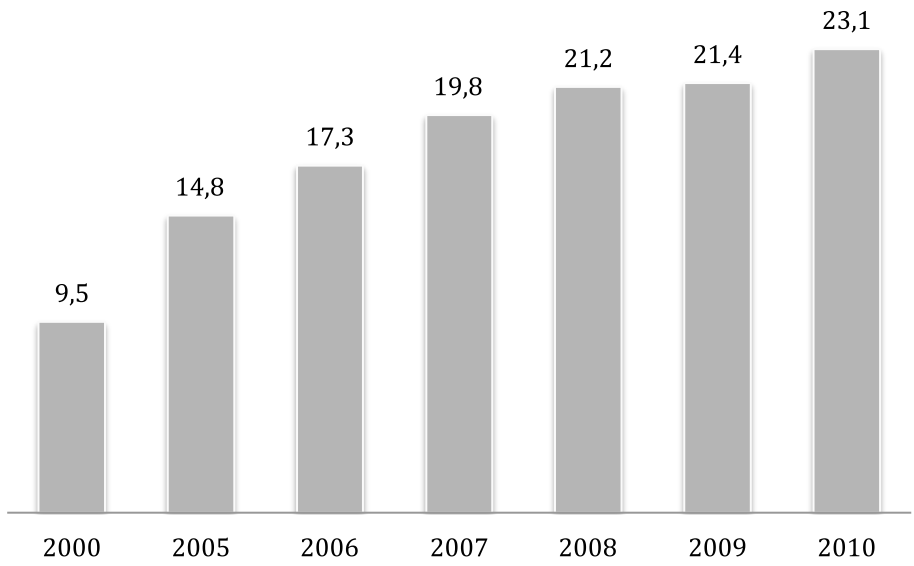

Figure 4 - IKEA annual sales in billion Euro

To give the reader a better understanding of the companies in the IKEA group a short description of each company will be presented below.

- **IKEA of Sweden,** IoS, is responsible for the complete range of approximately 9500 products for IKEA worldwide. The development of products as well as the controlling of the supply chain is done at IoS, from the office located in Älmhult, Sweden. The business is divided into 8 business areas, with the additional Free Range and IKEA Family, (Inter IKEA Systems B.V., 2011).

- **Swedwood and Swedspan** are two industrial suppliers within the IKEA group employing approximately 16 000 people. Swedwood has 41 production units in nine countries and consists of a group of companies responsible for the manufacturing and distribution of furniture's. Swedspan has five production units in five countries with the primary focus of producing wood-based panels for IKEA´s furniture production, (Inter IKEA Systems B.V., 2011).

- **The retail part of IKEA** consists of country specific companies responsible for the sales and stores in each country. The retail part employs approximately 96 500 people and had 626 million people visiting the stores in 2010.

2.2 Industry characteristics

The market for home appliances has a long-term momentum in the growth for the industry demand. Factors that drives demand is amongst other the need for replacing old household appliances for newer models and demand from new markets, especially the emerging markets. The general need for renovation of homes is a factor that also affects the demand for home appliances (AB Electrolux, 2011). The demand from emerging markets depends not only on market penetration but also on the growing middle class. In a global perspective more consumers have enough money to buy more home appliances.

More people are also moving into the cities and urbanization is a factor that drives the development of new solutions for appliances. Urban environment requires better utilization of living space and increase demand for smaller and more flexible appliances solutions. This trend applies for both developed and emerging markets and can be viewed upon as a general tendency for the future development in appliances (AB Electrolux, 2011). Regulations and energy saving objectives, noise levels and user-friendliness are also factors that drive development of new technology.

The appliances industry operates on a global market with regions of different value and conditions. In general the preferences for the products are consolidating over the global market but still the conditions differ over the market regions. Electrolux give details in the annual report for 2010 about the value of the market for appliances. Europe, Middle East and Africa are treated as one market region with a market value of about 23 billion EUR. The expected increase in industry demand for year 2011 for the European market is 2-4 percent (Whirlpool Corporation, 2011). Characteristics of the European market are that it is not consolidated and that the brand range is different for each country. Consumer demand and patterns varies from country to country. Figure 5 shows the distribution of the accumulated market value for appliances. The distribution of appliances in the European market constitutes of numerous local and independent retailers. The trend is though that the distribution share increase for kitchen specialists.

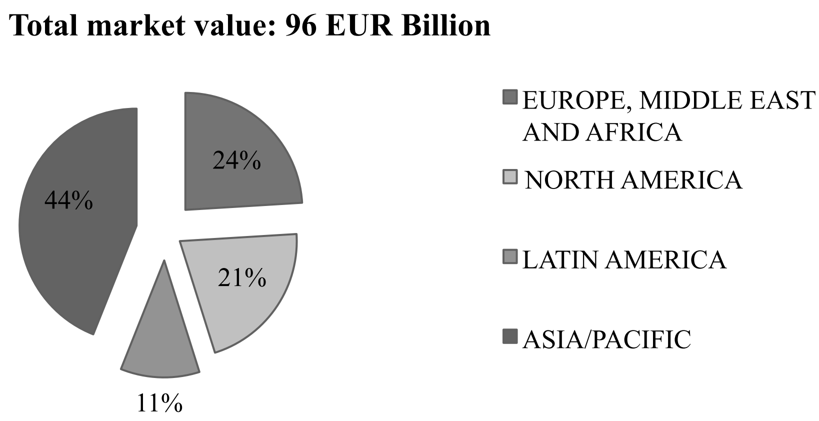

Figure 5 - Distribution of market value for appliances

The value of the market in North America is about 20 billion EUR and the industry demand expects to increase with about 2-3 percent over 2011 (Whirlpool Corporation, 2011). The North American market is less complex with a high level of consolidation amongst manufacturers and a homogeneous consumer pattern throughout the market. In North America there is also a high level of consolidation in retailers for appliances, where the four main retailers hold 60 percent of the market (Electrolux, 2011).

The market value for Latin America for appliances is near 11 billion, which is the lowest among the different markets. The expected increase in demand is instead the highest with a prospect of 5-10 percent over year 2011. In Latin America the greater part of production is domestic as a result of the high transport costs and import taxes. The market has a high level of consolidation regarding the appliances manufacturers and the retailers (AB Electrolux, 2011). In Brazil the three main manufacturers hold 75 percent of the retail sales.

The potentially largest market is the Asia/Pacific with the market value of appliances of 42 billion EUR (AB Electrolux, 2011). The expected increase in industry demand over 2011 is 6-8 percent in Asia (Whirlpool Corporation, 2011). The Asian/Pacific market has as of today no clear manufacturer in market leading position. In the Southeast Asia the consumers consider European brands attractive. The retail structure in Asia is much like the European market with many small, local stores. When it comes to Australia 90 percent of the sales come from the five major retailers. Each market region has its characteristics and manufacturers, and brands have thus different positions on each market. Table 1 demonstrate the major manufacturers on each market, no consideration is taken into size order (AB Electrolux, 2011).

Table 1 - Manufacturers per market

EUROPE, MIDDLE EAST AND AFRICA	NORTH AMERICA	LATIN AMERICA	ASIA/PACIFIC
Electrolux	Electrolux	Electrolux	Electrolux
Whirlpool	Whirlpool	Whirlpool	Fischer & Paykel
Bosch-Siemens	General Electric	Mabe	Samsung
Indesit	LG		LG
	Samsung		Haier

Electrolux

Electrolux is a global manufacturer with several brands on the household appliances market. On annual basis Electrolux sells about 40 million products on 150 different markets, with total revenues of 14.76 BUSD (AB Electrolux, 2011). Within this assignment one of the samples of the induction hobs is a model manufactured by Electrolux.

Whirlpool

Whirlpool is like Electrolux a global manufacturer with many brands on an international market. Whirlpool's annual sales amount to 18,4 BUSD spread over 130 different markets (Whirlpool Corporation, 2011). One of the analyzed samples of the induction hobs in this assignment is manufactured by Whirlpool.

2.3 Product description

In the research a number of products have been selected to work as reference products for the hoods and induction hobs range. To cover as large part of the ranges as possible, the selected products differ in design, specifications, price level etc. It is important that the reader understands the differences to fully comprehend the outcome of the research; therefore a short description of the products will follow. Pictures of the products can be found in Appendix II.

2.3.1 Hoods

In the hoods range there are five products included in this study. Four of the products are hoods and the fifth one is an additional chimney for one of the products. The products are divided into five segments, based on design and price level differences. The five segments are Lagan, Luftig, Dåtid, Framtid and Nutid. The selected products reflect the low, middle and high price range covering three of these segments.

The Hood 1 is a low price range product with simple design. It can be used as a built-in or wall-mounted hood with the combination of the Chimney for Hood 1. The Hood 3 and Hood 4 are medium price level products with high sales volumes. The Hood 2 is a high price range product with increased performance. The specifications for each model are presented in Table 2.

Table 2 - Specification for hood samples

	Hood 1	Chimney for Hood 1	Hood 2	Hood 3	Hood 4
Max. extraction rate:	275 m^3/h		560 m^3/h	325 m^3/h	400 m^3/h
Motor power:	120 W		175 W	240 W	120 W
Nr. of motors	1		1	2	1
Max. noise level:	65 dB		66 dB	64 dB	57 dB

2.3.2 Induction hobs

Induction is a rather new technology within the appliance industry, expected to replace the glass ceramic hobs with radiant cooking zones. The induction hobs consume almost 40 percentages less energy compared to radiant hobs. In the induction hobs range the research includes two products from two different segments, Framtid and Nutid.

The Induction hob 1 is a small domino hob with manual knobs and two induction zones. The Induction hob 2 is a larger model with 4 induction zones and touch controls. The models are produced by different suppliers with the specifications for each model presented in Table 3.

Table 3 - Specifications for induction hob samples

	Induction hob 1	Induction hob 2
Induction zones:	1x1800W, 1x1400W	1x2200W with booster 1x1800W with booster 1x1800W 1x1200W

3 Methodology

The following chapter will give a deeper understanding of the research methods used in this project. It covers the methods used for the progress of the project as well as methods used for the gathering and processing of data. It will also explain the chronological order in which the project was carried out.

3.1 Validity, reliability and objectivity

To be able to determine the credibility of a research project it is of great importance to understand the level of validity, reliability and objectivity of the results (Paulsson & Björklund, 2003). These three measurements are commonly used in research projects to give the reader the possibility to interpret the applicability of the outcome of a project.

- Validity: The level of validity is used to be able to tell to what degree the results of a study really reflect the studied object. In Figure 6 this is visualized as how close to the centre the arrows are, in the sense that the centre is the target value of the measurements. To increase the level of validity it is possible to use two or more methods for examining the same object, known as triangulation. By using more than one method the results will be less affected by possible deficiencies in the unique method and thereby decrease the risk of obtaining biased results.

- Reliability: To be able to use the outcome of a study it is important that the result of a single measurement is the same if the measurement is repeated. In Figure 6, this is visualized as how close together the arrows are, i.e. how corresponding the results will be if you do repeated actions. Also in this case the use of triangulation can improve the level of reliability, for example by the use of different tools for measuring the same object. It is of great importance to perform the study under conditions that are well stated and static during the measurement.

- Objectivity: To be able to define if the outcome of a study is affected by the authors perspective and preferences the level of objectivity is used. In a research project it is of great importance that the results reflect the reality and not the authors view of it. To improve the objectivity of a research it is important to fully define and explain the assumptions and choices taken by the authors (Paulsson & Björklund, 2003).

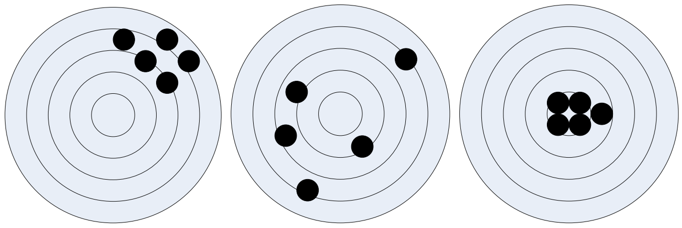

Figure 6 - Visualization of validity and reliability

According to Björklund and Paulsson (2003) the ambition of the study should be to achieve as high level of validity, reliability and objectivity as possible. Due to that research projects often have time and resource constrains it may be impossible to reach a high level in all dimensions and a prioritizing may be needed.

3.1.1 The authors own approach

The authors of this thesis have strived for a high level of validity, reliability and objectivity in this research. To reach the desired level two main factors have been considered. The gathering of data, both theoretical and empirical has to the highest degree possible been taken from two or more sources. This will increase the level of validity and reliability and decrease the risk of obtaining biased results.

To increase the level of objectivity the authors have decided not to mention the IKEA brand in the discussions with possible suppliers. This will decrease the risk of getting price indications that are affected by company specific issues, for example market and supplier strategies. To use suppliers that are not connected to IKEA today will also increase the objectivity of the results.

3.2 Qualitative and Quantitative research

The objective of a research is what really tells if it is of quantitative or qualitative nature (Paulsson & Björklund, 2003). This is to a large extent reflected in how the research is conducted making that the key difference between the two approaches. The level of flexibility and the ability to draw general conclusions are issues that differ and should be considered before conducting the research.

3.2.1 Qualitative research

A qualitative research is used for projects where a deeper understanding of a specific area or occurrence is required (Wallén, 1996). Interviews and observations are the most commonly used methods for gathering of qualitative information. This approach tends to be more flexible than the quantitative due to that the layout of the research can change during the working progress. An example of this may be when the researcher gains deeper knowledge during the gathering of information and therefore changes the purpose of the study. One disadvantage with the approach is the lack of possibility to draw general conclusions due to that the results of the research is highly affected by the difference in methods used at each studied occasion.

3.2.2 Quantitative research

A quantitative research is used when the researcher wants to examine information or data that can be measured in real numbers. This approach is far more structured then the qualitative one, both in the way the information is gathered and in the way the research is performed. The purpose and problem definition are set in the beginning and do not change during the course of the research. The data is gathered in a standardized way making it possible to compare information between different stages in the research. This also makes it possible to draw general conclusions out of a quantitative research (Wallén, 1996).

3.2.3 The authors own approach

In the choice of qualitative or quantitative approach the authors focused on the problem definition of the research. To be able to give answer to the problem definition numerical values needs to be studied and the requirement of verbal information will be limited, making the quantitative approach suitable. A second reason for this approach is the need of a standardized way of gathering data. This is required to make it possible to compare the results of the different objects studied in the research.

3.3 Data collection

For the gathering of data and information several methods can be used. It is important that the choice of which methods to use is made in an early stage of project to make the gathering as efficient as possible (Paulsson & Björklund, 2003). The data is usually divided in two types, primary and secondary data. The primary data is information that is gathered for the specific research while secondary data refers to information gathered for another purpose.

3.3.1 Primary data

The primary data in this research covers all the empirical data gathered together with the data provided by IKEA and external suppliers on request of the authors.

3.3.1.1 Interviews

The use of interviews is a good way of gathering primary data for a research project (Paulsson & Björklund, 2003). There are three main categories of interviews with the following characteristics.

- **Structured interview**
  When conducting a structured interview the questions should be defined before the interview session, together with the order in which they will be asked.

- **Semi-structured interview**
  With this approach the relevant area of subject should be defined before the interview session but the questions and in which order they are asked can be decided during the session.

- **Un-structured interview**
  In an un-structured interview the questions and area of subject are not defined before the session and the characteristic of the interview is close to a conversation or discussion.

In this research the authors have used the semi-structured and un-structured interviews to get a deeper understanding of the function and sourcing setup of the studied products. As there was no need for a deeper understanding of the processes inside IKEA of Sweden the structured interview was not used.

During the time at IKEA of Sweden unstructured interviews were conducted with people at IKEA of Sweden and other IKEA companies. The discussed areas were in the field of questions related to the progress of the research together with requested data available at IKEA. The semi-structured interviews were conducted together with technicians and sourcing developers at IKEA of Sweden. The discussion in these sessions was in the area of specific questions related to the area of expertise of the interviewed person.

3.3.1.2 Surveys

The use of surveys is another way of acquiring primary data. The amount of primary data acquired by the use of this method tends to be high compared to the workload (Peters, Sharp, & Howard, 2002).

A survey should contain a number of predefined questions, with either fixed or flexible response options. The fixed options can for example be the choice among different statements or grades on a scale. The flexible option makes it possible to give a more describing and specific answer to the question. In this research the authors have used surveys to obtain primary data related to information from suppliers. Due to that one of the mayor drawbacks of this method is that the respondents may not prioritize them, the authors decided not to use a standardized form (Paulsson & Björklund, 2003). A second reason for this was that each company needed specific information of the components or products in question. To get as quick replay as possible the questions were sent as a formal inquiry of a price quotation, still with a number of standardized questions. The inquiries were based on the following three questions.

- Can “company X” supply products with the quality and specifications required for usage in Europe?

- Can "company X" supply over 150 000 pieces per year of the products in question?

- What would the FOB price be for this product, with an annual purchase of 150 000 pieces?

The initial contact with the suppliers were made through inquires on the web and then continued by e-mail and phone.

3.3.1.3 Study visits

In this research the production setup of today is studied and therefore it is of great advantage to visit the production plant. This gives hands-on access to data and the possibility to gain deep understanding of the production process. During the project one study visit was performed, which gave the authors deeper knowledge and understanding of the production process.

3.3.2 Secondary data

The secondary data used in this research is used for the theoretical basis and for gaining deeper understanding of IKEA of Sweden.

3.3.2.1 Literature

For the gathering of secondary data articles and books have been used. These resources were gathered at the Chalmers library. For the theoretical basis the literature has been in the area of production, cost analysis and logistics costs. The literature regarding the methods and the work process has been in the area of science and research methodology. Several articles were used in the research, mainly gathered from the database Science direct, also available at the Chalmers library.

3.3.2.2 Internal documents

To get a deeper understanding of the processes required for the studied products internal documentation has been gathered. These have preliminary been in the area of the sourcing setup of the products, technical specifications and sales data.

