
# A model for commonality and modularity of table top family design

## Finding the right balance with a platform-based approach for a sustainable future

Master’s thesis in Product Development

Leo Eshagi
Asghar Ramezani

Department of Industrial and Material Science
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2020

Master's thesis 2020:11

# A model for commonality and modularity of table top family design

Finding the right balance with a platform-based approach for a sustainable future

Leo Eshaghi
Asghar Ramezani

Department of Industrial and Material Science
Chalmers University of Technology
Gothenburg, Sweden 2020

A model for commonality and modularity of table top family design
Finding the right balance with a platform-based approach for a sustainable future



Supervisors: Alfard Jansen, IKEA of Sweden AB and Iñigo Alonso Fernandez, Chalmers - Department of Industrial and Material Science
Examiner: Ola Isaksson, Chalmers - Department of Industrial and Material Science

Master's Thesis 2020:11
Department of Industrial and Material Science
Chalmers University of Technology
SE-412 96 Gothenburg
Telephone +46 31 772 1000

Cover: Combinations of three frames and three tops from internal documents at IKEA

Typeset in LaTeX
Printed by Chalmers Reproservice
Gothenburg, Sweden 2020

# Abstract

Over the years IKEA has developed over 700 tabletops. In the current range of tabletops, similarities can be found between several of them. The purpose of this project is to find the similarities among the tabletops, propose to eliminate tabletops with too many similarities and suggest a potential platform for the tabletops. Five research questions were then raised to be answered as the objective of the project:

1. What are the major factors (organizational, cost, logistics, production) in the current IKEA's tabletops strategy (not platform-based)? What needs to be changed (in IKEA's lean development process) to move for a platform-based approach?
2. What are the cost factors (development, production, and logistics) in today's product portfolio in tabletops and how could a platforming strategy affect these factors?
3. How to calculate the supply cost of today's product portfolio compared to a platform-based approach portfolio?
4. How to analyse (calculate complexity, and standardization) the current products (Tabletops) in an efficient way to develop the right standard procedure for other products (beyond tabletops)?
5. What metrics exits that shows the trade-off of internal complexity vs customer options? How can these be used to evaluate the current range and compare future scenarios?

To extend our knowledge and be able to answer the research questions, numerous theoretical methods such as literature study and research interviews were used, with the main subject of platform and modularization development and planning. These theoretical methods allowed to identify the benefits and drawbacks of platform and modularization strategy as well as the reasons why tabletops with a high degree of similarities have been developed over the years. In addition to the theoretical methods, logical methods were also used to categorize the tabletops in different groups based on different parameters such as their shape with subgroups based on different materials with the purpose of comparing them to one another easier. It was also necessary to gather data regarding the tabletops which was used to develop a differentiation and commonality plan that allowed to see the trade-off of developing tabletops based on platform and modularization strategy. With the collected and analysed data different size clusters could be found which resulted in three different platforms that was made based on their shape and size. Except for fining potential platforms, the task was to identify tabletops with too many similarities. With the collected data, compiled in spreadsheets similarities between the tabletops was identified. That resulted with suggestions of eliminating ten different tabletops. The improved methods needed to be analyzed to see potential time and cost savings. The development method was then analyzed by using an estimation method, and the result clearly showed that the method could save approximately around 50 % in development time.

Keywords: Tabletops, IKEA, Platform, Modularity, Circular economy

# Acknowledgements

This Master thesis was performed by Leo Eshagi and Asghar Ramezani which is a partial requirement for the fulfilment of a Master of Science degree in Mechanical Engineering - Product Development at Chalmers University. The Master thesis was performed at the Department of Industrial and Material Science and in collaboration with IKEA.

There are several people that we would like to thank for making this possible. Alfard Jansen our supervisor at IKEA for making this thesis possible and for the feedback through the whole project. The staff at IKEA who were always friendly and helped even though we came with lots of questions. Our examiner Ola Isaksson who was willing to become our examiner even if we started during summer. Last but not least we would like to thank and show our appreciation to our supervisor at Chalmers Iñigo Alonso Fernandez for all the valuable feedback, guidance and support trough the whole project.

Leo Eshagi and Asghar Ramezani, Gothenburg, November 2020

# Nomenclature

**BA** Business Area

**CAD** Computer Aided Design

**HDF** High Density Fibreboard

**MDE** Mechanical Design Engineer

**MDF** Medium Density Fibreboard

**PDE** Product Design Engineer

**PIA** Product Information Assistance

**PLM** Product Lifecycle Management

**PLUS** Product Lifecycle User Solution

**PRE** Product Requirement Engineer

**PSE** Product Solution Engineer

# Contents


**List of Figures** **xiii**

**List of Tables** **xv**

**1 Introduction** **1**
1.1 Background . . . 1
1.2 Aim . . . 3
1.3 Problem definition . . . 4
1.4 Limitations . . . 5
1.5 Stakeholders . . . 5

**2 Theory and Context** **7**
2.1 Product platforms . . . 7
2.1.1 Product architecture . . . 8
2.1.2 Platform planning . . . 8
2.1.3 The effect of modularization on variety . . . 9
2.1.4 Performance measurement of modular product platform . . . 10
2.2 Sustainable development . . . 12
2.3 Communication in organisations . . . 13
2.4 Product Lifecycle Management system . . . 14
2.5 Laws and regulations . . . 15
2.5.1 Minimum sizes for tabletops . . . 15

**3 Method** **17**
3.1 Research approach . . . 17
3.1.1 Literature study . . . 17
3.1.2 Research interviews . . . 18
3.2 Analysis and elimination of tabletops . . . 18
3.2.1 Information retrieval regarding the tabletops from PLM systems 19
3.2.2 Physical study of tabletops . . . 19
3.2.3 Studying and analysing the customer needs . . . 19
3.2.4 Determining factors for elimination from IKEA's point of view 19
3.2.5 Categorizing of tabletops . . . 20
3.2.6 Reducing the number of similar tabletops . . . 21
3.2.7 Proposal for potential platforms . . . 21
3.3 Estimation of time and reduced costs with a platform strategy . . . 22

**4 Results** **25**
4.1 Results of interviews . . . 25
4.2 Analyzing of tables . . . 26
4.2.1 PLM-system . . . 27
4.2.2 Physical study . . . 27
4.3 Categorization of tables . . . 27
4.3.1 Shape distribution . . . 28
4.3.2 Analysis of materials . . . 29
4.3.2.1 Particleboard . . . 30
4.3.2.2 Pine . . . 30
4.3.2.3 Board on frame . . . 31
4.3.2.4 HDF and MDF . . . 31
4.4 Analysis of interfaces . . . 31
4.4.1 Border fitting . . . 31
4.4.2 Cam lock and nut . . . 31
4.4.3 Leg attachment . . . 32
4.4.4 Wedge Dowel . . . 33
4.5 Differentiation and Commonality plan . . . 33
4.6 Platform planning for potential groups . . . 34
4.7 Elimination of tabletops . . . 36
4.8 Estimation of time and reduced cost with a platform strategy . . . 38
4.9 The costs of activities of the existing product portfolio . . . 42

**5 Discussion** **43**
5.1 The effect of platform and modularization approach on the products . 43
5.2 Development process . . . 44
5.3 Roadmap . . . 45
5.4 Research Questions & discussion . . . 47

**6 Conclusions and further research** **51**
6.1 Further research . . . 53

**References** **55**

**A Appendix 1** **I**
A.1 Interview template . . . I

**B Appendix 2** **III**
B.1 Elimination Matrix . . . IV
B.2 Simplified elimination matrix . . . V

**C Appendix 3** **VII**
C.1 Planned Gantt-Chart . . . VIII
C.2 Actual Gantt-Chart . . . IX

# List of Figures


1.1 Involved development areas . . . . . . . . . . . . . . . . . . . . . . 2
1.2 Example of a tabletop (IKEA.com) . . . . . . . . . . . . . . . . . . . 2
1.3 Range and visualization of tabletops . . . . . . . . . . . . . . . . . . 3

2.1 Different types of modular architectures courtesy of (Ulrich & Eppinger,2012) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 9
2.2 The effect of a modular architecture on two different instrument panel, courtecy from (Robertson & Ulrich 1998) . . . . . . . . . . . . 10
2.3 Constitutive framework for the performance measurement of modular product platforms courtesy of (G. Schuh, 2014) . . . . . . . . . . . . 11
2.4 The formality dimensions of communications within organizations (Kraut et al.,1990) . . . . . . . . . . . . . . . . . . . . . . . . . 14
2.5 Minimum surface area per person (internal documents at IKEA) . . . 15
2.6 Minimum distance (internal documents at IKEA) . . . . . . . . . . . 16
2.7 Recommended free space profil (internal documents at IKEA) . . . . 16

3.1 Funnel diagram for categorization of tabletops . . . . . . . . . . . . . 21
3.2 The three different platform leveraging grid, courtesy of (Siddique & Repphum (2001)) . . . . . . . . . . . . . . . . . . . . . . . . . . 23

4.1 Categorization of tabletops . . . . . . . . . . . . . . . . . . . . . . . 27
4.2 Shape distribution of the analysed tabletops . . . . . . . . . . . . . . 29
4.3 Distribution of the tabletop's material . . . . . . . . . . . . . . . . . 30
4.4 Part of the value chain for material production . . . . . . . . . . . . 30
4.5 Boarder fitting connection . . . . . . . . . . . . . . . . . . . . . . . 32
4.6 Cam lock and nut connection . . . . . . . . . . . . . . . . . . . . . . 32
4.7 Leg attachment connection . . . . . . . . . . . . . . . . . . . . . . . 32
4.8 The Wedge Dowel connection and the Wedge Dowel lock . . . . . . . 33
4.9 Groups of suggested tabletops to eliminate . . . . . . . . . . . . . . . 37
4.10 Chosen tabletops to eliminate . . . . . . . . . . . . . . . . . . . . . 38
4.11 Platform family A . . . . . . . . . . . . . . . . . . . . . . . . . . . 41
4.12 Platform family B . . . . . . . . . . . . . . . . . . . . . . . . . . . 41
4.13 Platform family C . . . . . . . . . . . . . . . . . . . . . . . . . . . 41

5.1 Roadmap . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 46

B.1 Elimination matrix . . . . . . . . . . . . . . . . . . . . . . . . . . . IV
B.2 Simplified elimination matrix . . . . . . . . . . . . . . . . . . . . . . V

C.1 Planned Gantt-Chart . . . . . . . . . . . . . . . . . . . . . . . . . . . VIII
C.2 Actual Gantt-Chart . . . . . . . . . . . . . . . . . . . . . . . . . . . . IX

# List of Tables


4.1 Commonality plan group 1 . . . . . . . . . . . . . . . . . . . . . . . . 34
4.2 Commonality plan group 2 . . . . . . . . . . . . . . . . . . . . . . . . 34
4.3 Commonality plan group 3 . . . . . . . . . . . . . . . . . . . . . . . . 35
4.4 Potential platform family A . . . . . . . . . . . . . . . . . . . . . . . 35
4.5 Potential platform family B . . . . . . . . . . . . . . . . . . . . . . . 36
4.6 Potential platform family C . . . . . . . . . . . . . . . . . . . . . . . 36
4.7 Activity hierarchy for the development of a single table . . . . . . . . 40
4.8 Associated time for each activity for a single product . . . . . . . . . 40
4.9 The result of calculation based on the estimation models . . . . . . . 40
4.10 The results from calculation of the estimating model . . . . . . . . . 41
4.11 The continues of table 4.10 . . . . . . . . . . . . . . . . . . . . . . . 41
4.12 Simulation model for entire platform family A . . . . . . . . . . . . . 41
4.13 Simulation model for entire platform family B . . . . . . . . . . . . . 42
4.14 Simulation model for entire platform family C . . . . . . . . . . . . . 42
4.15 The cost of activities for the existing products . . . . . . . . . . . . 42

5.1 Activity hierarchy and the effect of a platform and modular development process . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 44

# 1 Introduction

In this chapter the background and the problem description which consists of specification of issue under investigation, hypothesis, and research questions will be presented. Also, the aim, limitations, and identification of stakeholders will be described.

## 1.1 Background

IKEA is Swedish-origin company that designs, manufactures, and sells ready-to-assemble home furniture and accessories. One of the main goals for IKEA is 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 (Kamprad, 2001).

The products that are offered to the customers at IKEA stores are developed mainly at IKEA of Sweden which is located in Älmhult. IKEA of Sweden development departments is divided into more than 20 business areas (BA) such as dining, workspace, living room, etc. Business areas are divided into Home furnishing departments which itself are divided into development teams, for instance, development teams for tables. This structure is visualized in figure 1.1. Historically these business areas have worked independently, with little coordination and collaboration between them. However recently the development departments for tables and chairs were brought together in one Business Area (BA) which are called Dining, Outdoor and Workspace (DOW). However, they are still working in different teams and develop products simultaneously with little communication and collaboration. In practice, the old departments continue to operate with a high degree of autonomy, therefore communication, coordination and collaboration within the new departments are relatively scarce. Even within departments, when new products or product families are developed, different development teams are responsible for different market segments, for example, dining, and workspace. However, this phenomenon is not unique for only IKEA, there are many federated organisations with the same experience. This has been recognised in, for example, (Smith, 1997) article, where he mentions the history to concurrent engineering which has created the structure for many companies.

While developing tables tables, it is often the specific customer needs and specific supplier capabilities which drive most of the design decisions, rather than similarities between existing products and simplicity in the whole IKEA. This project

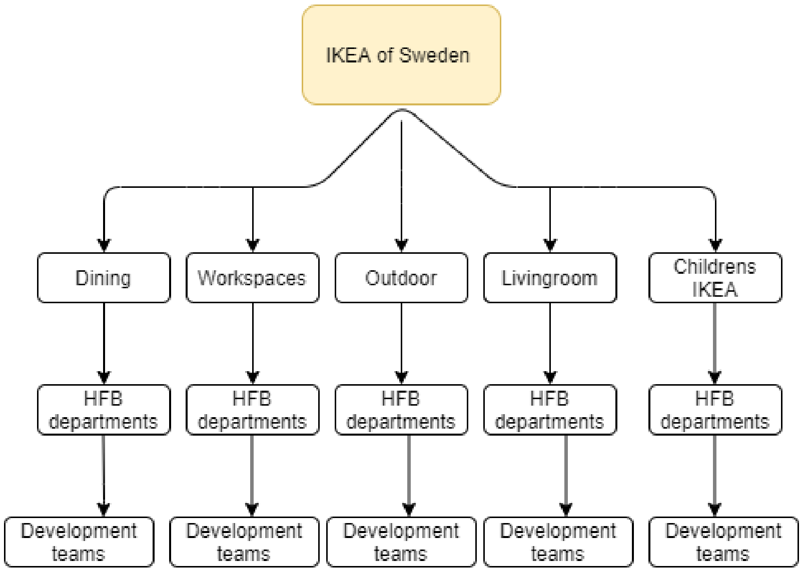



**Figure 1.1:** Involved development areas

have been performed in collaboration with engineers at IKEA of Sweden in the departments of Dining, Outdoor and Workspace (DOW) and focuses on tabletops, i.e. the top of the table which refers to the table connected to the legs, see figure 1.2.


**Figure 1.2:** Example of a tabletop (IKEA.com)

IKEA offers approximately 700 tables with a focus on different market segments, as shown in Figure 1.3. This thesis focuses on approximately 300 tabletops from business areas, which are visualized in figure 1.1. The simplicity of tabletops as a product combined with a high number of items has led to a high range of internal complexity, i.e. many tabletops that looks similar and meet the requirement of the same market segment. For example, two white desks, with the same sizes in length and width but very little difference in thickness.
The definition of complexity in this context is as Heylighen refers it "Let us go back to the original Latin word complexus, which signifies "entwined", "twisted together"(Heylighen, 1999). This may be interpreted in the following way: in order

to have a complex you need two or more components, which are joined in such a way that it is difficult to separate them. Similarly, the Oxford Dictionary defines something as "complex" if it is "made of (usually several) closely connected parts" (Heylighen, 1999). Modularization is one way to handle product variety, reducing the lead time, and differentiate products (Blackenfelt, 2001). Hence, by identifying the similarities within the tabletops, comparing them to each other in an efficient way and implementing a modularization and platform strategy on the development process of future tabletops, the number of similar items can be reduced. Reducing the number of tabletops could reduce the internal complexity within IKEA, considering the similar products will be in the same family and the number of articles will be reduced.

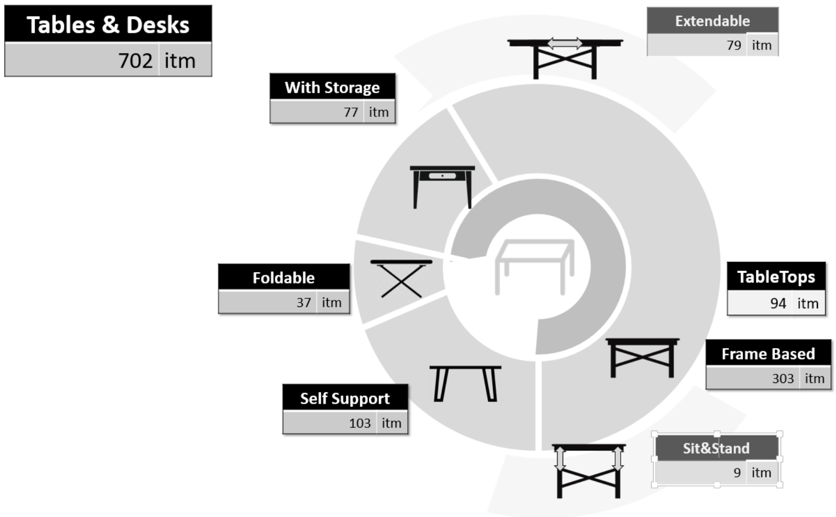



**Figure 1.3:** Range and visualization of tabletops

## 1.2 Aim

The aim of this study is to reduce the number of variants of tabletops that have too many similarities for instance in form, size, functions, etc. this was done by:

1. Suggesting an elimination of tabletops that are similar from the customer's perspective, i.e. shape, size, and colour (the degree of similarity that can lead to elimination is decided while comparing the products).
2. Developing a modular platform-based strategy for the potential tabletops that can be within the same platform family. The strategy is a guidance on how to reduce the internal complexity of many similar products in the existing IKEA portfolio while offering an adequate variety to customers.

## 1.3 Problem definition

The development teams for tabletops are currently working in the same business area (BA) but in different teams, with each team having the responsibility for different market segment such as dining, workspace, outdoor, etc. Hence, there is a possibility and opportunity of developing similar products in different teams for different purposes (market segments) simultaneously.

According to (Shaik, Rao, & Rao, 2015) the organizational aspect is often overlooked during the implementation of modularization. Each department within the company might not have the same aim with the implementation of modularization. Working as one organization gives the departments at IKEA the opportunity to utilize similarities and develop the whole range of tables and chairs from a more holistic perspective.

According to (Takeuchi & Nonaka, 1986) for an organization to be able to produce a product on a larger scale and extend the products lifetime, there needs to be a balance between customization and standardization.

The problem studied in this thesis is that at present several factors in play have created similarities in the tabletops. To investigate this problem a number of research question has been proposed as:

1. What are the major factors (organizational, cost, logistics, production) in the current IKEA's tabletops strategy (not platform-based)? What needs to be changed (in IKEA's lean development process) to move for a platform-based approach?