3.4 Work process

To give the reader a better understanding of the chronological order in which the research was carried out the following outline will highlight the critical parts.

- **Data collection and screening process**
  Due to time and resource limitations it was not possible to include all articles in the product range and therefore a group of reference products had to be selected. Relevant data for each product were gathered and in collaboration with involved personnel at IKEA of Sweden, seven products were selected for the reference group, see Chapter 2.3. Factors that the screening process was based upon were sales volume, suppliers, price segment and design solutions.

- **Workshop**
  To be able to document and study each component in the products several workshops were arrange. The products were disassembled and measurements were documented according to a standardized form. This form was developed by the authors in advance to make sure that all necessary data were gathered and that it was done in the same way for all products.

- **Development of cost breakdown tool**
  To be able to examine the costs involved in the products the authors had to acquire theoretical knowledge in the area of cost breakdown analysis. A standardized tool covering all costs involved in the products was developed to work as a template for the calculations for each product, see Appendix I.

- **Gathering of costs**
  Due to the different areas of costs related to one single product, different methods were used to gather the data. Interviews, inquiries and literature research were methods used for the gathering of costs related to components and material. For the cost of production activities, a theoretical model was used, see Chapter 4.4.

- **Computations of costs**
  Due to that the gathered data of costs in many cases were specified per unit weight or volume there was a need to apply these numbers on the specific dimensions of the products studied. Also for the manufacturing costs numerous of more complex calculations were required.

- **Summation of results**
  The last part of the research was to gather all the information and present it in a way that made comparison between the products possible.

4 Theoretical framework

In this chapter the theoretical framework that is the basis of this thesis is explained. The chapter introduces the reader to the concept of product cost lifecycle. It explains the basics of activity based costing and how the authors defined the activities suitable for this research. Finally the method used to estimate the costs for each activity will be described.

4.1 Product life cycle theory

According to Musadiq (2008) a products life cycle can be divided into four stages; introduction, growth, maturity and decline, see Figure 7. Different products have different attributes and may behave in different ways on the market, but this model can in general be applied for a generic product.

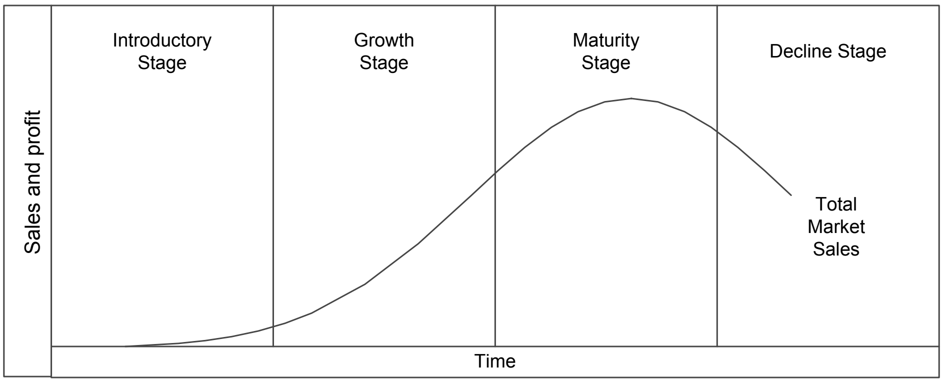

Figure 7 - Product life cycle

- The introduction stage is where a new technology or product is launched and the acceptance of the customers is tested. This is a period of slow growth, low volumes and high production cost.

- Next phase is the growth stage where the product sales increase significantly by attracting new customers and further purchase by existing customers. The demand is increasing and the new technology can deliver high profits. This leads to more suppliers and increased competition.

- In the maturity stage the competition is high and they struggle to take market share on a market that is increasing in a decreasing pace. Suppliers start to compete with price, which requires lower production cost and lower margins.

- The decline stage is when the sales and profit only decline. Production and storage cost continuously increase, in relative terms per product. In this stage the suppliers that are still acting on the market consider to put more effort in alternative products (Slack & Lewis, 2002).

4.2 Activity based costing

To be able to define the costs related to a specific product a method for product cost calculations is required. The model should state where and how to look for costs and what factors to consider. According to Ask & Ax (1995) the ABC model (Activity-based Costing) is the most established one within the area of product cost calculations, especially for manufacturing companies.

In the ABC model there are two central parts, the activities and the cost drivers. The model is based on that the costs for a product are closely related to the costs for activities required for that specific product (Aniander et al., 1998). It is the cost of the activities that is calculated and then assigned to the product. Examples of activities are manufacturing processes, material handling, product development, marketing etc. When the activities and its including costs are defined the cost driver is needed. The cost driver is used as a factor or variable to define the consumption of each activity for a specific product, i.e. how much of the cost for an activity that should be assigned to a specific product. The summation of the assigned costs for each activity adds up to the total cost of the product.

4.2.1 Work process of Activity-Based Costing

According to Ask & Ax (1995) there are five basic steps involved in the calculations of the total cost of a product. The steps will be shortly explained below and work as a guideline for the research.

1. **Identify and select activities**
   The first step is to identify the activities that are present in the process of a product. Depending on what level of detail the calculations should cover appropriate activities should be selected, the more activities that are included the higher complexity. The most favourable method to use is to perform study visits and interviews at the production site. In some cases this is not possible, then the study of flow charts or other documentation of the process involved can be used (Ask & Ax, 1995).

2. **Allocate costs to the selected activities**
   The second step is to define the costs of each activity. There are two kinds of costs related to an activity, costs of resources dedicated for only that activity and costs for resources that are included in more than one activity, for example labor and facility costs. These costs need to be spread out to define the specific cost for an activity.

3. **Select cost drivers**
   To be able to assign the consumption of each activity to a specific product a selection of cost drivers are required. Examples of cost drivers are the number of parts included, the set-up times, the production volume etc.

4. **Define the cost driver volumes**
   The fourth step is to define the specific values for each cost driver. As the cost for the activity is defined in the second step this step assigns the consumption of that activity to a specific product. When the cost for the activity and the cost driver volume is defined, it is possible to calculate the cost per product for that activity.

5. **Calculations**
   The last step is to perform the calculations and to sum up all the assigned activity costs to define the total cost for the product.

4.3 Product cost structure

There are several factors involved in the supply chain and production that affect the cost of the final product. There is no conventional cost structure that is in common use and applicable to the product set-up of this project. This implies that the definition of the cost structure must be defined for each product cost breakdown. This section describes a general structure that was used to divide and categorize these costs, with the general starting point in the activity based costing method described in previous section.

Jonsson & Mattson (2009) describe with a general model how the production process and the logistic process are coupled to each other regarding the material flow. From this model a product cost structure, shown in Figure 8, could be developed as a basis for the cost break down. Further configuration was done when it was applied at IKEA, for example was the packaging activity defined. The structure is created with consideration to the sample products and their production set-up. The product cost structure is in line with the activity based costing (ABC) method for accounting, see Chapter 4.2.

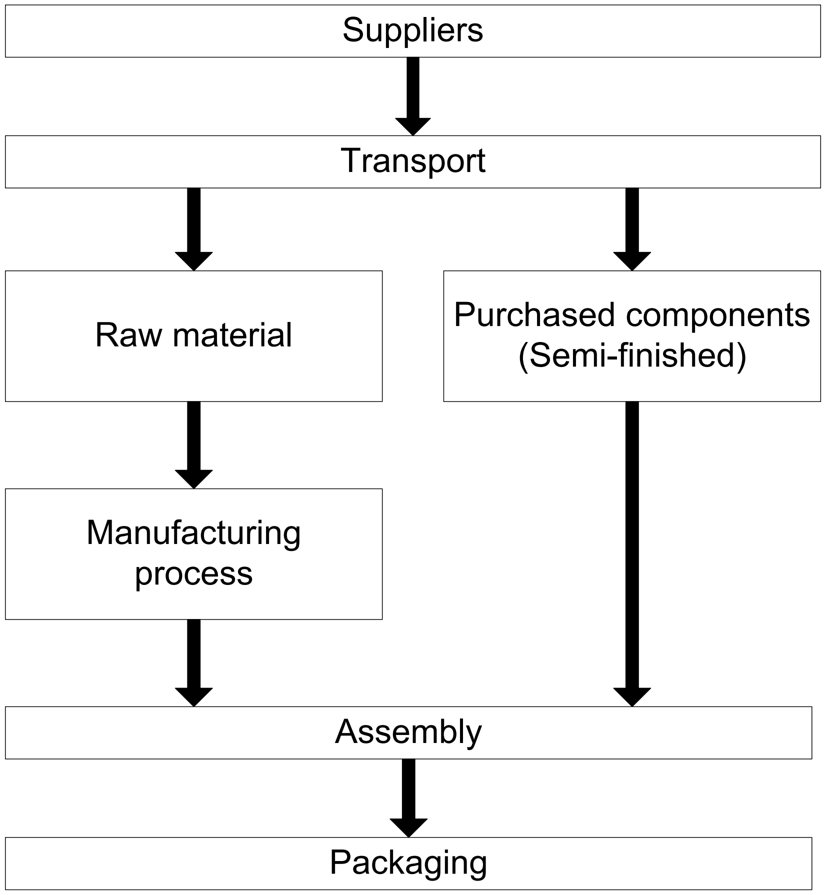

Figure 8 - Production and logistics flow

4.3.1 Material

The category for cost of material comprises component cost and direct cost of material. That means material that is directly associated to the product (H'mida & Martin, 2006). The cost estimation for material is affected by the spot price for the applicable raw material and the amount of required raw material. The amount of raw material is depending on the material type, shape complexity and the amount of waste in the manufacturing process of the product. There are obvious dependencies between material cost and processing cost. Specific raw materials have different suitability for different shapes and processing techniques (Swift & Booker, 2003).

Since a product can consist of several parts with different complexity and material composition, a total breakdown of the material composition can be difficult. Some parts can be considered as finished or semi-finished products that are bought off the shelf. These parts can be considered as material cost, or component cost. The difference between material and component is the level of processing and complexity they stand for. Both have been manufactured but components can be viewed upon as finished products that have been processed at higher levels. The cost for a component depends in general on the number, type and its specifications.

4.3.2 Manufacturing process

Components that are defined to be semi-finished or finished parts need no further processing before the assembly operations, see Figure 8. This distinguishes the logical flow for raw material and purchased parts according to Jonsson & Mattson (2009). The processing of raw material is only covering the machining to attain desired shape and function, not assembly operations. The manufacturing process cost of a part is dependent on factors such as necessary equipment and installation, required tools, the time for processing and the operating procedures (Swift & Booker, 2003). Jonsson & Mattson (2009) categorize production cost into three categories; capacity cost, set-up cost and cost for changing rate of production. Set-up costs are the costs that emerge when changing production of one item to another. These activities include tool changes and adjustments, downtime in production, re-balancing of line, testing new set-up and equipment configuration. The capacity cost is typical investments in machines and equipment, maintenance and operation cost. The category of costs for changing rate of production is costs for non-fixed factors. An example of this could be changing labor cost by varying overtime and sub-contracting of workforce in order to meet the demand over time (Johnsson & Mattsson, 2009). According to Jonsson & Mattsson (2009) the included factors in production can be visualized as in Figure 9.

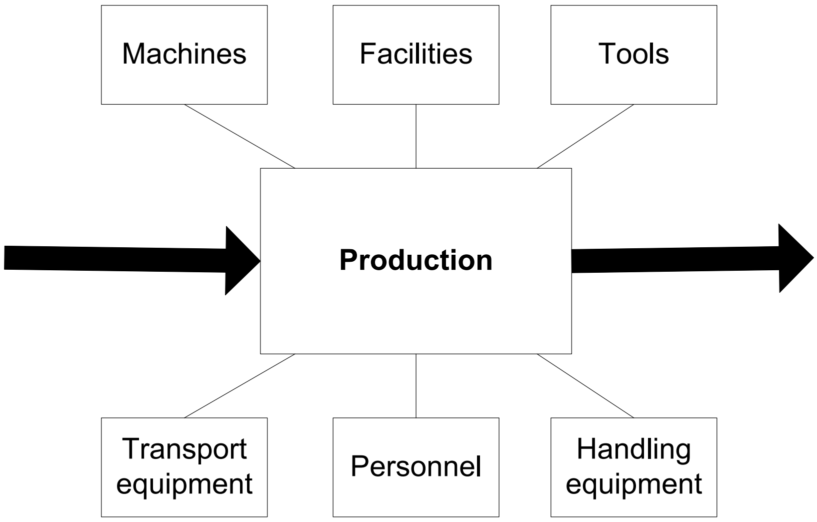

Figure 9 - Production factors

The manufacturing process cost is coupled to the material cost since the necessary equipment, tooling and processing time is dependent on the material type. This relation always has to be considered in the calculations of both the manufacturing process and material cost estimations. In the operating cost factors such as maintenance, labor intensity, level of automation, quality assurance and shift structure can be included. This is also a category where some overhead costs can be included, depending on chosen cost structure (Swift & Booker, 2003).

4.3.3 Assembly

Assembly expenditures are the cost for direct labor i.e. workers that are performing the mounting and fitting of parts. Depending on the product design various assembly operations may be necessary for finishing the product. Manual assembly is the most common system used in the manufacturing industry and highly relevant in the cost breakdown of a product. Assembly cost is dependent on the design complexity, which affects the number of operations, motions and difficulty in component handling (Freivalds & Niebel, 2009). These factors have an effect on the required time for assembly of a product and thus the cost. A fundamental approach to assembly cost is consequently to measure assembly time as the factor that influences costs (Swift & Booker, 2003).

4.3.4 Packaging

Cost related to packaging is considered as indirect cost and can vary between producers of the same product. Packaging material such as cardboard, foam and plastic materials are not material for the product itself and are thus indirect cost. The packaging and labelling process, can be either manual labor or with a higher level of automation. The packaging has an effect on the handling in production and transportation. Different types of packaging require different ways of handling material when it comes to packing and unpacking (Johnsson & Mattsson, 2009). More complex packing will require more work and consequently add cost. The packaging also affects the filling rate and the weight of transported goods, which affect the external transportation cost (Berglie & Hedberg, 2009). A straightforward way of dealing with these costs is to have one category with all costs related to the packaging.

4.3.5 Transport

The logistics cost is an extensive category that can include everything from cost for packaging, transportation, storage, alternative cost in tied-up capital and customs fees.

The external part of transportation is the movement between logistics nodes such as the production facility and the distributions centre. Costs related to the external transportation are mainly affected by the material supply and allocation in the logistics system (Johnsson & Mattsson, 2009). Though it has to be considered that the material supply is not unbiased to the production system in regard to the order quantity, lot sizing, delays and stock shortages. These factors have an effect on the required number of transportations, which makes the supply chain behavior act different. Internal transportation is the movement of goods inside warehouses, storehouses and production facilities (Johnsson & Mattsson, 2009).

Internal transportation is to high extent influenced by the production system and the production layout. Factors such as buffer sizes, number of buffers and just-in-time production are configured by the productions system, and influence the internal transportation. Factory layout such as the functional workshop or assembly line will have an impact in how the internal transportation will be utilized.

According to Jonsson & Mattson (2009) inventory cost is a part of the logistics cost and can be divided into three areas; storage cost, risk cost and capital cost. Storage costs are the expenditures related to the warehouse space utilization, material handling equipment and the storage shelves. The capital cost is not an expenditure but more of an alternative cost. Having material and finished goods in inventory implies low utilization of money, and cost in form of tied-up capital. The alternative could be to have corresponding value of the inventory invested at the bank and gain interest. This alternative cost is calculated by taking the inventory value times a pre-determined interest level.

The costs that are related to risk are insurance expenditures and product waste and scrap. Insurance expenditures depend on the total value of the inventory i.e. larger inventory results in higher insurance cost. Product waste and scrap depend on the level of obsolescence goods, which in return often depends on the inventory size (Johnsson & Mattsson, 2009). With large stock levels it can be difficult to sell everything before the product model gets old and later obsolescence. Even if all products are saleable the depreciation cost increase with increased inventory.

4.3.6 Other

The cost referred to as other costs can be divided into two parts, the overhead expenditures and the profit margin. In general, the overhead cost category refers to costs that cannot be assigned to a specific product but that still is required for the running of the production, for example administrative expenditures, costs for research and development, costs for marketing and sales (Freivalds & Niebel, 2009). According to Lennart Hjalmarsson[1], professor at the University of Gothenburg, the included costs in overhead differs between all companies. Therefore it is inconvenient to do this in a standardized way when products from different manufactures are to be compared. According to Lennart Hjalmarsson, only the costs that clearly are defined by the company to be overhead cost should be included. Profit margin is a financial statement and is defined by each supplier.

[1] Personal Communication 2011-05-18

4.4 Estimation of product costs

To be able to apply the product cost structure described in the previous chapter on the setup of this research several methods are required. These methods are required to be able to estimate the costs for each defined category, and will be described in the following sections.

4.4.1 Estimation of material and manufacturing process costs

In manufacturing industry, product cost is always a key issue and in many cases the main factor for decision making. The decision of a products realization is taken early in the product introduction phase when only conceptual ideas and designs are available. In many cases this causes a problem, due to that the provision of reliable cost information throughout the process of the product is limited (Swift & Booker, 2003). It is crucial for companies to be able to take the decisions of rejecting uneconomically designs before the production process has been initialized. This is mostly due to very high costs involved in making changes in the production phase of the product (Swift & Booker, 2003).

According to Swift & Booker (2003) estimations of the costs involved in the production process of a product can be performed with the use of a theoretical model. This demands no access to the production site or the need of specified production setup. The model is based on the design and material of the product and the characteristics of applicable production processes.

The method can be approached in two ways, with the difference in the accuracy of the results. The most favourable setup is to use specific data for the process that is considered. This setup demands access to the cost for tooling equipment, the required process time, overhead cost involved etc. for the specific manufacturing process. This approach is time consuming but the ideal one to obtain the most accurate results. The second approach is to use predefined data for each process, developed through the study of several main process groups in industry (Swift & Booker, 2003). This approach has been validated in many case studies in industry and is proven to give adequate results.