2. What are the cost factors (development, production, and logistics) in today's product portfolio in tabletops and how could a platforming strategy affect these factors?

3. How to calculate the supply cost of today's product portfolio compared to a platform-based approach portfolio?

4. How to analyse (calculate complexity, and standardization) the current products (Tabletops) in an efficient way to develop the right standard procedure for other products (beyond tabletops)?

5. What metrics exits that shows the trade-off of internal complexity vs customer options? How can these be used to evaluate the current range and compare future scenarios?

## 1.4 Limitations

The thesis was performed during the summer and autumn of 2020, considering the circumstances a number of limitation which could affect the study was identified:

- The focus of the thesis has mainly been on studying and analyzing tabletops and not other products.
- The current situation with Covid-19 (pandemic) made some limitations with physical meetings.
- The main work has been done during the summer, so there was a limitation of supervision in July. This was taken into consideration while planning so, there were enough data and information to work with.

## 1.5 Stakeholders

To investigate the problem it is important to identify the relevant stakeholders. Stakeholders, being the ones that have an interest in the results of the project in some way (Tonnquist, 2018). Stakeholders can be divided into three categories, core, primary, and secondary stakeholders. Core stakeholders are those who are in charge of the project and are decision-makers in the project. Primary stakeholders are those who are highly affected by the project, and secondary stakeholder is the ones who have a quite low interest in the project. The stakeholders were identified early in the project as described below:

Considering as this project is a thesis, the core stakeholder is the ones who are interested and will use the result, based on the recommendation, methods, and conclusions that are delivered. Hence, the core stakeholders of this project are Alfard Jansen (supervisor and owner of this project) at IKEA, Leo Eshagi, and Asghar Ramezani as the authors of the thesis. The primary stakeholders are engineers in the development department, the ones who are in charge of mechanical design engineer (MDE), product design engineer (PDE), Product requirement engineer, and product solution engineer (PSE).

# 2

# Theory and Context

In the following sections, the theory behind the methods that have been used to solve the problem are explained.

## 2.1 Product platforms

According to Siddique & Repphum (2001) companies are trying to offer a wide variety of products with lower cost, higher quality, and more customized products (Siddique & Repphun, 2001). In addition, (Takeuchi & Nonaka, 1986) claims, that speed and flexibility are crucial in rapidly changing and highly competitive markets. According to (Siddique & Repphun, 2001) in the new competitive market mass-produced standardized models have been replaced by product family design to fulfil the needs for distinctiveness and customization of the products. The purpose of customizing the products is to be able to meet a range of customer needs by modifying the products and offering numerous distinctive products (Landahl, 2018). Variety is used with the purpose of meeting a number of distinct customer needs (product variety) and different market segments (product families). The product family is a common concept to classify a group of related products i.e. products that share a common platform but have particular functions and features with the purpose to fulfil numerous customer needs and requirement (Meyer & Utterback, 1992).

There are various definitions of a platform, although all of the definitions, have "the sharing or reusing of assets between different products or systems" in common. That is because there is various type of platforms, including product platforms, production platforms, function platforms, technology platforms, flexible platforms, etc. (Landahl, 2018). Some of the most relevant platform definitions are:

"A product platform is a collection of the common elements, especially the underlying core technology, implemented across a range of products", (McGrath, 1995).

“A product platform is a set of common components, modules, or parts from which a stream of derivative products can be efficiently created and launched” (Lehnerd & Meyer, 1997).

"A collection of assets including people and relationships, knowledge, processes, and components and the design that are shared by a set of products" (Robertson & Ulrich, 1998).

A platform strategy should fulfil three objectives at the same time, decreasing the development time, cost reduction, and higher flexibility (variety) for the customer. The focus of the company often changes the degree which each objective is affected, for instance, companies with a focus on mass production set the cost reduction as their priority while very innovative companies e.g (in the field of electro motors) focus mainly on shorter time to market (Schuh, Rudolf, & Vogels, 2014).

To enjoy the benefits that a platform strategy can bring, companies need to make long term investments and stick to the platform strategy, that also brings more costs for a start (Cameron & Crawley, 2013). Platforms are more time consuming to develop than single products and (Ulrich & Eppinger, 2012) argues that the development of a platform could cost two to ten times more than a single product.

### 2.1.1 Product architecture

The objective of product architecture is to translate the functional elements, into physical terms i.e. define the basic physical structure of a product with regards to what each block do and what kind of interfaces they have to the rest of the product. The definition of physical elements of a product become more clear through the development process. A collection of components that define the function of a product is called chunk (Ulrich & Eppinger, 2012). An example of function for the tabletops can be the interface, where the components are the screws, bolts, the leg, and how the hole of the tabletop is designed.

### 2.1.2 Platform planning

According to (Hölttä-Otto, Tang, & Otto, 2008) " a good platform is to identify the common modules that will be share among products". As mentioned the common modules need to be identified from the product architecture as (K. Ulrich, 1995) defines the product architecture is that "the architecture of the product is the scheme by which the function of the product is allocated to physical components". It is desirable for IKEA to increase the variations of products with high distinctiveness while sharing common parts among the platform. The shared common assets between these products are called product platform (Ulrich & Eppinger, 2012).

The differentiation plan represents the distinctiveness of a product, from the market and customers perspective. This information system consists of a matrix with differentiating attributes of different types of tables which parameters that has a high value to the customer. The differentiation plan supports in the decision-making phase on how different products differ and that these specifications should match customers requirement (Ulrich & Eppinger, 2012).

The commonality plan represents the shared components and physical assets between different products and it is made by creating a matrix with rows that represents the chunks of the products that is contained of a collection of components. The plan helps to recognize and identify the common chunks between different versions of a product and help to identify the chunks that are the most suitable to be used in the product (Ulrich & Eppinger, 2012).

### 2.1.3 The effect of modularization on variety

"Variety is defined as the range of products that an organization can produce and offer within a specific time with regards to the market demands" (Ulrich & Eppinger, 2012). Modularity is one of the most important aspects of product architecture and can aid to develop a wide range of variation of a product without adding too much complexity in production (Ulrich & Eppinger, 2012). Two important properties of modular architecture in a product are that each functional term is performed by one physical chunk and the interfaces between the chunks are well-defined. These properties allow (1) each chunk to be designed independently of other chunks, and (2) design change to each chunk without the need of a design change to other chunks or jeopardizing the functionality of the product (Ulrich & Eppinger, 2012).
Slot, bus, and sectional are the three different types of modular architectures, figure 2.1 shows the conceptual difference between these three.

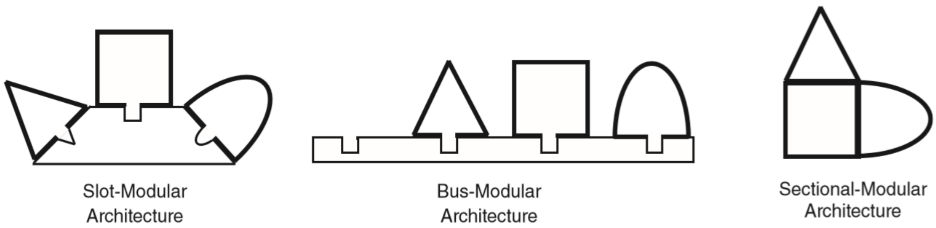



**Figure 2.1:** Different types of modular architectures courtesy of (Ulrich & Eppinger,2012)

Robertson & Ulrich (1998) use two different instrument panel designs (shown in figure 2.2) as an example to illustrate the difference between modular and integral architectures and show the importance of modularity. The modular architecture allows the developer to use the same interface for both products A & B. This increases the variety and decreases the degree of complexity in the development process (only one interface and support is developed and used for both instrument panel) and in manufacturing, (Robertson & Ulrich, 1998). The modularization degree of a product is dependent on several important aspects such as product variety, component standardization, manufacturability, and product performance. Hence, these decisions are related to the customer options i.e. marketing strategies, and product development management (Ulrich & Eppinger, 2012).
The interface is a term used in many areas. In this report, the interface refers to the connection surface between the tabletop to the legs. In tabletops, modular architecture refers to the interface that is common within a family or a group of tables. Helmer mentions that "Successful modular designs are highly dependent on well-defined interfaces between the different modules. One important feature of interfaces is their physical or geometrical design, i.e. properties like size, shape, etc."

(Helmer, Yassine, & Meier, 2010).

Therefore the interface defines how the legs or the base of a table are assembled to the tabletop and a modular interface allows different types of legs or bases to be assembled to the tabletop. The modular interface allows also changes to the product for instance if a physical part needs to be changed, there are several reasons to change physical parts. Some of these needs could be, upgrade, add-ons, adaption, flexibility in use, re-manufacturing of the product, and reuse according to (Ulrich & Eppinger, 2012).

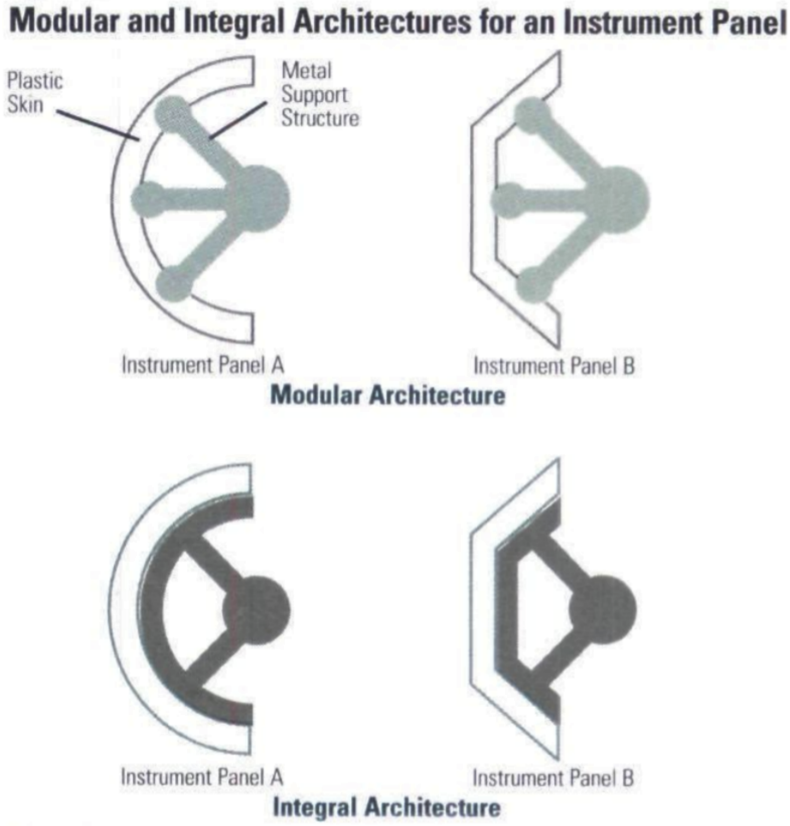



**Figure 2.2:** The effect of a modular architecture on two different instrument panel, courtecy from (Robertson & Ulrich 1998)

### 2.1.4 Performance measurement of modular product platform

Numerous metrics and indexes have been developed by (Schuh et al., 2014) with the purpose of calculating the performance measurement for future product platforms. There are three steps to evaluate the performance of the platform and modular approach. These steps are visualized in figure 2.3.
First, the aim with an approach for the company is set, cost, time, or flexibility. Secondly, the relevant performance figures are identified or newly developed, and third, an evaluation is necessary which can be done by using different IT-Systems,

ERP, PDM, CAD, etc.

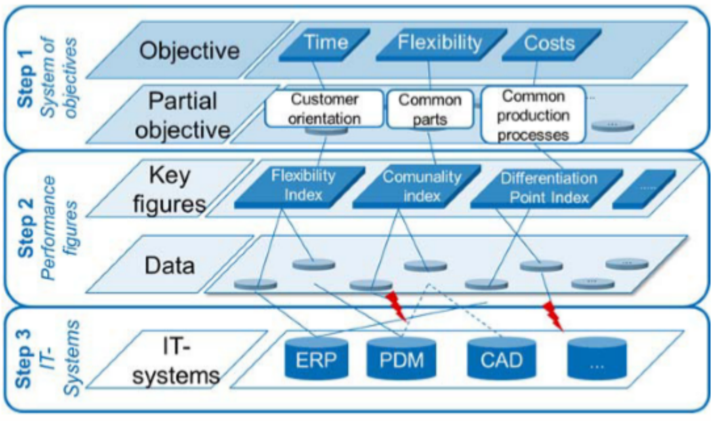



**Figure 2.3:** Constitutive framework for the performance measurement of modular product platforms courtesy of (G. Schuh, 2014)

The goal of this study is to increase the variety of the products for the customer by implementing a platform and modular approach in the development process which also decrease the development time and cost. Hence, the aim of the project and company's focus can be set as:

1. Higher flexibility and variation in products
2. Reducing the development cost
3. Decreasing the development time

The second step is to identify the performance figures that are relevant to this study. Three metrics (product-scale-balance index, product platform range, and price-cost ratio) were chosen that could help to identify the performance for developing the future products based on platform and modular approach.

Product-scale-balance index indicates the distribution between standard (Platform based families) and exotic models, the index is relevant to have an overview of what proportion of the products are not platform-based. This index is related to the objective of quick customer-specific adjustments.

$$PSBI = 1 - \frac{1,25 \times V_{80\%}}{V_{OA}} \tag{2.1}$$

$V_{OA}$ = Overall number of sold variants
$V_{80\ \%}$ = Number of sold variants, which made 80 % of the revenues

Product platform range will help to identify the proportion of the products that can be sold based on the platform in comparison to the overall sold products. This index is a way to show the effect and potential of the platform families compared to the exotic and other models. The exotic models are the non-platformbased models and the models that follows a trend with the purpose of attracting more customers. This index is related to the objective of offering more variants within the platform.

$$PPR = \frac{P_{PP}}{P_{OA}} \tag{2.2}$$

$P_{PP}$ = Number of sold variants of the product platform
$P_{OA}$ = Overall number of sold products
Price-cost ratio indicates the relation of price to costs for the modular platform and helps to track the profitability.

$$PCR = \frac{1}{V_{OA}} \sum_{v} \frac{P_V}{K_v^{PC}} \tag{2.3}$$

$V_{OA}$= Overall number of variants
$P_v$=Price for variant
$K_{vpc}$=Prime costs for variant

## 2.2 Sustainable development

Sustainable development has many definitions depending on the industry or the circumstances in which the concept is used, however, the definition that is used by the UN was already defined in 1987 by Bruntland and is the foundation for UN's Sustainable Development Initiatives (UN, 2021). The definition is describing sustainable development as "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). Sustainable is the effort and act which is taken to develop economic growth, social inclusion and environmental protection for a better future for people and the planet (UN, 2021). The interest in having sustainable production and sustainable development has increased since the '90s within large retailers such as IKEA, Automotive manufacturing, etc. Numerous methods and concepts have been developed to have such as Industrial Ecology, Eco-efficiency, and Circular Economy.

The circular economy focuses on maintaining natural resource flow such as material, energy and water within the civilization by using the principle of "reduce, reuse and recycle" (Ellen-MacArthur-foundation, 2020b). The circular economy builds around two different cycles, biological and technical cycles which are presented in the Butterfly diagram that was developed by Ellen MacArthur Foundation. The technical cycles focus on all materials or products that have been in use and can be recycled, maintained/prolong, reuse/redistribute, and refurbish/remanufacture (Ellen-MacArthur-foundation, 2020b). The Ellen MacArthur Foundation are working with big retailers such as IKEA to develop products based on circular principals (Ellen-MacArthur-foundation, 2020a). IKEA is investing and working towards having a circular economy by 2030 with implementing different methods such as designing products based on circular products, sustainable and recyclable products, etc. (IKEA, 2020). Implementing a modulrized approach in the development process allows the engineers to design the products in a manner which let the product to be upgraded och changes of parts (Ulrich & Eppinger, 2012). The connections of circular economy and modularized approach is further discussed in the conclusion.

## 2.3 Communication in organisations

In our everyday life, people are communicating with each other both in our professional and personal life. Communication is what ties people together as (Alessandra, 1993) mentions:

> "We live in a world filled with other people. We live together, work together, and play together. In our personal lives, we need each other for security, comfort, friendship, and love. In our working environment, we need each other to achieve our goals and objectives. None of these goals can be achieved without communication. Communication is the basic thread that ties us together. Through communication, we make known our needs, our wants, our ideas, and our feelings. The better we are at communication, the more effective we are at achieving our hopes and dreams" (Alessandra, 1993, P.3)

To communicate with each other a person needs to be a sender, someone that transmits a message and a person that receives the information. To communicate a message it could be written, speech or signals. If the message is through speech or signals the body language also affect the message. The message gets delivered trough channels, it could be verbal face-to-face, meetings, through phone or online. It could be written in emails, letters and reports. The sender sends their message to a receiver that gets the message, the receiver then needs to confirm the information (Mallett-Hamer, 2005).

In most companies cooperation is a must and then communication with others is needed to achieve the organizational and social goals (Kraut, Fish, Root, & Chalfonte, 1990). In organizations, there are two different types of communications that are mentioned, formal and informal (Agarwal & Garg, 2012). In figure 2.4 the definition of formal and informal communications is shown.

In the development process of a product, the communication between the development teams and internally within the team the communication is a key factor for efficient and successful development. If information between development groups or people is missing, it will increase the development time. If the organization has formal communication through meetings, anyone who is affected by the project should be included or be able to access the information afterwards (Bostrom, 1989).

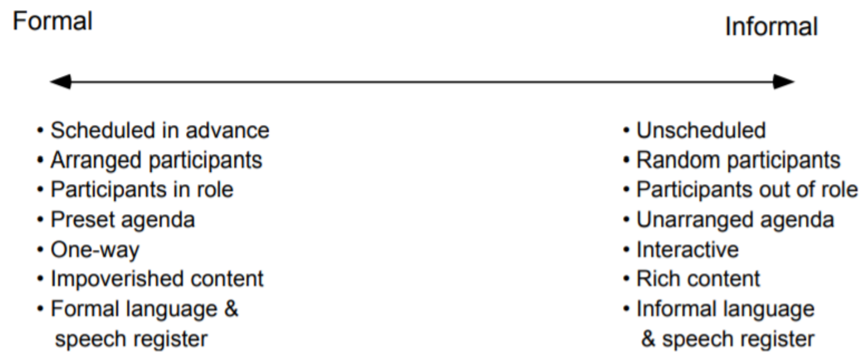



**Figure 2.4:** The formality dimensions of communications within organizations (Kraut et al.,1990)

## 2.4 Product Lifecycle Management system

Between 1950-60s a computer engineering tool was created called SKETCHPAD which is a Computer Aided Design (CAD) tool which allows creating 2D and 3D models. The CAD program was groundbreaking and several programs were created (Encarnação & Schlechtendahl, 1983). With the increasing use of design files from CAD, EDM (Engineering Data Management) and then PDM (Product Data Management) occurred in the late 1980s in the manufacturing industries to keep track of all the files. It was later developed into what is today called PLM (Product Lifecycle Management) (Saaksvuori & Immonen, 2008).

According to (Saaksvuori & Immonen, 2008) PLM "is a systematic, controlled concept for managing and developing products and product-related information. PLM offers management and control of the product (product development, productizing and product marketing) process and the order-delivery process, the control of product-related information throughout the product life cycle, from the initial idea to the scrapyard".