4.4.1.1 The model

To estimate the cost of manufacturing a product the material volume and process considerations are the base factors (Swift & Booker, 2003). The processing cost has a starting point in a basic process cost for an ideal design, with additional design-dependent cost coefficients. For the material cost the model considers the transformation of material to its final form. The total manufacturing cost (M_i), is the sum of the material cost (M_c) and the process cost (P_c), see Equation 1.

$$M_i = M_c + P_c$$

Equation 1 - Total manufacturing cost

To make it possible to apply the model on designs that differs from the ideal one, the complexity of the shape needs to be determined. This is done by the use of a shape complexity index where the part is positioned in one of three categories depending on its basic geometry. The different categories are solid revolution, prismatic solid and flat or thin wall section component.

Each category is divided into five bands of complexity. The band is unique for each category but in general it stretches from a very basic shape to irregular and very complex forms. Some of the factors affecting the level of complexity are wall thickness, internal features, non-uniform sections and contoured forms. The application of the shape classifications will be further explained in the following sections.

4.4.1.2 Material cost

For the calculation of material cost, three parameters are taken into consideration. The volume of material (V), is multiplied with the cost of material per unit volume (C_{mt}), and the waste coefficient (W_c), see Equation 2.

$$M_c = VC_{mt}W_c$$

Equation 2 - Material cost

The waste coefficient covers the additional amount of material that is required to produce the component but consumed by the particular manufacturing process, i.e. process waste. Waste coefficients for sample processes relative to the shape classification index are given in the method. The values for waste coefficients vary from one to eight, i.e. from combinations of processes and shapes not consuming any waste of material to combinations consuming eight times the material required for the final form. Though the majority of the values are between one and two times the final material need (Swift & Booker, 2003).

4.4.1.3 Manufacturing process cost

The manufacturing process cost consists of two parts, the basic process cost and the relative cost coefficient, see Equation 3. The basic process cost covers the costs for processing an ideal design of the specific part while the relative cost coefficient adds the costs for design-specific differences from the ideal one.

$$P_c = BP_cR_c$$

Equation 3 – Manufacturing process cost

4.4.1.4 Basic Process cost

The basic processing cost is more complex than the material cost due to that it is dependent on factors of which the costs are harder to identify. The factors included in the manufacturing process cost are equipment cost, processing times, operating cost, the cost of tooling and the demand of components. The basic processing cost is calculated with the following equation, see Equation 4.

$$BP_c = \propto T + {}^{\beta}/_{N}$$

Equation 4 - Basic process cost

$\propto$ Cover the cost for operating and setting up the process, including the costs for overhead, labor, factory site and cost for monitoring the process, specified per time unit.

β The tooling cost for producing a part of ideal design.

T The time consumed for processing a part of ideal design.

N The number of products produced per annum.

The result obtained by the basic process cost represents the minimum cost of the specific process. The result is based on the assumptions of an ideal design of the part, one-shift working and that the payback on investment is two years.

4.4.1.5 Relative cost coefficient

To be able to apply the model to a part of specific design, the values of the basic production cost, covering the cost for an ideal design, needs to be adjusted. This is done by considering specific design characteristics that influence the costs, see Equation 5.

$$R_c = C_{mp} C_c C_s C_{ft}$$

Equation 5 - Relative cost coefficient

C_{mp} Due to the difference in suitability of certain materials to a specific process, this factor accounts for the possible cost effect.

C_c To be able to adjust the cost to shapes that differs from the ideal design, this factor considers the shape complexity of the part. The part is positioned in the shape complexity index, see Chapter 4.4.1.1., which makes it possible to define a suitable coefficient to account for the change in costs.

C_s The factor accounts for the cost consequence of producing parts with specific wall/section thickness.

C_{ft} This factor is used to cover the costs involved in specific demands for tolerance and surface finish. It is build up on two separate values, one for tolerance and one for surface finish, where only the highest one is used.

According to that the relative cost coefficient considers design aspects of a more complex nature then the ideal design the initial value for each factor is one, i.e. the cost will not decrease below the cost for an ideal design.

4.4.2 Estimation of assembly costs

According to Swift & Booker (2003) approximately 50 percent of all labor working in the mechanical and electrical industries is involved in work closely related to assembly, handling and fitting processes. Due to that, the costs involved in these operations are crucial to include in a cost breakdown study.

To calculate the total cost of manual assembly the time consumed by each operation is multiplied by the labor rate per time unit (Swift & Booker, 2003). The time consumed by each operation is divided into two parts, handling times and fitting times. The method for calculation manual assembly cost used by Swift & Booker (2003) includes indexes for handling and fitting operations. The handling index considers difficulties involved with gasping and holding the part while the fitting index considers the difficulties involved in fixing or placing the part in its target position. The total cost of manual assembly (C_{ma}) can be calculated with the following equation, see Equation 6.

$$C_{ma} = C_l(F + H)$$

Equation 6 - Cost of manual assembly

C_l The labor rate per time unit. Including costs for tooling, equipment and other expenses involved in the operation.

F The component fitting index.

H The component handling index.

4.4.2.1 Handling index

The equation for the handling index (H) can be seen in Equation 7 and consists of three parts, a basic handling index (A_h) and two penalty coefficients (P_o and P_g) associated with the geometry and characteristics of the design. Penalty is in this case referred to as an additional cost due to less good design from an assembly point of view.

$$H = A_h + \left[\sum_{i=1}^{n} P_{oi} + \sum_{i=1}^{n} P_{gi} \right]$$

Equation 7 - Handling index

A_h The basic handling index accounts for the characteristics of the handling for a part of ideal design, defining the difficulties in the operation. The index varies from the value of one to three, in handling actions that is from the use of only one hand to the need of two persons.

P_{o1} The first orientation penalties referring to difficulties in the operator's possibility to see fixation points along the axis of insertion. The values vary from zero to 0,5.

P_{o2} The second orientation penalty referring to difficulties in the operator's possibility to see fixation points about the axis of insertion. The values vary between zero and 0,5.

P_{gi} The general handling penalties accounts for the extra time required due to the sensitivity of the part. Examples of issues affecting the sensitivity can be fragile material, sharp corners or thin walls. Several values can be used to cover for all sensitivity issues for a specific part.

4.4.2.2 Fitting index

The equation for the fitting index (F) is build up in similar way to the handling index, consisting of a basic fitting index for an ideal design with two additional penalty coefficients, see Equation 8.

$$F = A_f + \left[\sum_{i=1}^{n} P_{fi} + \sum_{i=1}^{n} P_{ai} \right]$$

Equation 8 - Fitting index

A_h The basic fitting index accounts for the difficulties involved in the fixation of the part of an ideal design using a given assembly process. The index varies from the values one to four, covering the variation of assembly processes from a simple insertion of the part to the need of screwdriver or rivet fastener.

P_{fi} The insertion penalties consist of six different coefficients covering the difficulties associated with the placement or insertion of the part. The coefficients are related to the insertion direction, collateral, stability, access, alignment and resistance.

P_{ai} The additional assembly process index accounts for a number of additional assembly processes carried out on components already positioned. Examples of additional operations are screw driving, welding and reorientation.

4.4.3 Estimation of packaging costs

Within the category of packaging the main costs are assigned to the packaging material and the additional parts added in the package, for example manuals, fitting and handling components etc. The material used in the packaging of hoods and induction hobs are cardboard and EPS (expanded polystyrene), the costs are presented in the results, see Chapter 5. In the package category the manuals are also included with an additional cost of 2 EUR per manual, based upon data from IKEA of Sweden. As the process cost of the packaging activity will not be regarded in this research the calculations of the packaging costs consists of the material consumption times the material cost per unit, plus the additional cost for manuals.

4.4.4 Estimation of transportation costs

The costs involved in external transportation are divided into two parts, the cost for transportation of semi-finished components and the cost for delivering the finished products to IKEA distribution centre.

4.4.4.1 Transportation of semi-finished components

The cost involved in the transportation of components covers all costs for getting a component from producer to customer. According to the Swedish Trade Council the costs can be divided into three categories, transportation, customs and the cost of tied-up capital and storage (Berglie & Hedberg, 2009). These costs are specific for each component due to differences in custom fees, dimensions of the products etc. The Swedish Trade Council (2009) has provided generic data for these costs based on a study of the costs involved in the sourcing of production. As can be seen in Table 4, there are different percentage values for the categories of electronics, cables and shafts.

Table 4 - Generic data for transport cost

Electronics	Cables	Shaft
0,05	0,08	0,12

4.4.4.2 Transportation of finished goods

The cost for transportation of finished goods refers to transportation by truck within Europe. To be able to estimate the cost for a specific product the cost per unit distance is required. According to IKEA of Sweden the general cost for transportation, of a container of 70 cubic meters, from supplier to a distribution centre in Europe is 1500 EUR. If the packaging dimensions are known it is possible to calculate the number of products that can be transported in one container and thereby the cost per product. According to IKEA of Sweden it is a good approximation the use a filling rate of 75 percentages to reflect the real situation.

4.4.5 Estimations of other costs

The cost for R&D and profit is based on data acquired from annual reports of each supplier of the product samples. The R&D cost is stated with a fixed percentage number which is added to the product cost. The profit is based on the stated EBITDA –margin (Earnings Before Interest, Taxes and Depreciation and Amortization).

Profit and R&D is only added for the tier one supplier. Cost for semi-finished components is quoted from second tier supplier and therefore are profit and R&D included in the quotation.

5 Empirical results

The following section presents the empirical data and the final results of the cost break down research, i.e. it will answer the stated question: What costs can be assigned to the product ranges of hoods and induction hobs?

5.1 Total product cost

The empirical result of the research for the complete cost break down of the products will be presented in Figure 10 and Figure 11. All values for the costs in this thesis have been altered. For a more detailed presentation of the absolute values for each product, see Appendix I. The costs are divided in the following categories:

- Material - Raw material and semi-finished goods
- Process - Total cost of processing the raw material
- Assembly - The cost of performing the assembly operations
- Transport - Transport of semi-finished components and finished goods
- Packaging - The material cost for packaging
- Other cost - Overhead and profit

5.1.1 Research preferences

The results presented in this chapter are acquired by an empirical study based on a theoretical method, see Chapter 4. To make the empirical study applicable to the theoretical method several considerations were required as well as differences in the approach for each category. These preferences will be explained in detail in the following sections for each category, see Chapter 5.2 – 5.7.

During the whole research the Euro has worked as the defined currency. Due to that several prices were given in other currencies the following exchange rates has been used for conversion, see Table 5.

Table 5 - Exchange rate

EUR / USD	EUR / SEK
0,673	0,112

5.1.2 Results - hoods

The empirical results for hoods are presented in Figure 10 and cover the total cost of the products. Due to that the value for each category may be hard to read, the costs are also presented in Table 6.

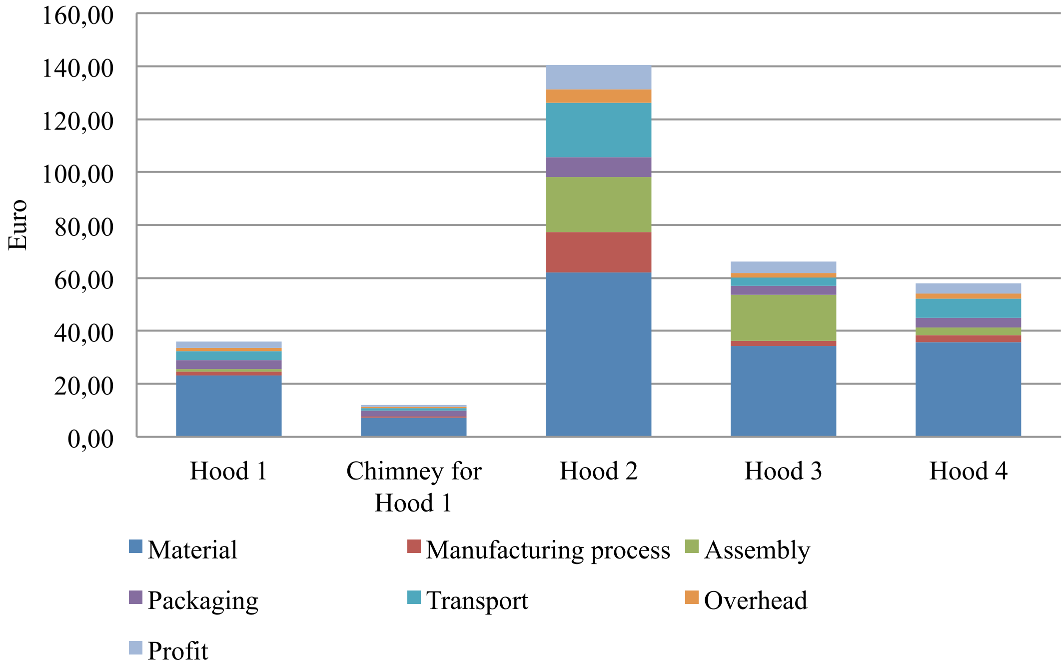

Figure 10 - Product cost for hoods

The total cost of the product differs between the products, which are expected due to the diversity in price levels for the reference products. The Hood 2 has a high retail price compared to the Hood 1 that has the lowest price in the IKEA hood range. For all products the material category accounts for most of the costs, for the other categories the results needs to be studied for each product, see Chapter 6 where the results will be analyzed.

Table 6 - Product cost for hoods (in Euro)

	Hood 1	Chimney for Hood 1	Hood 2	Hood 3	Hood 4
Material	23,07	7,28	62,03	34,25	35,79
Manufacturing process	1,46	0,38	15,32	1,87	2,55
Assembly	1,10	0,00	20,86	17,60	2,86
Packaging	3,41	2,33	7,38	3,28	3,78
Transport	3,31	0,91	20,61	3,10	7,12
Overhead	1,27	0,43	4,94	1,66	2,04
Profit	2,39	0,80	9,31	4,39	3,84
Total	36,01	12,14	140,45	66,15	57,98

5.1.3 Results - induction hobs

The empirical results for the hobs are presented in Figure 11, and the more detailed absolute values are presented in Table 7. In the case of induction hobs the complexity does not differ much between the products. Instead it is the size and specifications that makes up for the major difference.

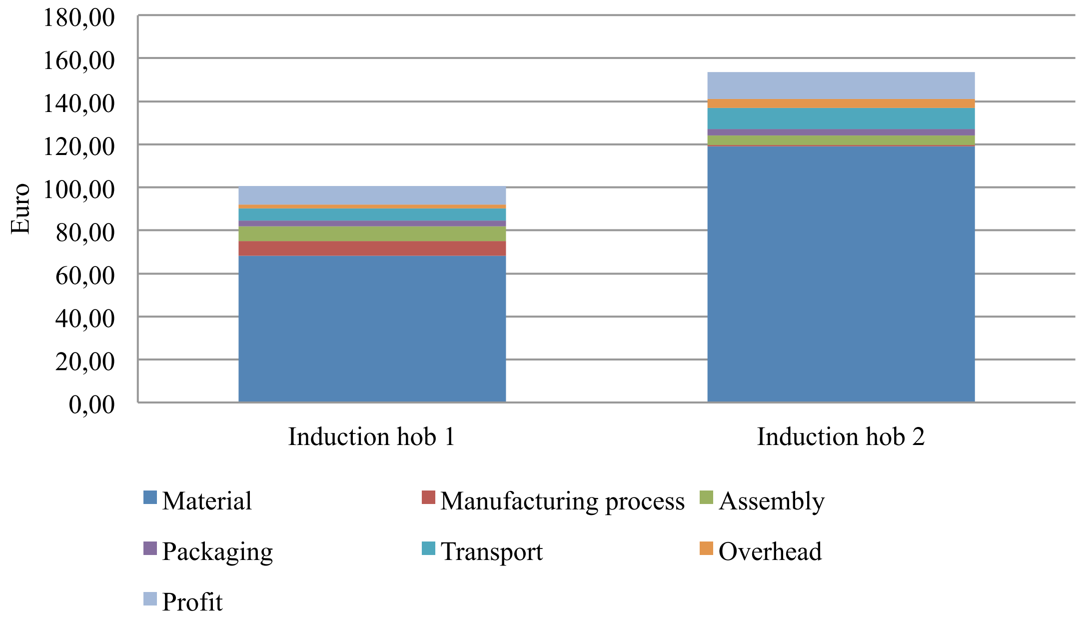

Figure 11 - Product cost for induction hobs

According to Table 7 the major difference in costs between the products can be assigned to the category of material followed by the manufacturing process cost. If the difference in material cost is ignored, the summation of the costs for the other categories will approximately be the same. There are though differences in each category that will be analyzed in Chapter 6.

Table 7 - Product cost for induction hobs (in Euro)

	Induction hob 1	Induction hob 2
Material	68,18	119,04
Manufacturing process	6,78	0,67
Assembly	6,95	4,51
Packaging	2,74	2,96
Transport	5,54	9,63
Overhead	1,93	4,21
Profit	8,48	12,59
Total	100,60	153,61

5.2 Material cost

The results for material cost in hoods and induction hobs are shown in Figure 12, and Figure 13. The figures show the absolute value of the different material types for each product sample. The empirical data that the figures are based upon can be found in Appendix I.

5.2.1 Research preferences

The structure of the research results for material cost is based on the theoretical product cost structure. The category for material includes both cost for raw material and cost for finished components. Data for raw material spot prices was collected by workshops and interviews with specialists in the field, at IKEA of Sweden, and are presented in Table 8 and Table 9.

The method used to calculate the material and manufacturing process cost is unclear in the definition of how to handle the number of holes in a part. As the complexity of a part is categorized in a complexity index it is the whole complexity that is rated and no considerations are taken to the number of holes. The authors approach has been to increase the level of complexity for products with a high amount of holes, to account for the increased cost. For further discussions of the effect of this approach, see Chapter 7. The total waste coefficient of a part is an average value of the waste coefficients from each process type that is comprised in the shaping of the part.

Table 8 - Plastic spot prices

	PP	PA	PC	ABS	SAN
EUR/kg	1,4	3,74	2,99	2,05	1,93

Table 9 - Steel spot price

	Aluminum	Stainless steel 304	Stainless steel 430	Carbon steel	Galvanized steel	Steel wire
EUR/kg	1,21	3,58	1,5	0,73	0,85	0,67

The costs for finished components consist of material prices based on data from suppliers in China. Due to that reason, no quality testing has been performed to confirm that the component meet the requirements.

5.2.2 Results - hoods

The analyzed samples of the hoods are in general rather different from the induction hobs regarding the material composition. The hoods are to large extent made up of steel material that is manufactured in-house, whilst the induction hobs consist of more semi-finished material. The absolute cost for material in the hoods is presented in Table 10.

The representative raw materials occurring in a cooker hood are steel and plastic. Typical steel types used in the hoods are stainless steel 430 and carbon steel. Table 10 show the cost stated in Euro-currency for each material category. The table clearly indicates that cost for steel is the majority part of the raw material cost. It also point out that for the finished components, bought off the shelf, it is the motor components that represent the majority cost.

Table 10 - Material cost for hoods (in Euro)

	Hood 1	Chimney for Hood 1	Hood 2	Hood 3	Hood 4
Plastic	1,46		2,15	1,53	3,29
Steel	8,64	7,23	22,48	5,36	13,13
Grease filter	1,22		1,20	2,39	2,39
Motor (scroll)	10,37		27,93	20,75	15,27
Electrical comp.	0,52		0,00	0,95	0,52
Lightning comp.	0,18		5,44	0,37	0,37
Cables	0,63		0,77	0,77	0,77
Screws	0,05	0,05	0,21	0,16	0,06
Other	0,00		1,85	2,15	0,00
Total	23,07	7,28	62,03	34,42	35,79

The total material cost of the product samples reflects the retail price range in which they are. For instance the Hood 2 is a hood in the premium price range, while the Hood 1 is in the lower price segment.

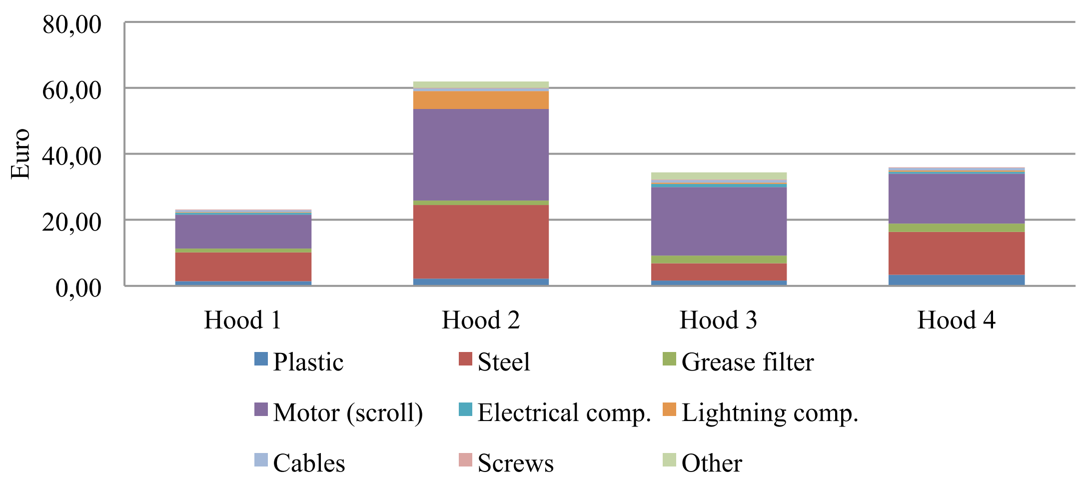

Figure 12 - Material cost for hoods

5.2.3 Results - induction hobs

The constitution of material cost for induction hobs is different than for hoods. Induction hobs are a much more complex product with more electrical components. The induction hobs are considered as a product based on new technology in the industry for kitchen appliances, see Chapter 4.1. It often includes components for touch control, such as capacitive sensors or opto-eletric sensors. Since the induction hob includes so many different electrical components it can indicate that it is built on modules from several different suppliers. A printed circuit board, PCB, contains more advanced components than a steel sheet. This is a significant difference between hoods and induction hobs. In Table 11 it can be shown that the raw material only accounts for a small portion of the material cost.

Table 11 - Material cost for induction hobs (in Euro)

	Induction hob 1	Induction hob 2
Plastic	1,47	3,08
Steel	2,76	1,99
Induction coil	6,37	14,42
Control panel	12,98	12,98
Induction coil controls	21,93	52,54
Fan	3,76	7,53
Glass	16,85	26,43
Screws	0,04	0,08
Cables	0,77	0,00
Other	1,25	0,00
Total	68,18	119,04

A significant part of the material cost can be referred to the induction coil controls, which is the main PCB in the induction hob. Each coil control board controls two induction coils, thus is the cost for coil control board lower in the smaller induction hob, Induction hob 1. In the Induction hob 2 the cost for induction coil control also includes the cost for a filter board. The Induction hob 1 has a different solution of the coil control board where the filter board is built in. The PCB´s are designed and specified by the supplier of the induction hobs but most probably manufactured in a low cost country by a second tier supplier.

The ceramic glass holds also a considerable part of the material cost. Ceramic glass is also a niche product that is bought from external suppliers. In these results the cost for ceramic glass is based on a China-sourced supplier. When it comes to sourcing the ceramic glass in Europe there are two major suppliers named EuroKera and Schott. It is noticeable how low part the plastic and steel plays in induction hobs in comparison to the hoods, see Figure 13.

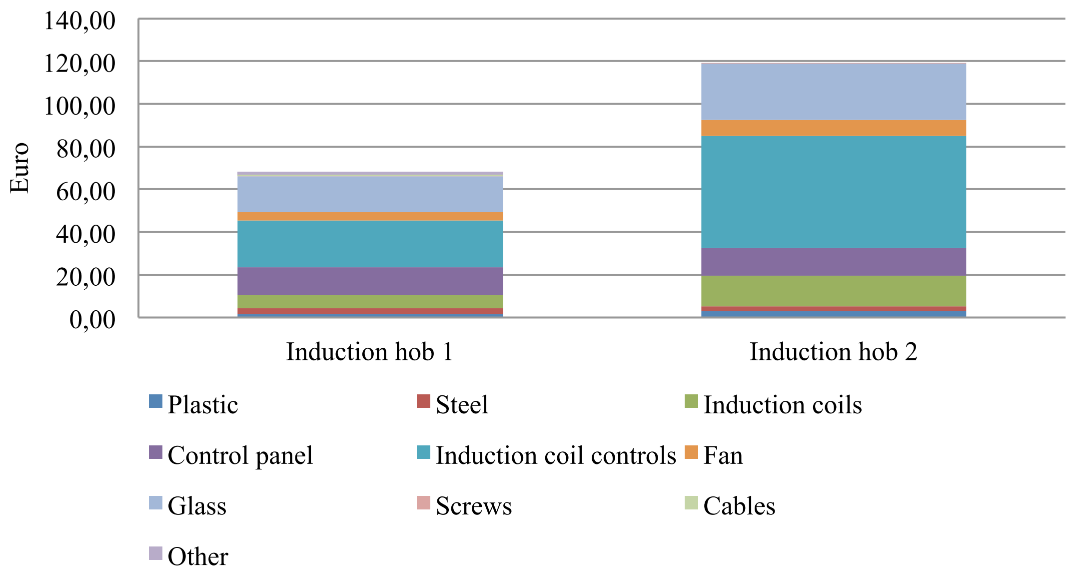

Figure 13 - Material cost for induction hobs

5.3 Manufacturing process cost

The following section presents the research results for the process cost of the raw material. In Figure 14 and Figure 15 the total processing cost is visualized. The processing cost cover the parts of the hoods and induction hobs that require shaping operations i.e. parts that are not considered to be bought as semi-finished components.

5.3.1 Research preferences

The processing costs are based upon collected data from workshops and the method for process costing explained in the theory chapter, see Chapter 4.4.1.3. Each process cost calculation is based on conventional manufacturing processes used in the industry. The definition of required process types were established in workshops, in cooperation with specialists in the field. Certainly there are other possible manufacturing processes for the types of shapes treated in this project. Following processes in this section is appropriate for the production of the topical products and also suitable for the used costing method. The reader is referred to Appendix I to get a higher level of details in the numbers and calculations.

The volumes used for the calculations are based on sales figures for each product, for the fiscal year 2010, in the European area, see Appendix I. Since the majority of the total sales are in Europe the results may be applied for the total market. These sales figures are also dependent of some attribute set-ups, such as colour, size etc. But the project is constraint to only use the numbers for the very specific product samples that was chosen. It can be assumed that some of the components are of generic type and used in several product models, and thus manufactured in higher volumes. This indicates that some component cost can be lower in real life, these results approximate the real cost.

As for the material costing no quality levels could be measured for the process costing. The type of quality levels that is neglected in the process costing concern the design specifications such as surface finish and tolerances. These factors are to some extent covered by the coefficient for process and material suitability, C_{mp}, see Appendix I. Furthermore are the raw material bought as sheets or roles that are pre-polished from the raw material supplier. Thus is this cost included in the spot prices for steel. Surface treatment methods for painting are not covered in the costing method and are neglected in the process cost, this affect only the models Hood 1 and Hood 3.

Quality levels regarding the production process are considered in the factor for waste, W_c, where material waste and production scrap is taken into account. The definition of a components shape complexity influences both the processing cost and the waste coefficient i.e. the material cost. The procedure for defining the shape complexity does not consider the size of a component as an influential factor. This was compensated for the process cost by increasing the complexity coefficient for larger components. For the material cost the component size plays an evidential role. The process costing method does not include some operations that most probably are used in the real life production. In these cases an approximation has been done with similar processes or possible solutions in order to get a cost estimate. For example are the hoods welded manually but in the calculations it is done with automatic machining.

The estimations of process cost are based upon a method that was developed in year 2003, with price levels from that year. To correct the cost for current price levels, the inflation rate between years 2003-2011 has been added as a factor.

5.3.2 Results - hoods

In general it can be said that cooker hoods mainly consist of steel material. That statement can be derived from the Table 12 and Figure 14, where the cost for sheet metal work in most cases is the main expenditure. Only for Hood 1 is the cost for processing of plastic material higher than for steel.

Table 12 – Manufacturing process cost for hoods (in Euro)

	Hood 1	Chimney for Hood 1	Hood 2	Hood 3	Hood 4
Injection molding	0,69	0,00	3,33	0,48	1,00
Sheet metal work	0,63	0,38	11,79	1,18	1,42
Automatic machining	0,14	0,00	0,20	0,09	0,14
CCE	0,00	0,00	0,00	0,12	0,00
Total	1,46	0,38	15,32	1,87	2,55

From the data, see Figure 14, it is clear that the Hood 2 has the highest process cost. A comparison of the material cost, in Figure 12, and the process cost, in Figure 14, indicates that there is a distinct relation. More material implies more processing and accordingly higher process cost. The factor of production volume also affects the process cost.

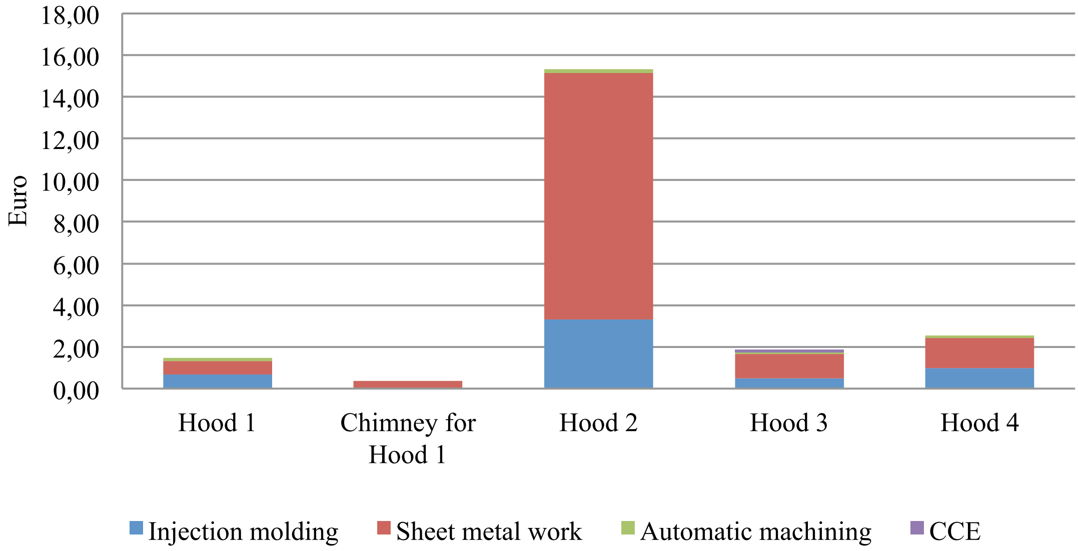

Figure 14 – Manufacturing process cost for hoods

5.3.3 Results - induction hobs

The manufacturing process cost for components in the induction hobs are presented in Table 13. The process cost for sheet metal work in Induction hob 1 is higher than most of the hoods, only Hood 2 has higher costs. Appendix I show that the induction hobs consist of much less raw material, especially steel. For that reason the process cost should be lower and the cause of the high cost in Induction hob 1 is the low production volumes. Actually Induction hob 2 is built on more raw material, since it is a larger model, and have higher raw material cost, see Figure 15. The typical required manufacturing processes are the same for the two hobs, but still Induction hob 2 have lower process cost compared to Induction hob 1, evidentially Induction hob 2 is a high volume model.

Table 13 – Manufacturing process cost for induction hobs (in Euro)

	Induction hob 1	Induction hob 2
Injection molding	1,27	0,15
Sheet metal work	4,43	0,39
Automatic machining	1,08	0,12
CCE	0,00	0,00
Total	6,78	0,67

In Figure 15 the absolute value of the total process cost is visualized for each induction hob.

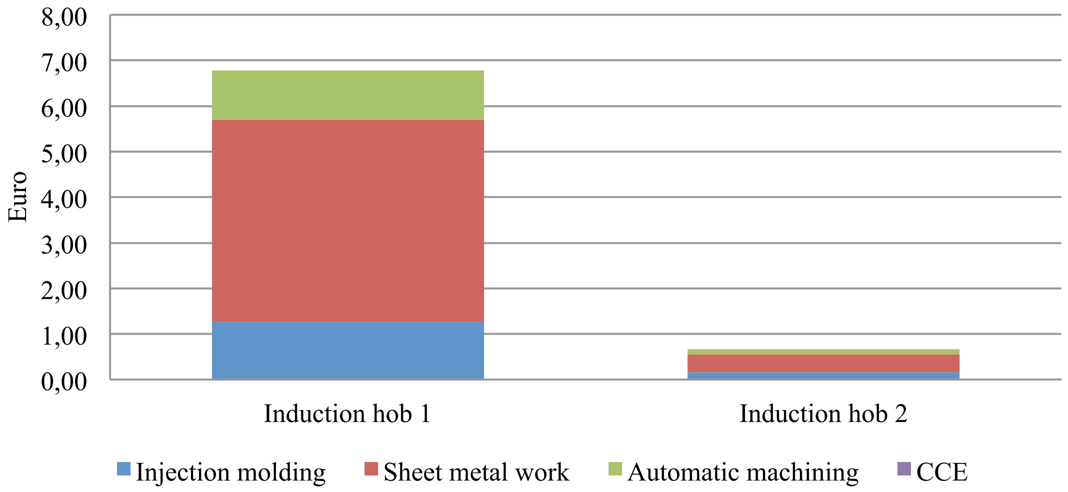

Figure 15 – Manufacturing process cost for induction hobs

5.4 Assembly cost

The empirical results of the costs involved in the assembly operations are presented in Figure 16 and Figure 17. The results are based on a time study analysis and a theoretical model for estimations of assembly cost, see Chapter 4.4.2.

5.4.1 Research preferences

The theoretical model described in Chapter 4.4.2 demands a high level of detail in the analysis of the assembly procedure. Due to that the scoop of this research mainly focus on the material and process costs, the time and resources required to fully apply the theoretical model were limited. The approach used by the authors has been to use the basic equation for cost estimations, based on the time spent for each assembly operation and the labor cost per time unit. The use of fitting and handling indexes described in the method has therefore been neglected. The labor cost for the countries of interest represent the levels in 2010 and is presented in Table 14.

Table 14 - Labor cost

	Poland	Italy	Germany
Labor cost (EUR)/h	6,8	30,4	42,2

Due to the absence of access to the production site for hoods the assembly studies has been based on the knowledge of technicians at IKEA of Sweden, theoretical assembly theory and the authors own experience in the field. The unlimited access to the products during the research made it possible to perform repeated assembly studies to acquire satisfactory results.

5.4.2 Results - hoods

The assembly cost for the five different products, four hoods and one additional chimney, can be seen in Figure 16. The figure show that the assembly cost varies a lot between the different models. The chimney has no cost in the assembly category, due to the lack of assembly operations required for the product. For a complete documentation of the results, see Appendix I.