PLM is the organisation's way of managing the information about their products through the lifecycle from start to finish all the way from the idea of the product to disposal (Stark, 2020). PLM does not stand for some specific software or method to use the basic concept of PLM is the creation, conservation and information storing regarding the organisation's products and activities which result in having a better understanding and control over the products (Saaksvuori & Immonen, 2008). How each company implement PLM to benefit them in the best way is different but how PLM benefits the company generally with revenue increase, cost reduction, time reduction, quality improvement and operational benefits (Stark, 2020).

## 2.5 Laws and regulations

For creating and developing products there are some laws and regulations that need to be fulfilled. For increasing the safety standards and to meet the requirements from the market and suppliers. Some basic knowledge will be explained further but will not go into depth in the area.

Laws and regulations vary in different countries and follow different regulations depending on the local institutions. In Sweden for instance there are Swedish Standards Institute (SIS), International Standard for Organization (ISO) and European Standards (EN).

For the requirements of tables, it is possible to separate them into two categories, domestic use and office use. Different requirements are set for these two categories and are stricter for the office category.

There are several tests that the product needs to pass for example within the material, surface finish, chemical materials and sets safety, packaging and mechanical requirements that every product needs to pass to name a few examples. At IKEA it is the Product Requirement Specialist that is responsible that the products pass the requirements, tests and standards.

### 2.5.1 Minimum sizes for tabletops

From internal analysis at IKEA, they created certain dimensions that should be fulfilled for the dining tables in IKEA. The minimum sizes for one person area are 600 mm in width and 375 mm in radius. That is the minimum surface area per person as seen in figure 2.5

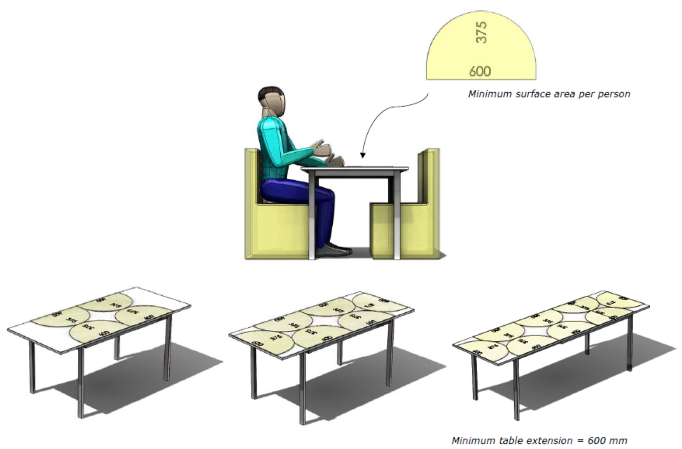



**Figure 2.5:** Minimum surface area per person (internal documents at IKEA)

The minimum distance between the legs is connected to the chairs and how wide the person need to sit. In figure 2.6 two examples are shown with chair A and B which are max 580 and 480 mm wide. For chair A with two persons next to each other the minimum distance are 580x2 + 30x3 = 1250 mm in width for the legs where 30 mm is the free space between the persons. For chair B the distance are 480x2 + 30x3 = 1050 mm in width between the legs.

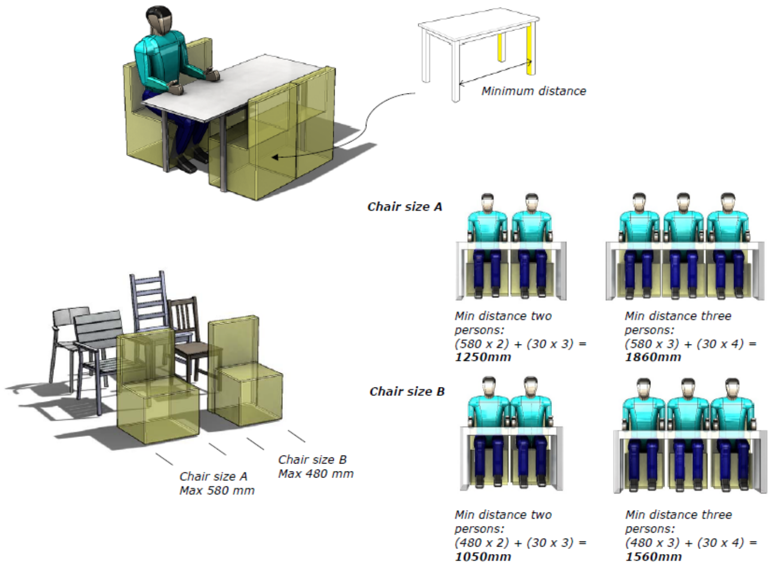



**Figure 2.6:** Minimum distance (internal documents at IKEA)

When it comes to the height of the tables the minimum height is 640 mm and the recommended free space profile is 750 mm as shown in figure 2.7.

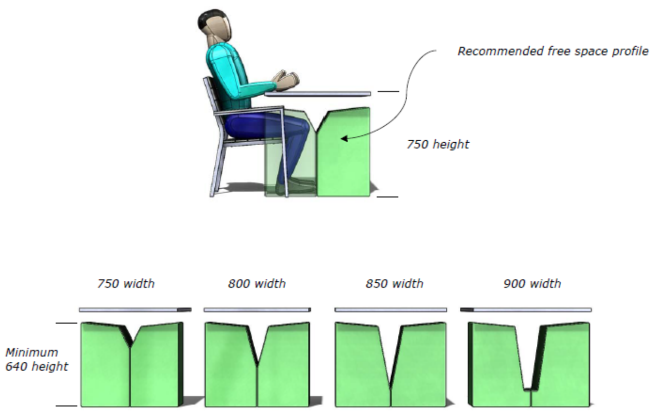



**Figure 2.7:** Recommended free space profil (internal documents at IKEA)

# 3
# Method

In the following chapter, the methods that have been used in order to collect data and to interpret the results are described.

## 3.1 Research approach

Qualitative and quantitative methods were used to gather and find comprehensive data. The necessary data were collected through a literature study and research interviews. The necessary data to study tabletops were gathered by using IKEA's PLM-system, physical studying of tabletops, and categorizing the products based on different parameters using Microsoft Excel.

### 3.1.1 Literature study

A literature study is a qualitative research method to gather information and collect valuable data. This method is a good first possibly to expand knowledge in the area. Literature study can be used to learn about the subject in a deeper level, for this reason, this method often goes beyond of the only collection of facts and describes the structure in the work, i.e. with the help of literature study it is possible to find the right method to solve the problem. A literature study is used to document the idea for a permanent record, "if not for all time, at least in a stable form well beyond the moment in which it was produced" (Denscombe, 2014).

There are many advantages when using a literature study, one of the main ones is the accessibility from anywhere. The researcher needs only to visit a library or use a computer or a mobile phone. The source and credibility of a piece of literature need to be evaluated based on trustworthiness, how up-to-date it is, the authoritativeness of the site, and the popularity of the source (Denscombe, 2014).

The literature study in this thesis has been used to discover methods on how to investigate the problem, what is a product platform, how to develop the platform families, and discovering methods on how to estimate the development time savings while implementing a platform-based approach. The literature was mainly identified by using the Chalmers University Technology Library databases and Google Scholar. The keywords to search for appropriate cases are Platform and modularization, modular service platform architecture, platform strategies, modular strategies, modular production, modularity modules, modular manufacturing, modularity, modularization, modularization in concept development using functional development, product platform, product variety, Product service system (PSS), product architecture, product families, functional requirements, complexity, service development, assembly line, mass customization and agility, and product structure.

### 3.1.2 Research interviews

The research interview is a method for collecting data during investigating complex issues where qualitative facts such as experiences and opinions are important. In the research interviews, the answer to the questioners is the source of data. Since the source of the information are the answers to questionnaires, the data can be compared to observational methods (to look at what people do) and the use of documents (in which the what has been written and recorded is the source of the data) (Denscombe, 2014). The interviews are made online and are recorded, notes are written down during the meeting. According to (Denscombe, 2014) when someone agrees to be interviewed, they recognize that they are taking part in a formal research interview which involves a set of implicit assumption about the situation that is not in a normal conversation. This implicit assumption for instance can be, that they permit them to participate in the research, interviewees words can be used as research data and that the researcher chooses the agenda of the interview(Denscombe, 2014).

Research interviews are divided into three different categories based on the flexibility of the interview; structured, semi-structured and unstructured. The semi-structured interview allows the researcher to set the agenda of the interview but allows the interviewee to discuss the subject, develop ideas and speak more widely regards the issue brought up by researcher(Denscombe, 2014).

Semi-structured interviews have been used to collect the primary data on the organizational aspect of this thesis. This method will even be used during a follow-up meeting with IKEA staff to discuss the parameters, mapping, and elimination of tabletops, to get feedback on the proposal. The interviewees were mainly engineers from the development team, who are responsible for the developing of products in the DOW-department. The interviews were performed by using Microsoft teams i.e. considering the restrictions of the pandemic. The interviews were recorded in Microsoft teams with the consent of the interviewees, and the result was documented during the interview. The result of the interviews are presented

## 3.2 Analysis and elimination of tabletops

The following methods will be used to study, analyse, find the important parameters, determine the trade-off of eliminating tabletops with similarities, and reduce the number of unique tabletops.

### 3.2.1 Information retrieval regarding the tabletops from PLM systems

IKEA is currently using three databases to store data (PLUS, PIA, and Qlikview which are described in chapter two). For the 3D models and drawings of the products, above all two databases called PLUS and PIA are used more frequently to save and collect all information concerning the products. These systems were used to collect data and information regarding the existing tabletops. The desired parameters will be produced in a later stage to understand what data should be collected regarding the tabletops. All product information concerning the tabletops exists in the system, the documents that were analysed are drawings, 3D-models, law and regulation specifications and material description. The parameters were collected are size (length, width, and thickness), colour, a picture, shape, material. These parameters were collected for approximately 300 tabletops.