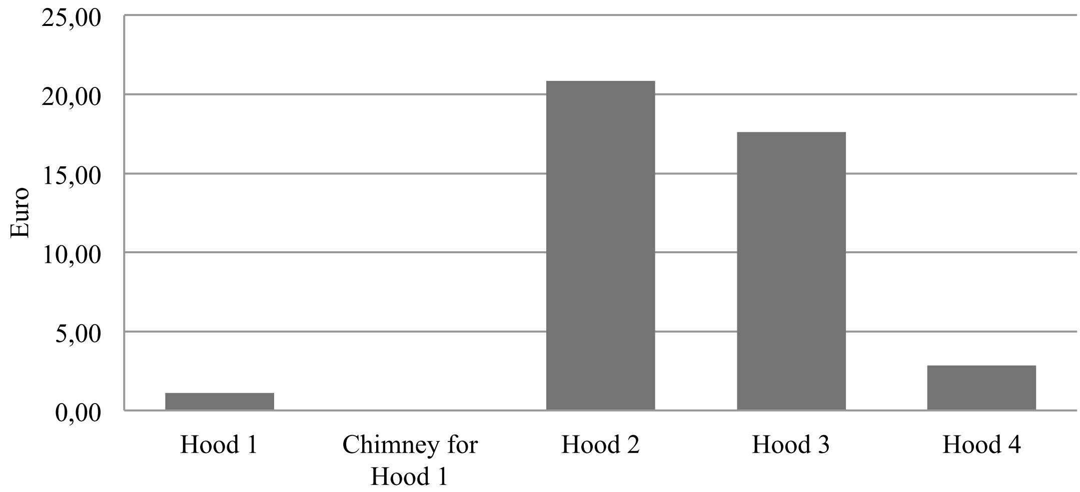

Figure 16 - Assembly cost for hoods

5.4.3 Results - induction hobs

The assembly cost for the two induction hobs included in this research are presented in Figure 17. The cost for the Induction hob 1 is clearly higher compared to the Induction hob 2, but the variation is lower than for the hood range.

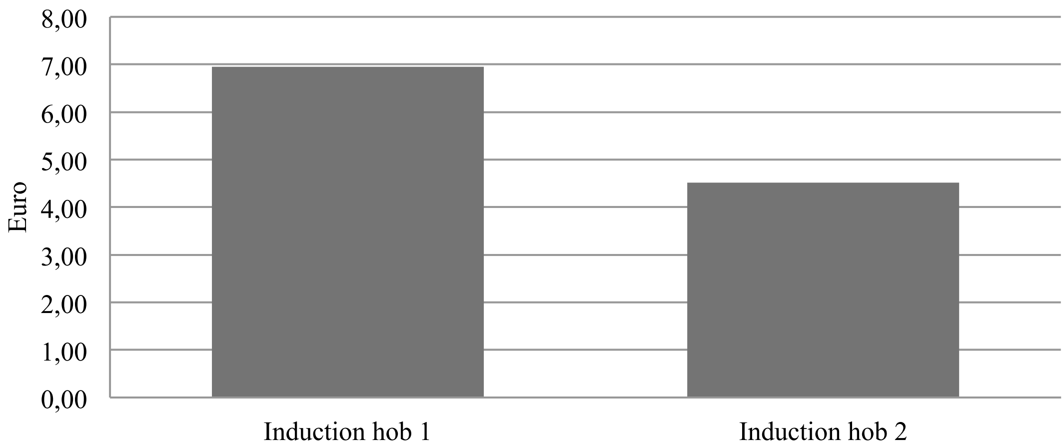

Figure 17 - Assembly cost for induction hobs

5.5 Transport cost

The empirical results of the costs involved in the transportation of products and semi-finished components are presented in Figure 18 and Figure 19. The approach by the authors has been to cover the costs for components and material provided by sub suppliers as well as the costs involved in the transportation of finished products to IKEA.

5.5.1 Research preferences

There are several ways to handle the costs involved in the transportation of material and components, with the difference in the level of detail of the specific method. Due to that the needed level of detail is fairly low, and due to limitations in time and available data the approach has been to apply generic data for transportation cost, see Chapter 4.4.4. The generic data that was used covers the cost of transportation, customs, tied up capital and storage. The data is applied on components that are provided by sub suppliers, for example PCBs and small electrical components. For the transport cost of raw material the price acquired by IKEA is the landed price at the supplier, i.e. transport is included in the price. For the transport cost of finished products the approach has been to calculate the cost from the supplier to an IKEA DC, see Chapter 4.4.4.2.

5.5.2 Results - hoods

The transport cost for the hoods are presented in Figure 18, covering the cost for semi-finished components provided by suppliers and the cost for transportation of finished products. In the cost for transporting the finished goods almost accounts for the total cost.

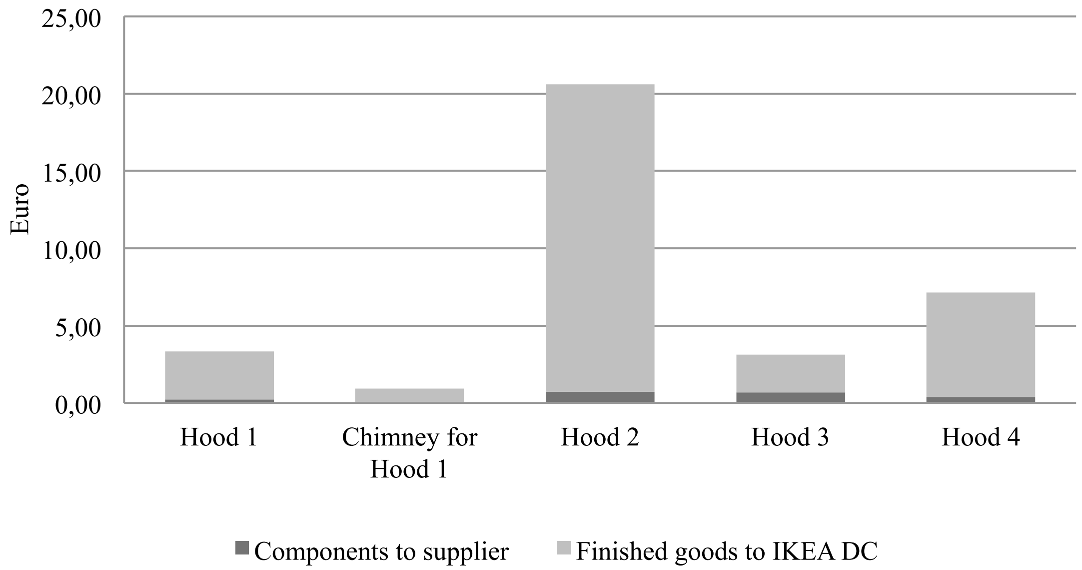

Figure 18 - Transport cost for hoods

5.5.3 Results – induction hobs

The empirical results of the transport cost for induction hobs can be seen in Figure 19. The result is the opposite towards the hoods. The total cost can almost be described by the cost for transportation of semi-finished components.

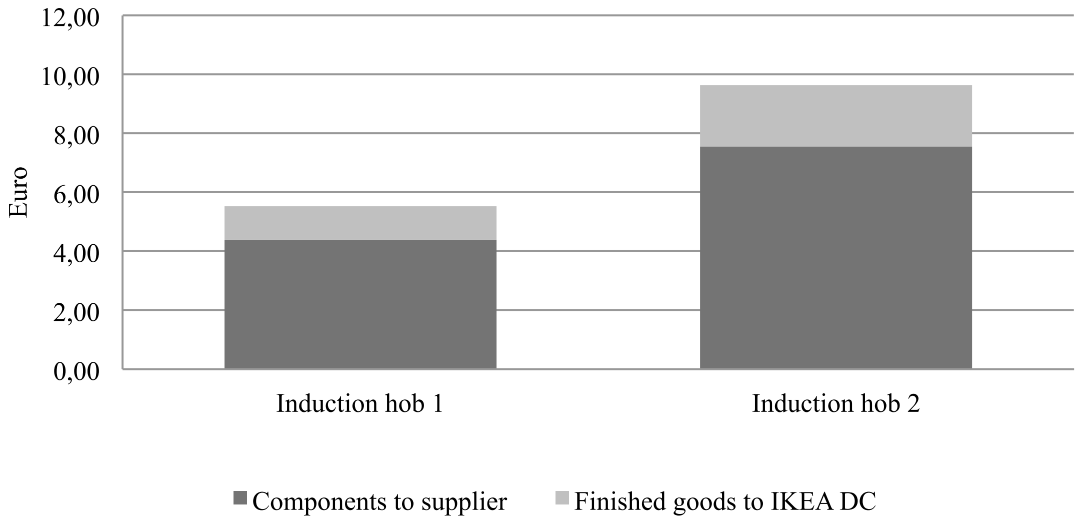

Figure 19 - Transport cost for induction hobs

5.6 Packaging cost

The empirical results of the costs involved in the packaging of the finished products are presented in Figure 20 and Figure 21. The cost cover the material required for the packaging while the process cost of the packaging operation is excluded.

5.6.1 Research preferences

To cover the total packaging cost for a product both the material used and the cost of the packaging process needs to be included. To be able to consider the cost for the packing operations the possibility to study the real process is necessary. The lack of this possibility required to many assumptions to be made to acquire accurate results, therefore this part was excluded from the research.

The materials included in the packaging of the products are cardboard and expandable polystyrene (EPS), also known as cell plastic. The cost of the cardboard is based on prices provided by IKEA and considers cardboard packages that are “ready to use” but unfolded. The quality of the cardboard that IKEA uses for the hoods differs for each model, though an average value has been used in the calculations. The cost for EPS is also based on prices provided by IKEA. An assumption is made that all products uses the same type of EPS. Cost indications for the materials are presented in Table 15.

Table 15 - Packaging material cost

	Cardboard	EPS
EUR/kg	0,49	1,53

5.6.2 Results - hoods

The costs for the material included in the packaging of the hoods are presented in Figure 20. The cost used for manuals is 2 EUR and it is the same for all models. The result for the Hood 2 is not in line with the other products, due to the high amount of cardboard used. The reasons behind this will be analyzed in Chapter 6.5.1.

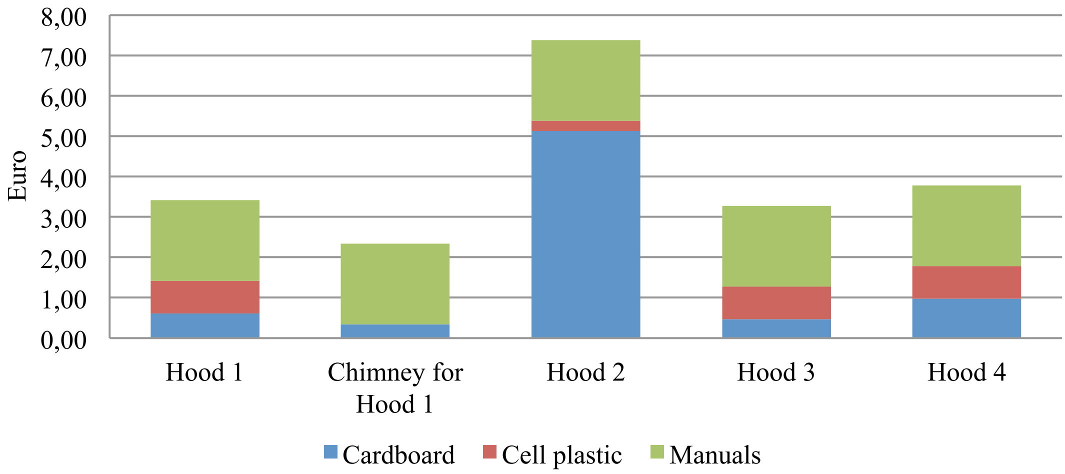

Figure 20 - Packaging cost for hoods

5.6.3 Result – induction hobs

The results for the costs involved in the packaging of the hobs are presented in Figure 21. The packaging of the induction hobs only consists of manuals and EPS, placed on the sides of the product and kept in place by a plastic shrink film. The results are well in line with the expectations of a small increase in cost for the Induction hob 2 due to larger dimension than the Induction hob 1.

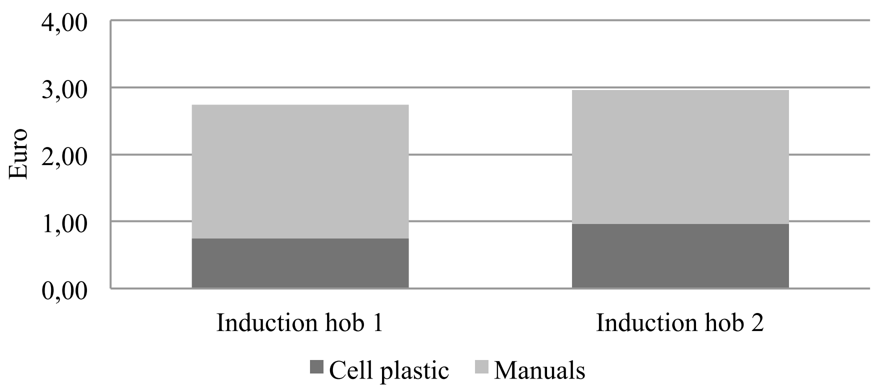

Figure 21 - Packaging cost for induction hobs

5.7 Other cost

The empirical result of the costs related to overhead and profit of the studied products are presented in Figure 22 and Figure 23. The data represents expenditures for research and development as well as the profit margin that is added for each product.

5.7.1 Research preferences

The cost for research and development are gathered from the yearly report for each of the companies involved in the production of the studied products, see Chapter 4.4.5. There are limitations in the amount of information that can be gathered from this kind of source and the applicability of it. The percentage value for overhead cost is added to each cost area for the products, except the process area where overhead cost are already included.

The data for the profit is based on the EBITDA margin for the companies. The percentage of profit margin is added to each cost area of the product and then summarized in other costs.

5.7.2 Results - hoods

The results for the costs involved in overhead expenditures and profit, for each product in the hoods range, are presented in Figure 22. Since all of the products are produced by one supplier the same percentage value is used for all products. This imply that the results closely reflects the difference in cost of the product, see Chapter 5.1.2.

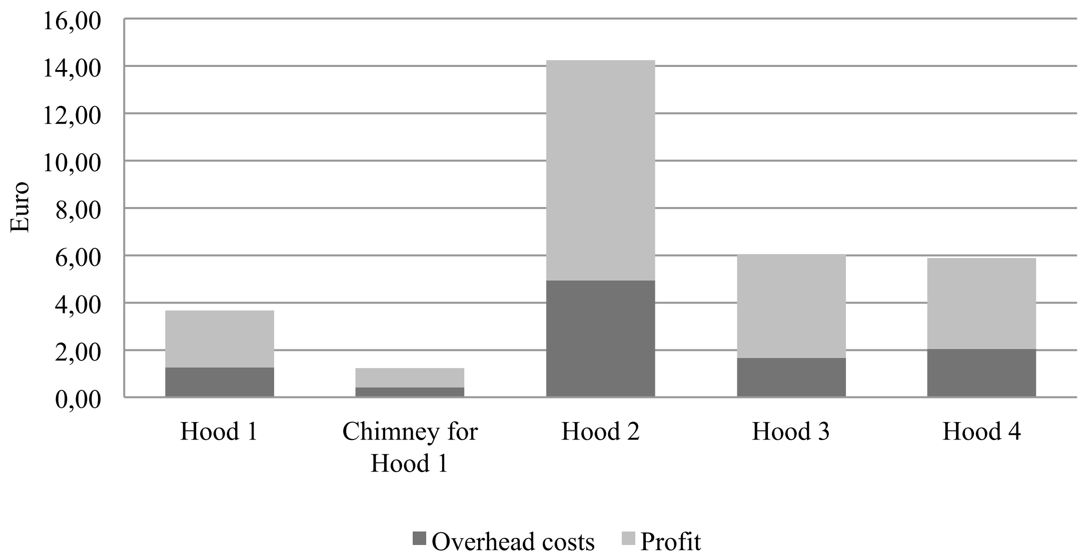

Figure 22 - Other cost for hoods

5.7.3 Results - induction hobs

The results for the costs involved in overhead expenditures and profit, for each product in the induction hobs range, are presented in Figure 23.

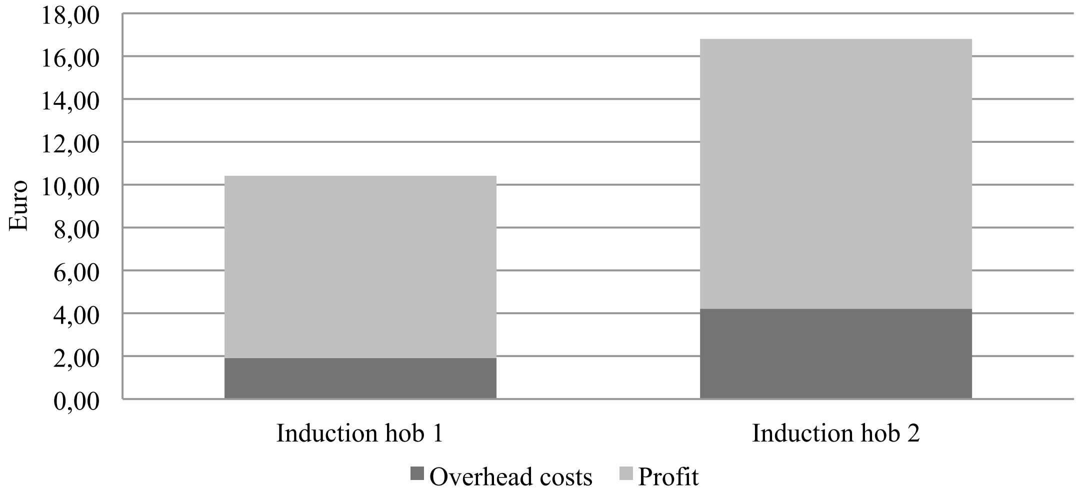

Figure 23 - Other cost for induction hobs

6 Analysis

This chapter explains the analysis of the results performed by the authors of this thesis. First the total cost for the products will be compared to give the reader a range perspective and an overview of the product costs. Secondly each category will be further analyzed to understand the cost drivers and the cost saving potentials.

6.1 Total product cost

In the results for the total cost of the product, presented in Chapter 5.1, it is clear that there is a big variation in the costs involved in the products. This outcome was totally expected due to the differences in design and performance of the products. The major difference is between the two kinds of products, hoods and induction hobs, and due to that reason the results will be analyzed separately in the following sections.

Due to the differentiation of reference products, in terms of design and performance, the total product cost differs as mentioned above. To be able to fully understand the results a comparison to the purchase price of IKEA was requested. The numbers were presented to the authors but due to confidentiality it cannot be presented. Instead the result will be compared to the retail prices of IKEA, see Figure 24.

One has to consider that the estimated product cost only includes costs for the tier one supplier. For IKEA the total product cost will be higher since internal costs at IKEA are added, for example cost for storage and overhead expenditures. The retail prices in Figure 24 are altered by a conversion factor.

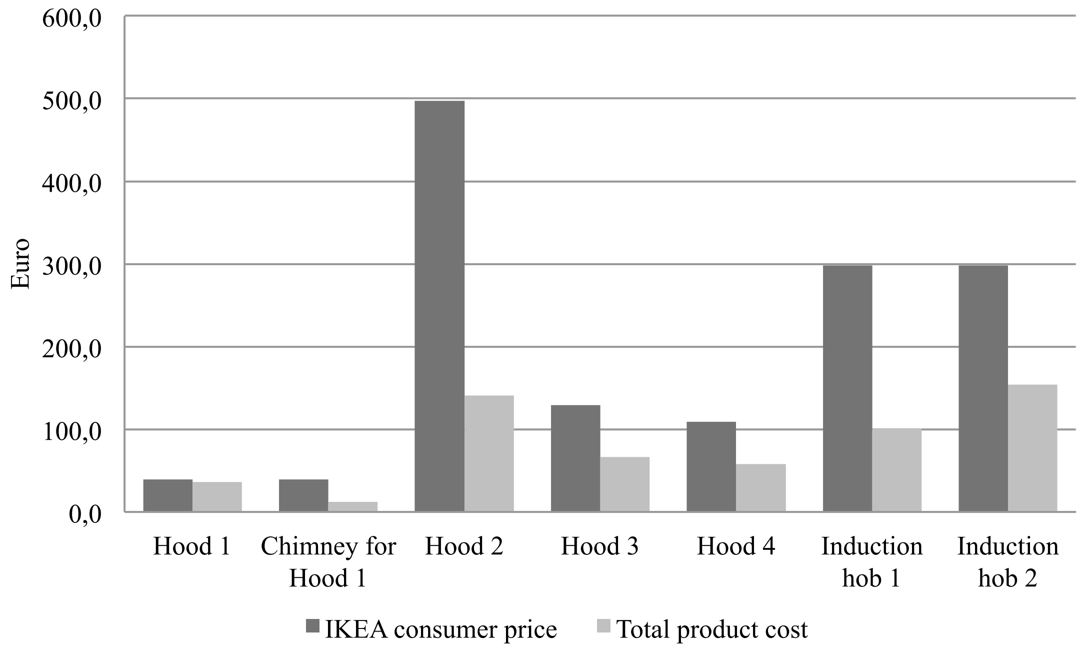

Figure 24 - Retail price (incl. VAT) relation to product cost

In Figure 24 one can see that the gap between consumer price and production cost is very different among the products, especially for the hoods. The induction hobs have the same retail prices but some difference in production cost. The highest gap is for the Hood 2, with the chimney for the Hood 1 close behind. Both these products has a gap of about five times the cost of producing the product, see Table 16. The smallest gap is for Hood 1, due to that IKEA has put a lot of effort in keeping the price down for this particular article. The product has the lowest consumer price in the range, within IKEA this is known as a BTI (breath taking item). In the following two sections the empirical results for each product will be analyzed.

Table 16 - Retail price relation to product cost (in Euro)

	Hood 1	Chimney for Hood 1	Hood 2	Hood 3	Hood 4	Induction hob 1	Induction hob 2
Total product cost	36,0	12,14	140,45	66,15	57,98	100,6	153,6
IKEA retail price	44,6	44,6	558,4	144,8	122,4	334,8	334,8

6.1.1 Hoods

In Figure 25 the percentage distribution of the costs included in each product is presented. The results for each product will be shortly commented in this section followed by a deeper analysis for each category in Chapter 6.2-6.7.

- **Hood 1**
  This is a product in the low price segment, supposed to have the lowest price on the local market. In Figure 25 it is clear that the material category consumes most of the costs, approximately 60 percent of the total cost of the product. The costs for the other categories are spread out among the remaining 40 percent with the packaging cost as the second largest. The major costs in the material category are steel and the cost for the motor, see Chapter 5.2.2 for further explanation.

- **Chimney for Hood 1**
  The chimney for Hood 1 is a very simple product consisting of a metal sheet that is processed with low complexity. The major costs add up from the material and the packaging activities. Packaging accounts for the second highest cost in this product, which can be explained by the low utilization of the packaging size, due to the product shape.

- **Hood 2**
  The Hood 2 is the most expensive one in the hoods range, both in retail price and in product cost. The most cost consuming categories are material, process, packaging and assembly. The high material cost can be explained by the high consumption of steel as well as the high cost for the motor, see Chapter 5.2.2. Compared to the other products the process cost has a larger impact on the

total cost of the product. This is due to the low volumes of the Hood 2, see Chapter 5.3.2. The assembly cost can be explained by the complex design solutions and the high labor rates in Italy, see Chapter 5.4.2.

- **Hood 3**
  The product is one of the most selling hoods of IKEA within the medium price level. The material and assembly categories are the two major cost consuming parts, adding up to over 80 percent of the total cost, see Figure 25. In the material category the high consumption of steel drives the costs together with the choice of motor, see Chapter 5.2.2. As in the case for the Hood 2 the assembly is highly affected by the complex design solutions and the high labor rate in Italy, see Chapter 5.4.2.

- **Hood 4**
  The Hood 4 is also one of the top selling models and has almost the same relation between the product cost and the retail price as the Hood 3. The material category is the main cost consuming category also for this product, with the same explanation as for the other hoods. The assembly cost is very low, compared to Hood 2 and Hood 3, explained by a less complex design and that the production is placed in Poland with much lower labor cost.

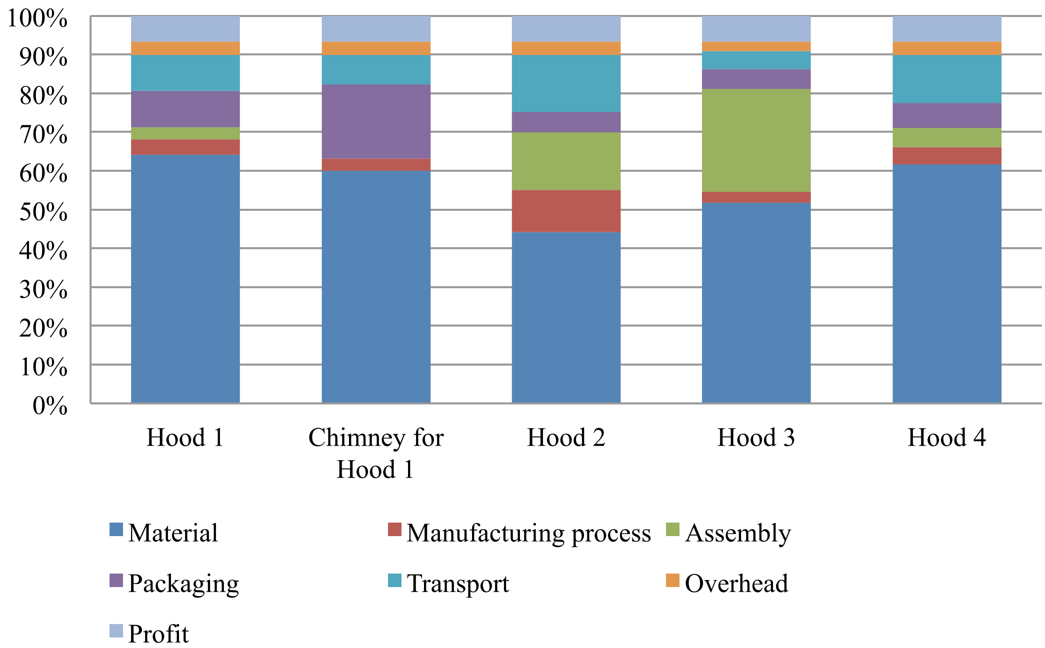

Figure 25 - Relative product cost for hoods

6.1.2 Induction hobs

In Figure 26 the percentage distribution of the costs included in each product is presented. The results for each product will be shortly commented in this section followed by a deeper analysis for each category in Chapter 6.2-6.7.

- **Induction hob 1**
  For both the induction hobs the material category accounts for the most of the costs included in the product. Compared to the hoods, the number of semi-finished component included in the product is much higher which increases costs. The level of manufacturing process work is at the same time less compared to the hoods, which also increases the percentage value for material, see Figure 26. Due to low volumes the manufacturing process cost accounts for a larger part in the Induction hob 1 compared to the Induction hob 2.

- **Induction hob 2**
  The Induction hob 2 is one of the top selling models in the induction hobs range and is therefore produced in high volumes. In Figure 26 it is clear that the material cost accounts for most of the costs. Within this category the semi-finished components drives the cost, as mentioned above. The components of highest cost are the glass and the induction coil controls, see Chapter 5.2.3.

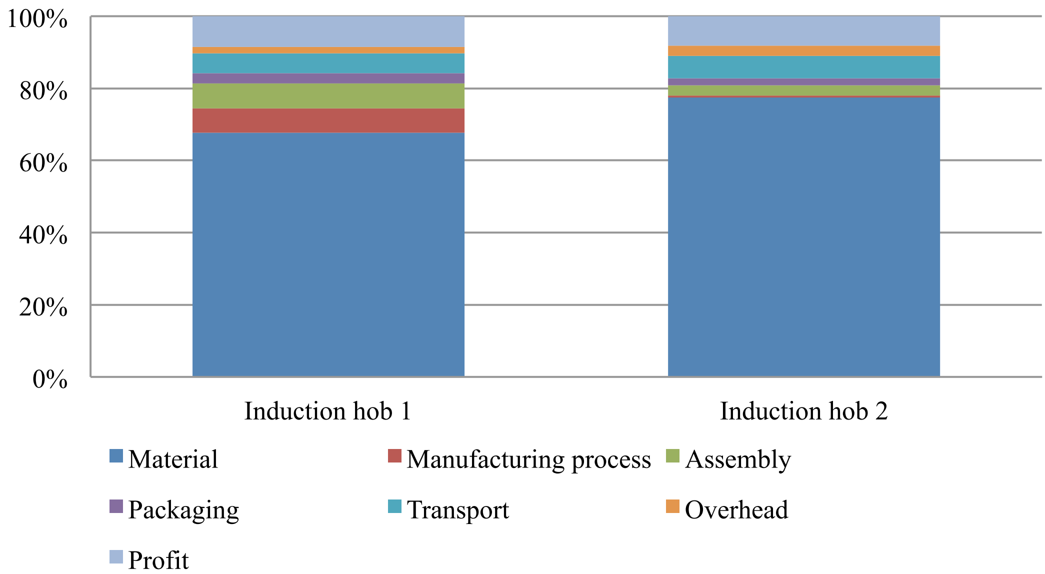

Figure 26 - Relative product cost for induction hobs

6.2 Material

The following section is an analysis of the research results from Chapter 5. Table 17 shows the relative proportions of the material costs.

6.2.1 Hoods

The research results indicated that a significant part of the material cost for hoods are the steel and motor cost. Table 18 demonstrates that the cost for steel in general accounts for about 36-40 percent of the total material cost. An exception is the Hood 3 where the steel cost is only 16 percent of the material cost, even though it has relatively high proportion of steel. The reason for this is that Hood 3 is constructed with mainly low cost carbon steel, while the other models use stainless steel for the cabinets, see Table 17. For instance, the Hood 1 has higher steel cost but lower steel weight, compared to the Hood 3, see Chapter 5.2.2 for research results. This indicates that the cost driver in this case is the consumption of steel with a clear cost saving potential in the choice of steel material and quality. The material choice often depends on customer preferences and process suitability, which also has to be considered before changing material. For example replacing the stainless steel 430 to carbon steel in the Hood 1 would reduce the steel cost with more than 50 percent, with no considerations taken to the material characteristics. Since the steel cost is a cost driver this would reduce the total product cost with almost 20 percent.

Table 17 - Steel composition

	Hood 1	Hood 3
Stainless steel	99,26%	5,88%
Carbon steel	0,74%	91,76%
Aluminium		0,71%
Galvanized steel		1,65%
Total	100,00%	100,00%

The subsequent highest material cost in hoods is the cost for motor and scroll, the cabinet to the motor. In general this cost accounts for about 40-50 percent of total material cost in the hoods, see Figure 27. All models, but the Hood 2, use a motor model which is a cheap solution with lower performance compared to the motor model used in Hood 2. The cost for a low performance motor is almost half of the cost for a high performance motor, but the specified performance is also the half.

The research showed that differences in performance relates to the orientation of the motor and the conveyor. The Hood 3 uses two motors with a performance of 325 m^3/h, while the Hood 4 uses one motor with performance of 400 m^3/h. This indicates that vertical mounted motors and horizontal conveyors, as in Hood 3, have lower performance. By re-designing the motor orientation it is possible to go from two motors to one motor. This would reduce the motor cost with approximately 25 percent. Since the motor is a cost driver this would reduce the total product cost with almost 16 percent. It would also reduce the necessary assembly operations in the production, and accordingly lower assembly cost.

Table 18 - Relative material cost for hoods

	Hood 1	Chimney for Hood 1	Hood 2	Hood 3	Hood 4
Plastic	6,33%		3,47%	4,44%	9,19%
Steel	37,46%	99,38%	36,24%	15,58%	36,67%
Grease filter	5,30%		1,93%	6,96%	6,69%
Motor (scroll)	44,96%		45,03%	60,28%	42,66%
Electrical comp.	2,24%			2,75%	1,45%
Lightning comp.	0,79%		8,77%	1,06%	1,02%
Cables	2,71%		1,24%	2,24%	2,16%
Screws	0,20%	0,62%	0,34%	0,46%	0,17%
Other			2,98%	6,24%	
Total	100,00%	100,00%	100,00%	100,00%	100,00%

Table 18 confirms what was described in the results about the semi-finished components i.e. they account for a small proportion of the total material cost, except for the motor. For the semi-finished components there are three parts that drives majority of the cost, the motor, the grease filter and in one case the lightning components. The results pointed out that it was only in the case for Hood 2 that the grease filter stood for less than five percent of the material cost. The research demonstrated that Hood 2 and Hood 4 uses the same model of grease filter, but Hood 4 is built with two and Hood 2 with only one, which consequently lower cost. Both models are also designed with one conveyor so the reason for using one grease filter in one case and two in the other is not clear. Since the Hood 2 is in the higher price range with higher performance specifications, it should be sufficient with one filter in the Hood 4 as well. There is a cost saving potential for the Hood 4 by reducing the number of grease filters.

All models but Hood 2 uses incandescent lamp for the lightning, while Hood 2 uses halogen lamp. The Table 18 indicates that the solution with halogen lamp drives cost significantly. The actual halogen holder with halogen lamp is not the factor which drives the cost for lightning, see Chapter 5.2.2, it is the required transformer for the halogen solution. The cost for the halogen lamp and transformer is based on an IKEA supplier and products that IKEA have in-house. An idea could be to use existing sourcing for halogen solutions in the next coming hood models, since they most likely meet the requirements.

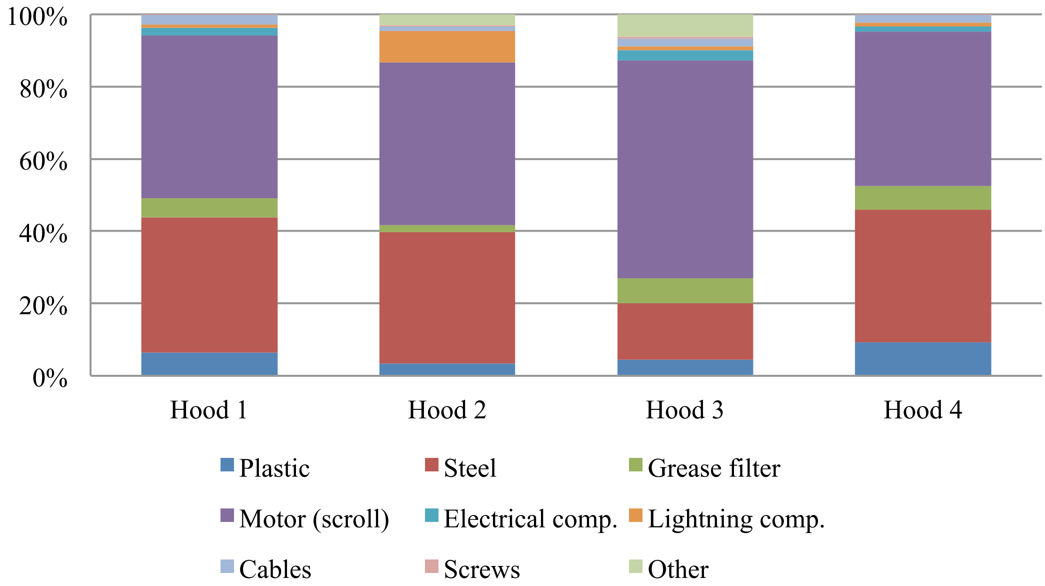

Figure 27 - Relative material cost for hoods

6.2.2 Induction hobs

The research results indicated that raw material such as steel and plastics are not a factor that drives cost for the induction hobs. Instead are the semi-finished components more important for the total material cost, i.e. opposite situation compared to the hoods. The main part of the cost for semi-finished components depend on the PCB's, such as the control panel and induction coil control. The glass also accounts for a significant part of the cost.