### 3.2.2 Physical study of tabletops

A number of study visits at local IKEA stores were also planned and performed with the purpose of analyzing the physical properties of tabletops. These properties can include color, the feeling of the surface finish, quality, material, etc. which can be the aesthetic parameters that can decide the customer's choice. The study gave also a deeper understanding of the corresponding price and quality of the products, which was used in a later stage while deciding to suggest the elimination of tabletops.

### 3.2.3 Studying and analysing the customer needs

Customer needs are one of the most important aspects while developing a product and should be considered as well while eliminating the tabletops. Customer needs can also be translated into some important parameters such as shape, size, color, material and price. While categorising tabletops and analysing the trade-off of elimination a number of articles. The information necessary for this data collection is available in IKEA's PDM-systems.

The parameters that are important to customers while choosing a tabletop are also important on how the products are categorized in different groups. These parameters should be taken into consideration in the elimination phase since the products with higher sell quantity attracts more customers and then has a lower chance to be eliminated. What type of table, price, shape, size, and colour are some of the different parameters that a customer's choice is based on. These parameters are based on assumptions, parameters that are used in IKEA's webpage to filter through the products, and the interviews with the staff at IKEA of Sweden (IOS).

### 3.2.4 Determining factors for elimination from IKEA's point of view

20% of the IKEA's product is replaced every year with new products according to the interviews with the staff at IKEA, and the reasons are having a product flow and due to the rapidly changing trends in the market and society. A lot of factors are in play to eliminate a product. Some of these factors are a new style, different trends depending on the season, sell quantity, profit margin, etc (personal communication with employees at IKEA of Sweden). These parameters will help in discovering the most prominent tabletop from a group of products which will not be eliminated in the elimination phase.

### 3.2.5 Categorizing of tabletops

The parameters from the Customer's and IKEA's point of view resulted in a funnel diagram, seen in 3.1. This is because the categorization is performed by using the filter function in a spreadsheet. Categorizing is done in several steps based on the parameters where, after each filter, there are fewer products in the list.

The diagram is used as a guideline to categorize the tabletops in different and smaller groups. The goal is to develop a platform-based approach i.e. a standardization on assets which means that a family of products should have the same base material, hole patterns, and size. This can lead to reduced lead time in the development and more efficient production. The funnel diagram that is shown in figure 3.1 is divided into different stages, where the first two "filters" filter the tabletops based on shape and size. This will help to group the tabletops based on the initial design and tabletops that have aesthetic similarities.

The third step is to look at the material, and group the tabletops based on the base material, and different standards that needs to be fulfilled. These standards should be taken into consideration in the elimination phase.

The fourth step before elimination is the price-class and price. Price is a very important variable for both IKEA and customers since one of the main goals of IKEA group is 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 (Kamprad, 2001).

After grouping the products that belong to the same group, the products were analyzed. The design of products such as hole patterns, the size of rounded corners, rounded edges, etc. was compared to find the distinguishments that are not visible to customers. The next step is the actual elimination of tabletops that have too many similarities. In this part the sell quantity and profit margin of products were taken into consideration and compared, this part needs also to be in close collaboration with staff at IKEA.

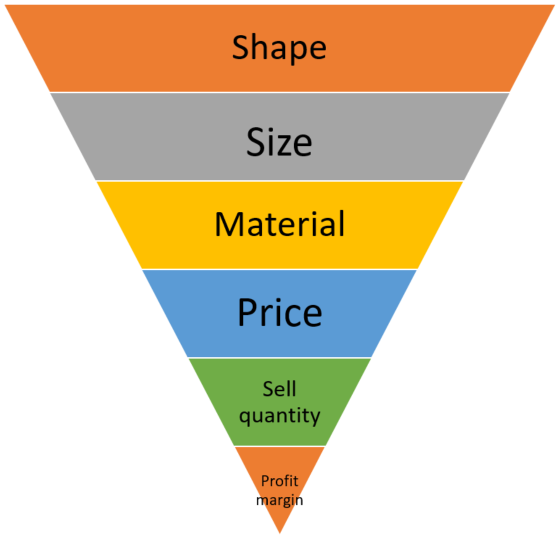



**Figure 3.1:** Funnel diagram for categorization of tabletops

### 3.2.6 Reducing the number of similar tabletops

After the categorization of the tabletops, the thought is to propose which tabletops could intend to be eliminated. The elimination is based on the funnel diagram 3.1, where the categorization of tabletops has to sort out the tables into different groups and subgroups based on shape, material, and size. The groups were analyzed to find similar characteristics and map out which are similar to each other. The next step is to look at the tabletops with a high degree of similarities, i.e. using the elimination matrix and suggest tabletops that could be eliminated. The method is used for 12 groups of identified similar tabletops which are presented in section 4.7. The initial elimination matrix is visualized in appendix 2 B.1 and a more simplified version is presented in appendix B.2 .

### 3.2.7 Proposal for potential platforms

After categorizing the tabletops, four standardized groups were identified to study and analysed further on. These four groups which are based on their shapes (circular, square, rectangular, and rectangular with rounded corners)

The desired specification of product architecture is that it should be able to allow the company to offer a wide variation of products with high distinctiveness, yet with many parts in common. Component design and the shared common assets between these products are called product platform. Planning the product platform is essential to managing the trade-off between distinctiveness and commonality. These trade-offs can be handled by using two simple information system: the **differentiation plan** and the **commonality plan**(Ulrich & Eppinger, 2012). The result of a combined differentiation and commonality plan is presented in section 4.2 .

## 3.3 Estimation of time and reduced costs with a platform strategy

As mentioned in chapter two, one of the benefits of implementing a platform strategy is that company can offer more variety to the market as well as reduce development time and cost. Therefore, one aspect that needs to be considered is "What will be the financial effect of moving toward a product family approach?" (Siddique & Repphun, 2001). To be able to answer to this question, time and cost for product design and development needs to be calculated, which can occur a problem since the needed data related to product platform is not available (Siddique & Repphun, 2001). Although a cost model to calculate the approximate development time and cost while implementing a platform strategy has been developed by Siddique & Repphum (2001). The model was then verified by applying it to a hard disk spindle motor development case study to estimate the development cost for implementing a platform strategy (Siddique & Repphun, 2001). The calculation of cost for a new product family that is developed by utilizing a platform approach comes with some uncertainty, therefore the Monte Carlo simulation technique is applied to calculate the probability of effect's of uncertainty on the calculation .

The cost model that is developed by Siddique & Repphum (2001) includes 5 steps from problem formulation to the solution, which are used to estimate the time development savings while implementing a platform strategy. This model is based on "Activity Based Costing" which means that each activity in the development process consumes resources and products are based on those activities.

There is a slight difference between the model presented by Siddique & Repphum and the method that is used in this paper. Since each activity consumes engineering hours and is the highest cost in the development process at IKEA, in the calculation step, the amount of hours is used instead of cost(Moneywise). The reasoning behind this action is that the actual data for the calculation was presented by IKEA which made the calculation less complicated, and otherwise there would have been a need of estimation instead of the cost instead of the actual data.

**1.** Identify platform strategy

Horizontal leveraging, Vertical leveraging, and Beachhead approach are the three types of platform leveraging strategies that are developed to utilize market segmentation grid, these are illustrated in the figure 3.2. In which, the main market segments are mentioned on the horizontal axis and different price class and performance level on the vertical axis of the grid. The grid is later used to estimate development cost for product platform family.

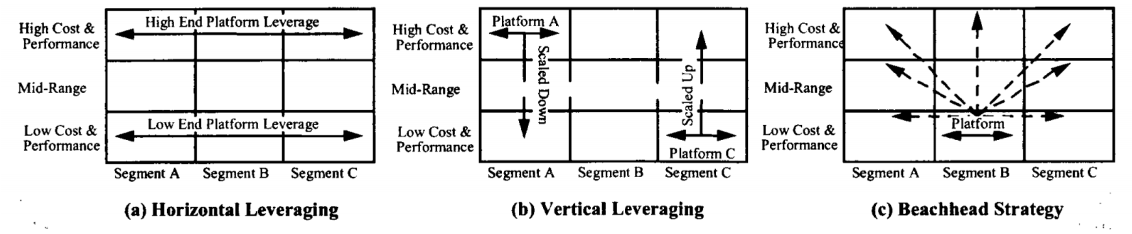



**Figure 3.2:** The three different platform leveraging grid, courtesy of (Siddique & Repphum (2001))

**2.**Develop Activity Hierarchy associated with platform approach development

The activity model is developed to identify all activities in process of product development approach which affects the total cost development, this step can be divided into two sub-steps; 1. the activities that are necessary to develop one single product are identified, 2. the result of the step one is then used to generate a new activity hierarchy for the product platform family. The second step is done by adding, deleting, and modifying activities from the result of the first step. The result of the developing and activity hierarchy can be divided in two different groups of activities, 1. activities which are necessary to perform to develop the initial platform, 2. activities which are related developing of each family member from product platform.

**3.** Identify associated cost distribution for each activity

The cost and time of each development activity for a single product were identified based on the activities that are done during the development of a tabletop at IKEA.

**4.** Perform cost model simulation to approximate development time

The development time is estimated by simulating activity models which were developed in step 3. This step is done in three steps as follows.

The first step to simulating these models is, to estimate the cost and time for the entire product platform by using the following:

$$F_{DT} = P_{DT} + n \times M_{DT} \tag{3.1}$$

- $F_{DT}$ = Development time for entire product family
- $P_{DT}$ = Development time for initial product platform
- $M_{DT}$ = Development time for product family members from platform
- n = Number of family members excluding initial platform

The second step is to approximate the cost and time of a single product in the development process, which can be used to calculate the cost and time spent to develop a product platform family.

$$S_{DT} = (n+1) \times Sp_{DT} \tag{3.2}$$

- $S_{DT}$ = The estimated development time for developing the product family without using platform approach
- $Sp_{DT}$ = the development time estimate for a single product

The saving time for developing a product family while a platform strategy is implemented would then be estimated by:

$$F_{DT} - S_{DT} \tag{3.3}$$

A Monte Carlo simulation was run with 2000 iterations for each of the platforms, using Microsoft Excel. The simulation is utilized to decide the probability of saving development time and cost.