Induction hob 1 is a smaller model compared to the Induction hob 2 and has only two induction coils instead of four. Since each control board can manage two induction coils, the Induction hob 1 need one control board and Induction hob 2 require two control boards. That is one reason why Induction hob 2 have higher relative cost for the control boards. An important difference is also that the Induction hob 2 require an external PCB for the filter board, which is built-in to the control board for the Induction hob 1. This adds to the cost for PCB and furthermore it adds cost for the assembly work of the induction hob. Assuming equal quality and performance it can be argued that the supplier, of the Induction hob 1, have a more cost efficient solution for the PCB's in comparison to the supplier of the Induction hob 2. Even if the components on the external filter board are required in the Induction hob 1, it has reduced the number of PCB's. By not using external filter board weight is reduced, which save cost concerning handling ergonomics in production and logistics.

Another observation made is that the filter board which is the heaviest PCB is though the cheapest one. Very likely is this dependent on the components mounted on the PCB. Since 30-45 percent, see Table 19, of total material cost are related to the control board it is reasonable to review cost saving potentials for this component. A start could be to find a different solution with the filter board.

Table 19 - Relative material cost for induction hobs

	Induction hob 1	Induction hob 2
Plastic	2,16%	2,59%
Steel	4,04%	1,68%
Induction coil	9,34%	12,11%
Control panel	19,03%	10,90%
Induction coil control	32,16%	44,14%
Fan	5,52%	6,32%
Glass	24,71%	22,20%
Screws	0,06%	0,06%
Cables	1,13%	
Other	1,84%	
Total	100,00%	100,00%

The control panel is also produced as a PCB. During a study visit it was told that the control panels are standardized PCB's which are common for several models of the induction hobs. The supplier confirms this by stating, in the annual report 2010, that module system is a long term strategy they work with. This sort of module system facilitates cost reduction in research since design solutions can be reused. Probably it also reduces the production cost per unit since the production volume increase. But then this also means that in some models there will be components that are not in use nor required. The results from the workshop demonstrated that the control panel in the Induction hob 1 actually has led-components, but they are not required.

The Induction hob 1 are designed with manual knobs on the cooker top and require thus a mechanical converter i.e. potentiometer in addition to the standardized control panel. Thus it can be derived that other solutions than touch and led drives additional cost, as of today. Knobs require also additional assembly operations and consequently add assembly cost. This reflection point out that some design solutions that may be perceived as low price devises to the customers, might actually carry higher costs.

Figure 28 visualize the distribution of the material cost and it indicates that the glass component account for about 22-24 percent of the material cost. This is at a significant level and the highest cost after the control board. According to information acquired from the study visit at the supplier there are several factors driving the cost; colour of the glass, edge shape and the prints on the glass. The glass is delivered in standardized formats that are always manufactured with a specific edge shape i.e. c-shape. If the glass is ordered with other formats it adds cost and if other edge shapes are wanted it requires additional manual grinding processes. Thus depending on the glass supplier's production, divergent format design drive cost for the glass component. The cost for glass is also influenced by the design for the knobs. If the induction hob design requires holes to be drilled in the glass to mount the knobs this add cost. A cost saving solution for this design is to mount a steel trim around the glass, like the one in Induction hob 1, and mount the knobs in the steel trim. Drilling process in sheet metal is most likely cheaper than drilling in ceramic glass.

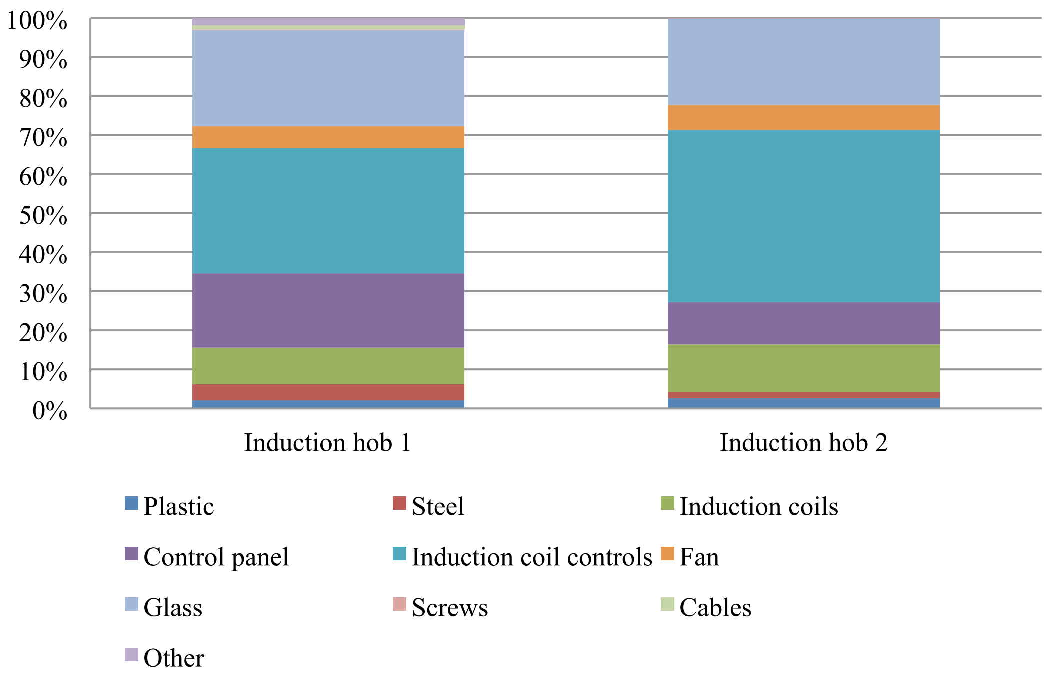

Figure 28 - Relative material cost for induction hobs

The research result indicated that the induction coils account for about 9-12 percent of the material cost. Factors that affect the cost for induction coils are the holder of the coil, number of strands, cycles around the coil, number of ferrite cores and mainly the quantity of the copper. The empirical data, see Appendix I, showed that the construction of the coils is the same with and without booster effect. But the cost for the coils is affected by the required power, although not significantly, see Appendix I. This indicates that, in the case of Induction hob 2, the supplier has chosen to go for higher volumes to reduce cost per unit i.e. volumes affect price more than the other factors.

6.3 Manufacturing process

The results in Chapter 5 showed that the quantity of the raw material affect the processing cost, which is self-explanatory. It pointed out that the number of parts to process affects the process cost more than the total quantity i.e. 10 parts of 1 kg cost more than 1 part of 10 kg. This indicates that the number of required processes drives cost.

For all product samples the sheet metal work can be assigned for the majority of the number of manufacturing processes. The data for the manufacturing process cost did not always reflect this. It turned out that the share for the plastic processing cost were not proportional to the number of processes, it was always higher. This results point out that plastic processing is more expensive than processing of steel.

6.3.1 Hoods

The results showed that the total manufacturing process cost were significant higher for Hood 2 than for the other hoods. The reason behind this is not only that it is an advanced design that requires a lot off processing. Actually the Hood 3 requires more manufacturing process steps but have much lower process cost. This result depends on the low volume that Hood 2 is produced in, which increases the production cost significantly, see Chapter 5.3.2. The process costs are mainly driven by the cost of processing steel i.e. sheet metal work, which is natural since the hoods are mainly made of steel, see Table 20.

Table 20 - Relative manufacturing process cost for hoods

	Hood 1	Chimney for Hood 1	Hood 2	Hood 3	Hood 4
Injection molding	47,21%		21,74%	25,82%	39,03%
Sheet metal work	43,13%	100,00%	76,97%	63,21%	55,44%
Automatic machining	9,66%		1,29%	4,75%	5,52%
CCE				6,22%	
Total	100,00%	100,00%	100,00%	100,00%	100,00%

Figure 29 visualize the process cost for each sample of hoods. It shows that Hood 3 has a process cost for cold continuous extrusion, CCE, which accounts for about 5-6 percent of the costs. This 5-6 percent is based on processing only one component and indicates that this sort of process is very expensive. The result also indicates that components in aluminium are very expensive to work with and should be used as little as possible. The process cost can be lowered by reducing number of parts in each product, reducing components made in plastic, aluminium and increase volumes as much as possible. Working with sheet metal processes such as cutting, bending and shearing are less costly in high volumes.

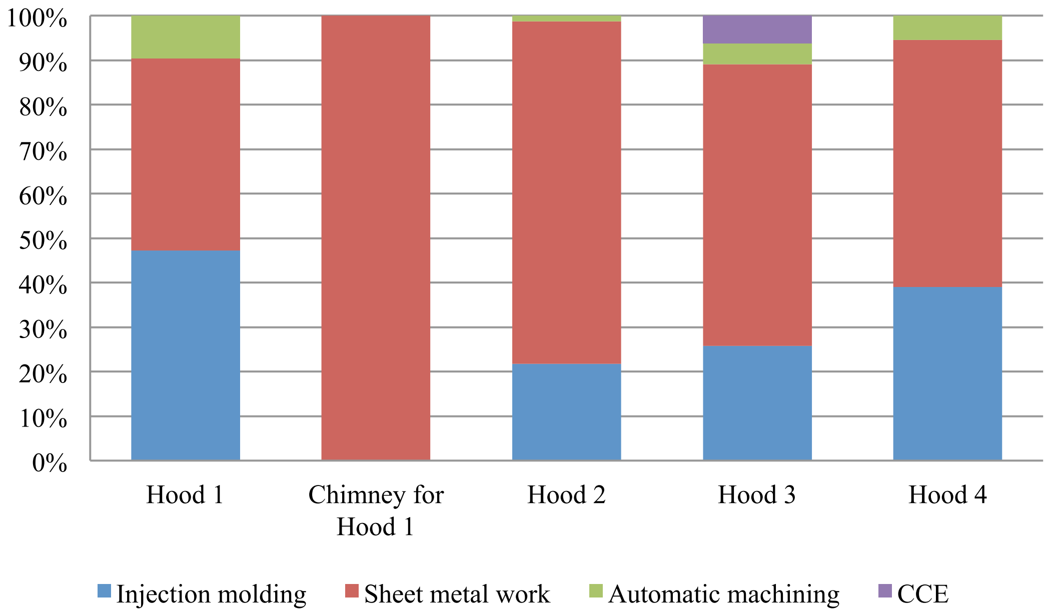

Figure 29 - Relative manufacturing process cost for hoods

6.3.2 Induction hobs

The induction hobs are mainly made of semi-finished components and requires thus less processing compared to the hoods. Still Induction hob 1 has relatively high manufacturing process cost and it can be explained by the low volume. The analysis of the hoods also applies on the induction hobs. The main part of the manufacturing process cost is assigned to the steel processing, see Figure 30. Cost saving potentials appears by reducing required process steps i.e. reducing the amount of components.

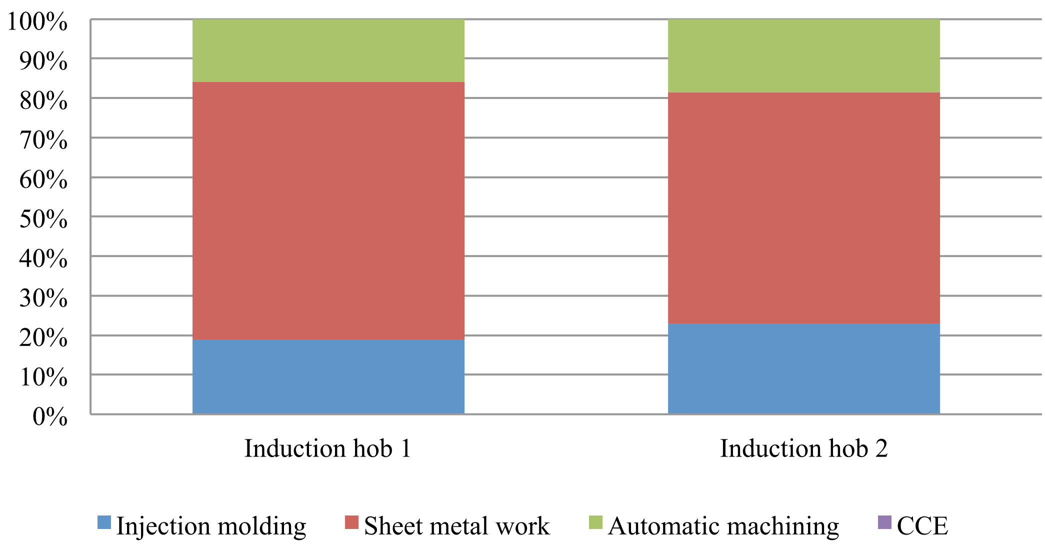

Figure 30 - Relative manufacturing process cost for induction hobs

6.4 Assembly

The results presented in Chapter 5 indicated high differences in the costs related to assembly operations for the product range. The factors included in the study of the assembly cost are the assembly time required for each product and the labor cost in the specific country of operation. As can be seen in Table 14 in Chapter 5.4.1 the labor cost differs a lot between the countries and therefore has a major impact on the costs. The labor cost in Poland is approximately 16 percent of the labor cost in Germany. To produce products with a high degree of manual work is therefore not favourable in either Germany or Italy and the possibilities to move the production to a low cost country should be considered.

The time consumed by the assembly operations is also closely related to the costs and in most cases a factor that can be improved with less effort, compared to moving the production. When performing assembly operations the complexity of the operation is more important than the complexity of the product. The use of fitting and handling operations that demands the operator to use tools or that needs to be done with high precision should be avoided. To illustrate this the amount of screws in each product is compared with the time consumed by the assembly operations, see Figure 31. As can be seen, the higher amount of screws, thereby increased demand for screwing operations and complex fitting operations of placing the screw in position, increases the assembly time. To design the products and components for assembly is a good way to decrease the time consumed by the operations and thereby lower the cost. The cost driver in this category is the assembly time, with the cost saving potentials in moving production to a low cost country or by lowering the assembly time.

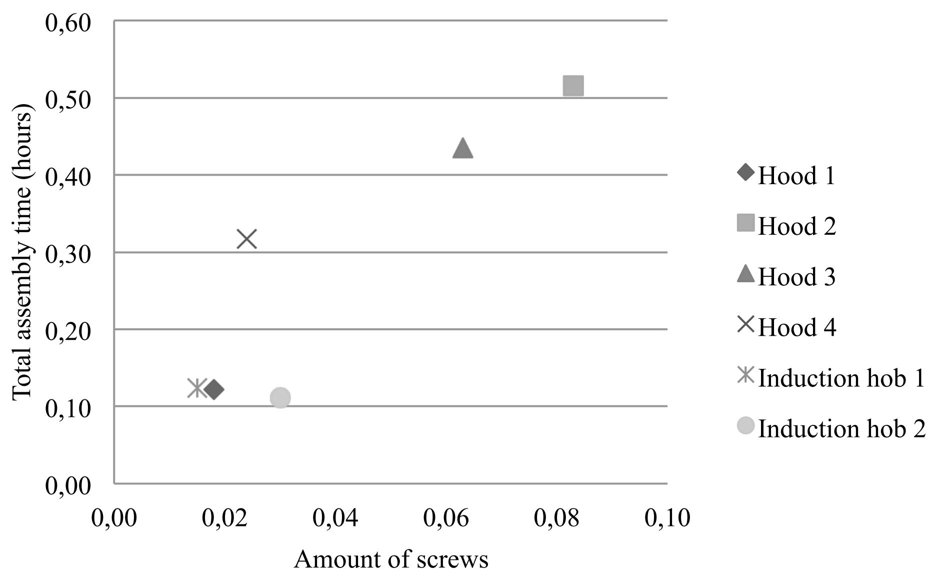

Figure 31 - Operation complexity chart

6.4.1 Hoods

The supplier of the hoods has production units in Italy and Poland. The setup of today is that the models Hood 1 and Hood 4 are produced in Poland while Hood 2 and Hood 3 are produced in Italy. As mentioned above, the labor cost is a major difference between the countries and thereby affecting the total assembly cost. For example sourcing assembly operations for Hood 3 and Hood 2 would reduce the assembly cost by approximately 70-80 percent. Since assembly cost is the cost driver for Hood 3 this would reduce the total product cost by more than 20 percent. For the Hood 2 this would reduce the total cost by approximately 12 percent.

In general the authors of this research question the presence of design for assembly issues considered in the construction of the hoods. The reasons are for example that the screws are often placed in tight spaces and could in many cases be replaced by clips or similar quick fastening solutions. The high number of separate parts, especially in Hood 2 and Hood 3, can also be questioned. As simplification of the product is one of the major methods to improve assembly performance, decreasing the number of parts should be considered.

6.4.2 Induction hobs

Both Induction hob 1 and Induction hob 2 are produced in Europe but in different countries. The difference in labor cost between the countries has to be considered when comparing the results, but does not differ as much as between the products in the hoods range.

As these products mainly consist of components that are provided by suppliers and delivered preassembled, the number of parts are not as high as for the hoods. The number of screwing operations are limited and the complexity of the once who are required is low. In that sense the issues of design for assembly has been taken to account in the construction of the hobs. This also shows in the way that the induction coils are mounted, especially for Induction hob 2. The metal frame on which the coils are placed has small metal pins, making the coils align in position, in the end decreasing the time consumed by the activity.

6.5 Packaging

The cost for packaging consists of the cost for manuals, cardboard and EPS. The price level for manuals is the same for all products and has a major influence on the total cost of packaging, see Figure 32. The price indications for the materials are, 0,49 EUR per kg for cardboard and 1,53 EUR/Kg for EPS. According to Figure 32 one can see that the cost for cardboard still is a major part of the total cost, though the cost is a third of the cost for cell plastic.