**5.** Determine if platform approach will provide significant financial gains

The iterations and Monte Carlo simulation from step four can be used in ordinary statistical analysis because of the randomness of the assumptions. The normal distribution of the model can aid in making a decision about the new development approach. The decision can be determined by comparing the existing development time with the time that was estimated by this method to see is a platform approach decreases the development time.

# 4
# Results

In the following chapter results of interviews, analyse of tabletops, platform planning and elimination of tabletops will be presented.

## 4.1 Results of interviews

The first step of collecting data was made with interviews. The interviewees were engineers who are mechanical design engineer (MDE), product design engineer (PDE), product requirement engineer, and product solution engineer (PSE) for tables at the DOW department. The interviews provide valuable information, and the most important aspects and answers are summarized below.

**Tabletops** and products in IKEA are getting formed and developed based on several factors such as customers perspective that comes first, the information about the customers perspective and needs are collected from the local stores. Market insights have a big impact on which products that is in the stores, such as global trends but also local and micro trends to keep up with the customer needs. More trend-based products are planned around one year ahead. Supplier is the other factor that matters in the development phase because it is several requirements that need to be fulfilled by the supplier. In the total product portfolio, it is only possible and desired to have a certain amount of products therefore an outflow of products is wanted to be able to add new products. The product lifecycle is different for various of products, some of them have from the beginning a start and end date and some products has unspecific end dates, then the market and economic can control the situation. Every year it is around 20 % of the products that go out of sales and 20 % new products that will be added to the product collection. Requirements are set both internally and externally based on the customers, they can also vary in different countries. Testing of the products is conducted in Sweden and China. The products need to pass the tests before it is ready to launch including mechanical, surface, chemical testing and so on.

In IKEA they use three different **PLM-systems** which are Product Lifecycle User Solution (PLUS), Product Information Assistance (PIA) and QlikView. Plus is used for technical production documentation and requirement management and is a web-based solution. PIA is the source for product information for IKEA collaborates and suppliers. Qlikview is a database that all the information regarding products, market and the economical aspects are gathered. The opinions regarding the PLM-systems varies, but the overall impression from the interviews was pointing at that both PlUS and PIA needs to be upgraded or even be replaced because its not user friendly enough and at times slow and inefficient.

**Communication** is something most interviewees saw opportunities for improvement in. From the interviews, the communication was poor or deficient between different groups and between the different business areas (BA). The communication between the communicator and mechanical engineers seemed like it could be improved. Also, everyone involved in a project should be included in meetings so the information would not be lacking.

**Similarities** between products or above all tabletops the interviewees mention that the reason is that for some years back it was several teams developing different tables but now they changed the system. While developing new products it is lack of bench-marking of the existing products according to the interviewees.

Thus three hypotheses were developed based on the initial research and the assumption which are based on the initial research interviews with engineers at IKEA of Sweden.

First assumption: The lack of communication and coordination between different teams and the different business area has led to the development of tabletops simultaneously with similarities in different teams. The proposed reason behind this issue is the simplicity of tabletops as a product and the lack of collaboration between different business areas and teams in the same department. By having better communication and collaboration, between different business areas and different teams, a better overview of the products can be achieved while developing new concepts simultaneously.

Second assumption: The Product Lifecycle Management (PLM) system at IKEA is too slow and complicated to use which makes the development procedure more complicated. The initial interviews with the engineers at IKEA points out this issue. A complicated product lifecycle management (PLM) -system leads even to increased lead development time.

Third assumption: IKEA does not work with standard tabletops sizes. According to the initial interviews, and similar projects which have been conducted by a shared platform department, one of the assumptions are that IKEA does not work with standardisation of tabletops size.

## 4.2 Analyzing of tables

In order to collect and gather data regarding the tabletops, the different PLM-systems were used to gather eligible tabletops properties and physical studies in local stores were conducted. The data were compiled in extensive spreadsheets.

This section will present the results of the analysis.

### 4.2.1 PLM-system

In this study, the vast majority of data was gathered from the PLM system. In Qlikview the tables that were going to be in the analysed portfolio was taken out and consisted of 304 tables. Including different product types such as work, dining, outdoor, coffee and changing tables. Most of the product specifications were found in PIA where specific parameters were looked at regarding the tables. The most important parameters were set up in an early stage of the project and the most extensive data collection was derived from PIA, where the different parameters consisted of the base item, article number, shape, base material, type of material, colour, picture, family name, length, width, thickness, product type, sales numbers, sales quantities and profit. The data were extracted manually and compiled in the excel sheet.

### 4.2.2 Physical study

To gain a better understanding and knowledge about the tabletops study visits were made in local IKEA stores. It was possible to gain knowledge by feeling the surfaces, see and touch a different kind of edges of the tabletops and identify the tabletops in the actuality. This study was necessary to see the similarity between the existing products from the customers perspective and aided in the suggesting of reducing similar products. This activity were a good complement to the data collection.

## 4.3 Categorization of tables

After the collected and compiled data in the spreadsheet of the 304 tabletops, the tabletops were categorized into different groups based on the method which is presented in section 3.2.5. The tables were categorized into ten main groups based on shape, and subgroups based on different materials as shown in 4.1.

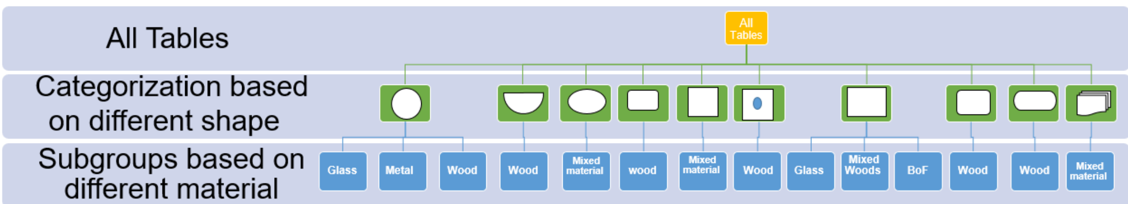



**Figure 4.1:** Categorization of tabletops

The first group was out of circular tables with 27 articles, particularly of coffee tables. The first group was divided into three subgroups based on glass, metal and wood. Where the group based on wood was by far the largest with 22 tables, the glass group consisted of three tables and the remaining two tables of metal.

The second group consisting of half round tables all from the same family BEKANT which is a big product family within the workspace area. This group contained four half round tables, all made of wood.

Group three consists of oval-shaped tables with a number of six tables with three different families and two different main materials wood and glass. This group was not divided into smaller groups because of the low amount of tables in the main group. Four of the tables were made out of wood and the remaining two of glass.

In the fourth group, there are three tables that are rectangular/oval-shaped, all of the same family OMTÄNKSAM and all made of wood.

The fifth group was one of the bigger ones consisting of 35 tables with a square shape. This group was not dividend into subgroups because 31 of tables were made out of wood, three of glass and one of glass.

The sixth group contained the BEKANT family with a square with a hole in the middle shape. Consisted of four tables.

Group seven were by far the largest group containing 178 articles and was rectangular shaped tables. This group was divided into three subgroups, first, the tables made of glass and contained five tables. The next subgroup was made out of wood or solid wood and contained 102 tables. The last sub group was made of BOF with a number of 65 tables.

Group eight are tables with a rectangular with rounded corners shape. It contained 35 articles in this group but was not divided into subgroups because one was out of glass and the remaining ones were made of wood.

In group 9 it was four tables all out of different families and was rectangular with circular ends formed.

In the last group, group number ten it was more of the exotic tables or not so common shaped tables, such as triangular, hexagonal-shaped tables and changing tables. The group contained of 13 tables.

### 4.3.1 Shape distribution

In the analysed portfolio more than half of the tables consisted of rectangular tables, followed by rectangular with rounded corners and square-shaped tables. Circular tables were just under ten percent. The other tables were more of the exotic or more unusual tables that were put together into one group which consists of four percent. In figure 4.2 the material distribution is shown.

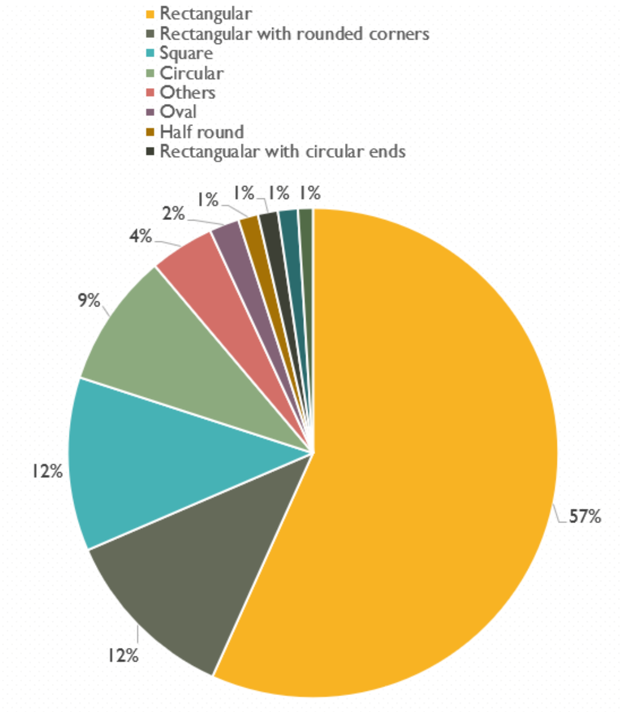



**Figure 4.2:** Shape distribution of the analysed tabletops

### 4.3.2 Analysis of materials

For the analysed tabletops there where 21 different materials. The main groups consisted of wood, glass and metal. The wood material group includes of *Acacia, Ash, Ash veneer, Birch, Birch veneer, Beech, Bamboo, Board on Frame (BoF), Eucalyptus, High-Density Fibreboard (HDF), High-pressure laminate (HPL), Medium Density Fibreboard (MDF), Particleboard, Pine, Pine veneer, Plywood, Rubberwood.* Glass consists of *Tempered float glass and quartz* and metal consists of *Aluminium and Steel.*

The biggest groups of the material of the analysed tabletops are particleboard, pine, HDF, MDF and BoF respectively. This material gets presented more deeply further down. In figure 4.3 the distribution of materials is presented in percentage of the analysed tabletops. The material including in the others section in the figure are Aluminium, Ash, Eucalyptus, HPL, Moulded layer-glued, Birch veneer, Plywood, Quartz composite, Rubberwood, Sliced ash veneer and Sliced pine veneer.