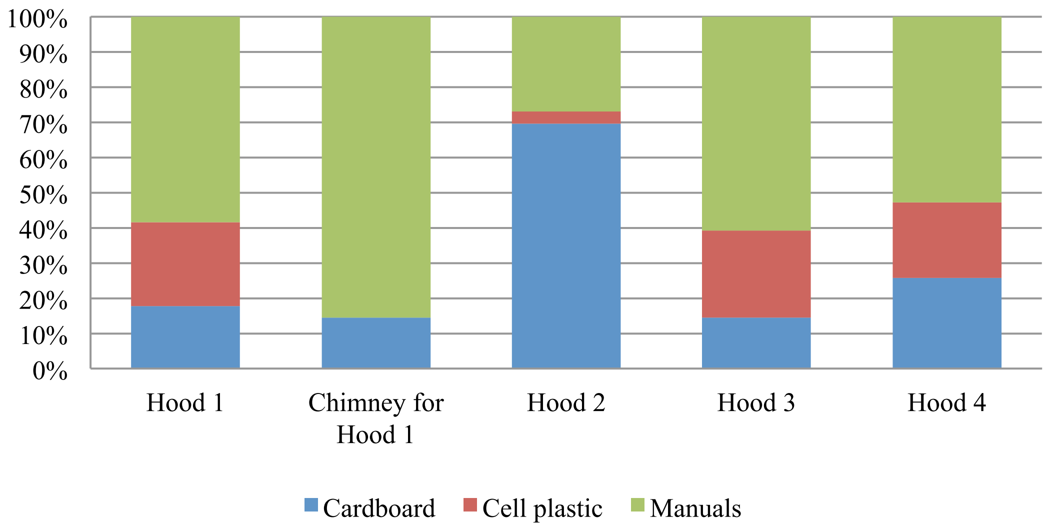

Figure 32 - Relative packaging cost for hoods

6.5.1 Hoods

The results presented in Chapter 5.6.2 indicated similar levels of costs for three of the hoods with the Hood 2 as a remark. The usage of cardboard for this model is huge in comparison to the other products. This is an interesting result due to that the dimensions of the product is very similar to the once for Hood 4. In Figure 33 the volume for each package of the hoods is compared which further states that there is a potential of lowering the consumption of cardboard and thereby lowering the costs for the Hood 2. With almost the same dimensions of the products of Hood 2 and Hood 4 the difference in packaging volumes should not be that high.

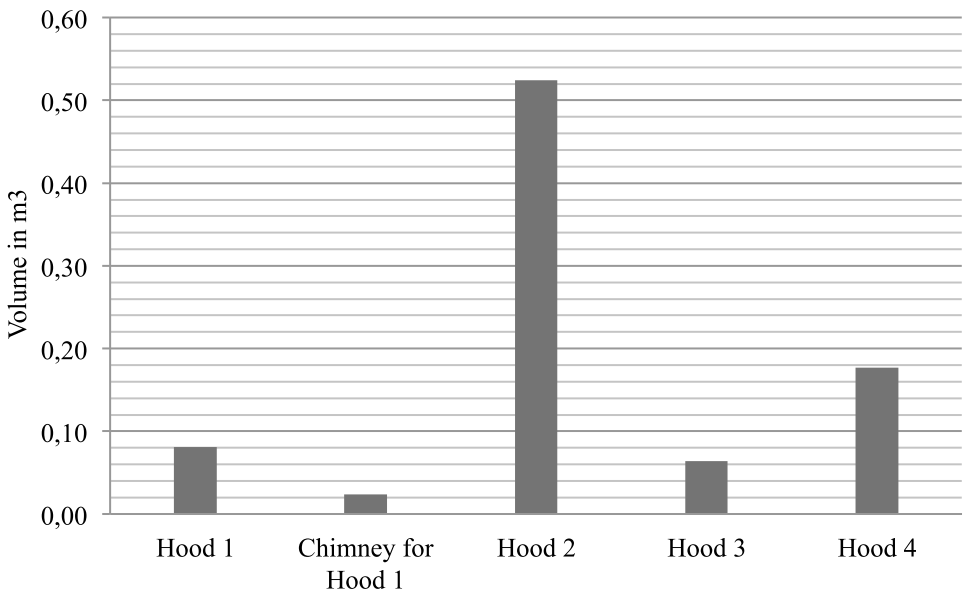

Figure 33 - Volume of packaging

6.5.2 Induction hobs

The hobs are packaged with the use of only cell plastic and a plastic shrink film. The film makes the cell plastic stay on the sides of the product while also protecting it. The package is in that way simplified and the cost saving potential is fairly low.

6.6 Transport

The transportation cost consists of two parts, the cost for transporting semi-finished components and the cost for delivering finished products to IKEA Distribution Centres. The cost for transporting components is related to the number of component provided by sub suppliers for each product, while the cost for transportation of finished products is related to the dimension of each product and its packaging solution.

6.6.1 Hoods

In Figure 34 it is clear that the transport cost for hoods in all cases is mainly affected by the cost of transporting finished goods. One of the reasons for this result is that the semi-finished components provided by suppliers in other countries are small and of low cost. The components are transported in high volumes and the specific cost for a single product becomes very small. The second reason is that the finished products are big in comparison with these components. The transport cost for these components is mainly affected by the volume and therefore this drives costs. The Hood 2 has approximately the same volume as the Hood 4 but with significant larger packaging dimensions, see Figure 33. By re-calculating the transport cost for Hood 2 with the packaging dimensions of Hood 4 it is possible to reduce the transport cost by 65 percent. Since transport cost is a major cost category for Hood 2 this would reduce the total product cost by approximately 10 percent.

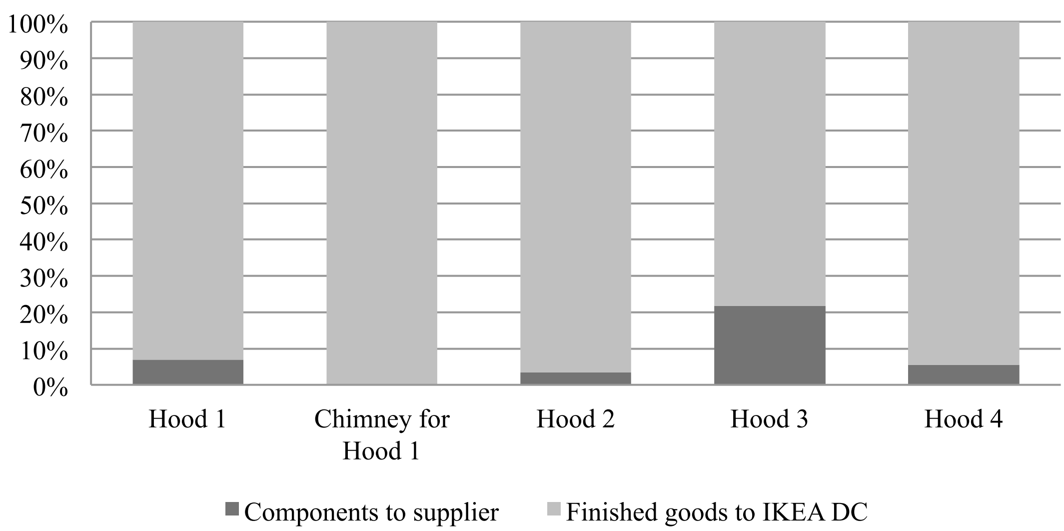

Figure 34 - Relative transport cost for hoods

6.6.2 Induction hobs

As can be seen in Figure 35 the situation is different when it comes to induction hobs. The cost for transportation of finished goods is very low compared to the cost for the transportation of components that in this case drives the cost. This is due to that the induction hob mostly consists of components provided by sub suppliers, thereby adding cost for the transportation activity. Looking at the packaging solution for the hobs the use of only cell plastic makes the dimensions of the packaging very similar to the dimensions of the product resulting in low transportation cost for finished products.

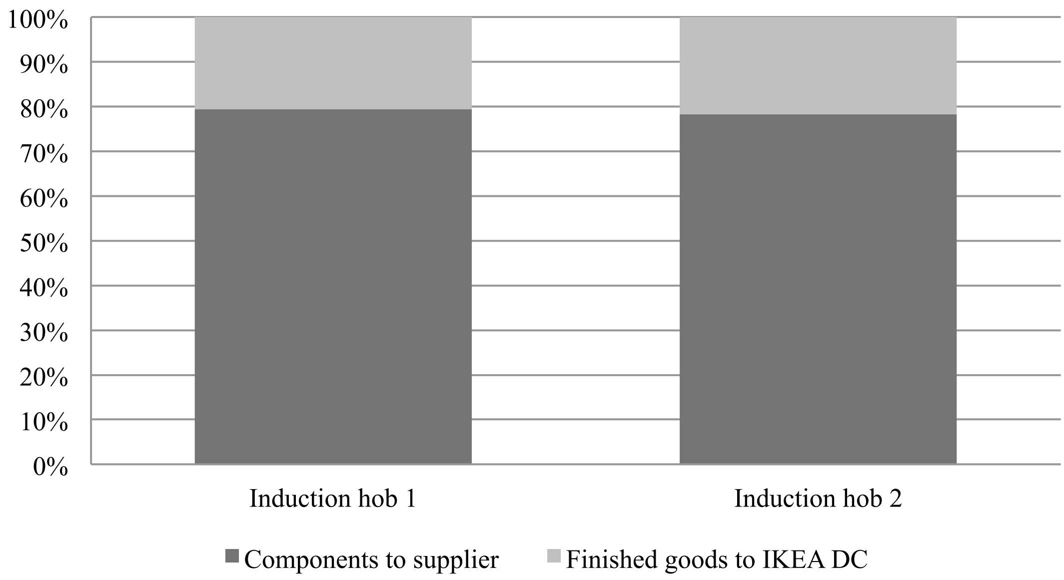

Figure 35 - Relative transport cost for induction hobs

6.7 Other cost

The other costs consist of profit and overhead costs, the results for the studied range of products are presented in Chapter 5.7. As the data for these costs are in percentage values it reflects the total cost of the products and a comparison is not that interesting. It is more interesting to look at the profit margin and overhead expenditures for each company, see Table 21.

Table 21 - Other cost per supplier

	Supplier 1	Supplier 2	Supplier 3
R&D	2,09 %	3,07 %	3,77 %
Profit	9,2 %	8,93 %	7,1 %

The level of cost dedicated for research and development vary between the companies, from 2,09 percent to 3,77 percent. The profit is an average of the profit margin for the company as a whole and thereby not reflecting the individual profit levels for each product. The authors of this thesis have compared the results of the research with the purchase price that IKEA pays. The numbers cannot be presented in the report due to secrecy issues but the indications are clear, the profit margin for induction hobs are higher than for hoods according to this research. The theory of a products life cycle, see Chapter 4.1, also describes this situation with the induction hobs still being in the introduction phase while the hoods are a more established product.

As the overhead cost for the products only reflects the cost for research and development, with other costs missing, and due to that the profit reflects an average value for all products the cost drivers cannot be stated. The high profits in the induction hob range are the remark in this category and where the potential of saving cost lies within.

7 Discussion

In this chapter the process and outcome of the research will be discussed to give the reader insight in considerations and issues that may have affected the final result. First the methodology approach will be discussed and the credibility of the outcome will be considered. This chapter also reflects over the theoretical approach and the last section discusses the results and analysis of the project

Methodology approach

The methodologies used for gathering of data and information are described in Chapter 3. As described in the chapter the authors approach has been to achieve a high level of credibility in the results, mainly by the use of triangulation. Regarding the data collection the methods described in Chapter 3 have proven to be sufficient for acquiring the needed information. The limited access to the production plants is a drawback and has affected the accuracy of the results. During the project this made the validation difficult, but in the end the results could be compared and validated with data from IKEA.

Theoretical approach

Due to that there is no clear definition of what costs to include in a cost break down analysis the authors had to develop a unique approach for this specific research. This will affect the possibility to define the credibility of the research due to that it is not clear what to compare against. The authors approach has been to base the structure on the activity based costing method and the activities included in manufacturing processes. By using these two theoretical sources to define a cost breakdown structure the authors regard the credibility of the project to be satisfying. This has also been validated by personnel at IKEA of Sweden and at Chalmers University of Technology.

The theoretical model used for the estimation of material and manufacturing process cost is a generic model and therefore the outcome should be regarded as an indication rather than an exact value. A second reason is that the data in the model are presented in diagrams where the level of detail in the readings is low. It is though important to point out that the model is validated and used as lecture material at Chalmers University of Technology, indicating that it is a conventional method.

The results for material cost and manufacturing process cost are highly dependent to each other. The process selection is dependent on the choice of material and vice verse. A condition this leads to is the waste coefficient for material consumption during processing of a part. The method used for calculating material and manufacturing process cost focus on the shape complexity of a part when determining the amount of waste in a process. The definition of shape complexity, described in Chapter 4.4.1.1, account for many factors related to the manufacturing process selection and material choice. It could though be questioned to what extent the shape complexity depends on the amount of holes in a part. A different method to approach the factor of waste is to actually measure the volume of the holes in a part and divide it with the total material volume. The total waste coefficient of a part is an average value of the waste coefficients from each process type that is comprised in the shaping of the part. It should be noted that no considerations are taken to the possibility to sell material residues.

Results and analysis

In general the results of this research should be treated as an indication of costs rather than the absolute values. This is mainly due to that there has been very limited possibilities to acquire insight in the production processes in the production of today and due to that the suppliers used today has been hard to contact. The approach of the authors has been to use theoretical methods and data available at other suppliers. This surely affects the product cost identified by the research, making it an indication of costs rather than a reflection of the actual production of today. This setup also requires some reflections in terms of quality and functional issues. Due to that the majority of the suppliers contacted in the project are placed in China, there has been no possibility to secure the quality level. The function and specifications has been described for each component but the possibility to secure the suitability is also in this case limited.

It is important to point out that there are differences in the specifications of some of the components that are present in more than one product. One example is the motor that in some products includes the costs for the conveyor and the plastic or steel scroll, while in some products it only covers the cost for the separate motor and conveyor. This affects the comparison between the specific categories of the products by in some cases indicating the wrong relation. To fully understand the included costs for each product the reader should study Appendix I. It should also be pointed out that some components have not been included in the calculations. The reason for this is that the authors did not find the cost for them. It regards very few components and it has been indicated that they are not significant for the total cost.

The cost for some PCB's and the electric motors are based upon data that has been received from suppliers. The supplier has owner interests in companies that manufacture this type of products, and it can be argued that they have lower cost for these components. This has not been regarded in the thesis.

The authors have had the opportunity to compare the outcome of this research with the purchase price of IKEA. The number cannot be reviled in the report but it should be mentioned that is clearly validates the credibility of the research. Even though it validates the results it also indicates that for products with high volume the cost are to some extent over-estimated.

8 Conclusion

In the introduction of this thesis three questions were defined. The answer to the first question can be found in Chapter 5 and Appendix I. The answer to the second and third question are based upon the answer of the first, derived from the results and analysis of the research and finally presented in this chapter.

8.1 Hoods

In general the material cost accounts for the majority part of the total cost in the hoods, while assembly and transport cost varies between the samples but also account for a significant part of the cost. Table 22 indicates the cost drivers and cost saving potential related to each cost driver.

The motor is the main cost driver for the hoods. The motor cost varies considerably between the models but is always the main cost. Cost saving potentials appears by the possibility to reduce the number of motors or change the motor model. The analysis showed that the hood design affects the required number and model of motors. Thinner designs require a motor setup where the conveyor is mounted in horizontal direction. This setup tends to have lower performance and require a more powerful motor, or more than one motor, which drives cost. There is therefore a cost saving potential in the choice of hood design. Designs that make it possible to mount a motor with vertical conveyor require lower motor power, which can reduce motor cost.

Table 22 - General cost driver and cost saving potential for hoods

	Cost driver	Cost saving potential	Cost reduction
Material	▪ Quantity of steel 8-24% of total cost	Use less stainless steel, replace with carbon steel.	Up to 20% cost reduction.
	▪ Motor solution 20-31% of total cost	Reduce the number of motors, change motor model. Increase awareness of the design effect.	Up to 16% cost reduction.
Assembly	▪ Required assembly time 3-27% of total cost	Source assembly to low cost countries.	Up to 20% cost reduction.
	▪ Number of parts	Apply DFA.	
Transport	▪ Packaging volume 5-15% of total cost	Optimize the packaging to the product.	Up to 10% cost reduction.

Cost of raw material for steel is the second largest factor that influences the cost for hoods, and the quantity is the cost driver. The analysis shows that a cost saving potential is to use carbon steel instead for stainless steel to lower the cost for raw material. These two cost drivers account for the majority of the material cost and a small cost reduction in them would be as significant as a large reduction in the other material cost.

Cost for assembly operations varies between the models, but are significant for several of them. The analysis indicated that the required assembly time is a cost driver together with the number of parts in the hood. Required assembly time is highly affected by the number of components in the hood, and by reducing the amount of components the assembly time will be reduced. By using methods like design for assembly it is possible to reduce the number of parts and lower the assembly cost. The analysis also indicated that by sourcing assembly operations to low cost countries there is a potential to reduce the assembly cost significantly.

The transport cost is very significant for one sample and the cost driver is the packaging volume. Transport cost can be reduced considerably by optimizing the packaging solution. As of today large share of the transport cost is made up of transporting air.

8.2 Induction hobs

The total cost for the induction hobs is mainly affected by the material cost. The raw material adds modest cost and the main cost are assigned to the semi-finished components. The main cost drivers for material are shown in Table 23.

Table 23 - General cost driver and cost saving potential for induction hobs

	Cost driver	Cost saving potential
Material	▪ Induction coil control ~17% of total cost	Integrate filter board, reduce number of PCB.
	▪ Ceramic glass 22-34% of total cost	Design products with standard edge shape and format.

The main cost driver in the induction hobs is the induction coil controls. This cost can be reduced by integrating the filter board into the induction coil control. This is done by the supplier of the Induction hob 1 and the analysis show that it lowers the cost.

The ceramic glass is the most significant cost driver after the induction coil controls. The cost for ceramic glass can be reduced, or held on low levels, by using glass with standard edge shape and size. For models that are designed with manual knobs the glass cost can be reduced by using metal trim for mounting knobs instead of mounting them in the glass.

The analysis of the induction hobs also indicates that the suppliers have high margins on this product and there can be potential cost savings by negotiating with several suppliers, for example in China.

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10 Appendix I

Only available in the non-public version.

11 Appendix II

Only available in the non-public version.