Two of IKEA's eight key values are **Caring for people and planet** and **Renew and improve** (Kamprad, 2001). Therefore are they focusing on sustainability and only responsible managed forest from their suppliers. A part of the value chain is seen in figure 4.4 note that this is not the whole chain. IKEA is advancing in this field and moves towards a circular business model (Szerakowski, 2017). It starts with renewable wood that comes into the supplier and then goes trough sawmilling. Then the woodcuts and splits in desirable size the next step is to add form and function to the table. Then the expression is added to the table with surface treatment. Depending on how the product is built the next step could be assembling. The last

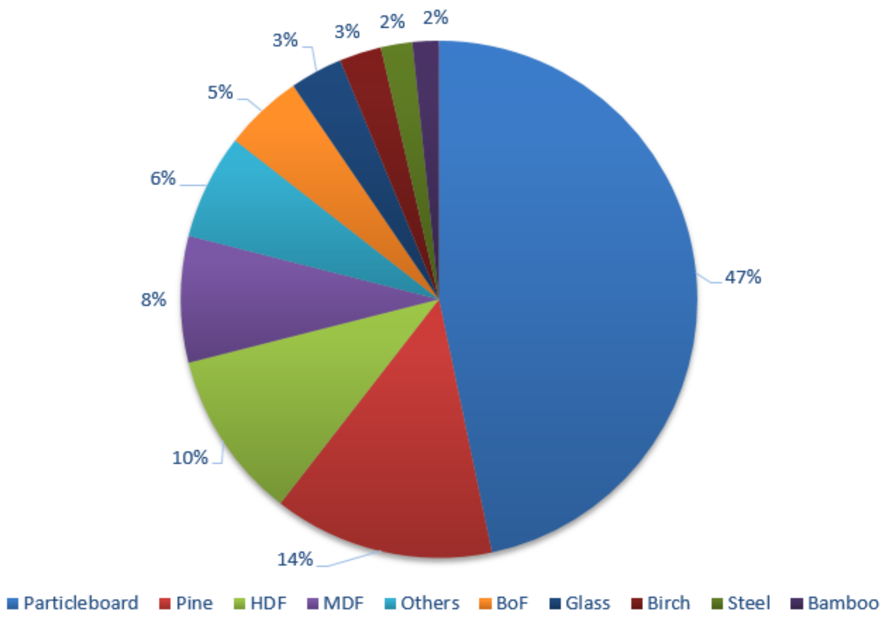



**Figure 4.3:** Distribution of the tabletop's material

step is to pack and distribute the products.

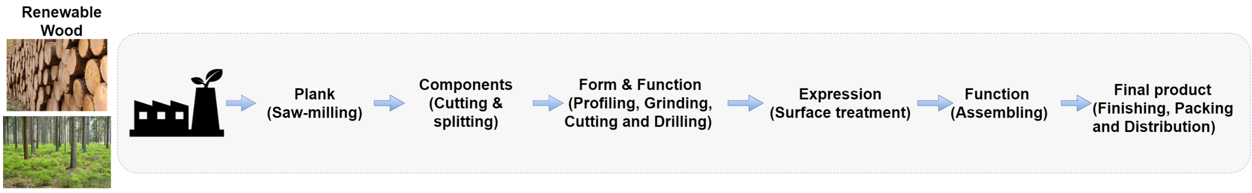



**Figure 4.4:** Part of the value chain for material production

#### 4.3.2.1 Particleboard

Particleboard also refereed as chipboard is a material that gets manufactured with wood particles that are heated under pressure with glue. Particleboard is the most common material in IKEA's tabletops that stands for 47 % of the total number of tabletops in the analysed portfolio. Usually, a cover material is added on the particleboard to create different expressions and to protect from moisture and be more durable.

#### 4.3.2.2 Pine

Pine is one of the more used materials in the tabletops with 14 % of the analysed portfolio. IKEA has a high capacity in the production of pine and is the most available wood species for furniture production. The material is used in its natural appearance which has a yellow colouring with brown knots. It could also be treated with clear lacquer or paint.

#### 4.3.2.3 Board on frame

The board on frame solution that usually consists of particleboard, paper and HDF. It is based on a frame that is particleboard and the surface material HDF is used as a bottom and top board. Between the top and bottom board it is a paper honeycomb structure to create a strong support beam. The solution is design to be robust, lightweight and to reduce the price.

#### 4.3.2.4 HDF and MDF

HDF and MDF that stands for high- and medium-density fibreboard. MDF is made by small wood fibres combined with wax and a resin binder that is formed to panels with applying temperature and pressure. What separates MDF and HDF in the production is that HDF is made with exploded wood and are highly compressed which creates a more dense, stronger and harder material than MDF.

## 4.4 Analysis of interfaces

Over the years IKEA has developed several different kinds of interfaces and connections to their tabletops. One of IKEA's key values is **Simplicity** (Kamprad, 2001) which means that the tables must be easy to install, all tabletops have drilled holes and the needed accessories with assemble instructions for the table in the package when the tables are bought. In the analysed portfolio it is some different variants but the most commons are boarder fitting, Cam lock and nut connection and Leg attachment. The Wedge Dowel connection is not so common but is an interesting connection type. These different connections get presented more down below.

### 4.4.1 Border fitting

The border fitting connection is a very common connection type in IKEA's tables. It is established on frame-based tables and it's used mostly in square tables but also in rectangular and circular tables as well. It is structured with a frame consisting of four parts that are assembled with brackets in each corner. The assembled frame is attached to the tabletop and the associated legs are attached in the corners into the brackets. An example of a square table with the border fitting connection is shown in figure 4.5.
There are different variants of the border fitting connection in size and attachment but the principle is the same for all border fitting connections.

### 4.4.2 Cam lock and nut

Cam lock and nut connection are quite common in desks and when there are more parts than only leg and tabletop to assemble. The principle for the connection are two parts one cam and one screw that is joined, when they are together the screw gets tighten and they are secured joined. In figure 4.6 a half-assembled desk with a cam lock and nut connection is shown.

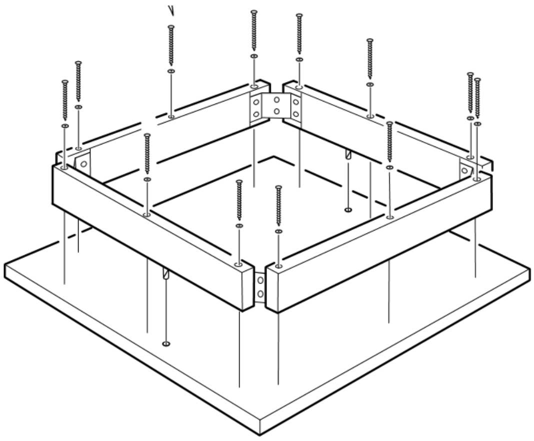


**Figure 4.5:** Boarder fitting connection

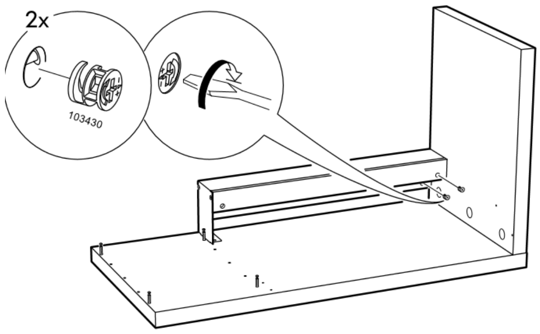



**Figure 4.6:** Cam lock and nut connection

### 4.4.3 Leg attachment

Leg attachment is used in all kind of tables without a frame. The connection can look different but the basic principle of the concept is the same. The leg is assembled to the tabletop by turning the "screw" into the threaded tabletop or a threaded bracket that is attached to the tabletop.

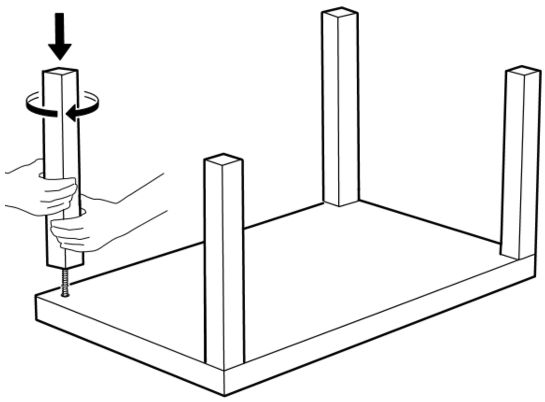


**Figure 4.7:** Leg attachment connection

### 4.4.4 Wedge Dowel

The Wedge Dowel connection is a quite new interface concept which occurs in two families which are the LISABO and OMTÄNKSAM family. The connection is quite interesting because it so few parts to assemble. It is quite similar to leg attachment connection but without threads. The principle of the connection is to attach the legs into the drilled holes in the corners that looks like a wedge, the leg is inserted like in figure 4.8 to the left and then the lock is connected as shown in figure 4.8 to the right.

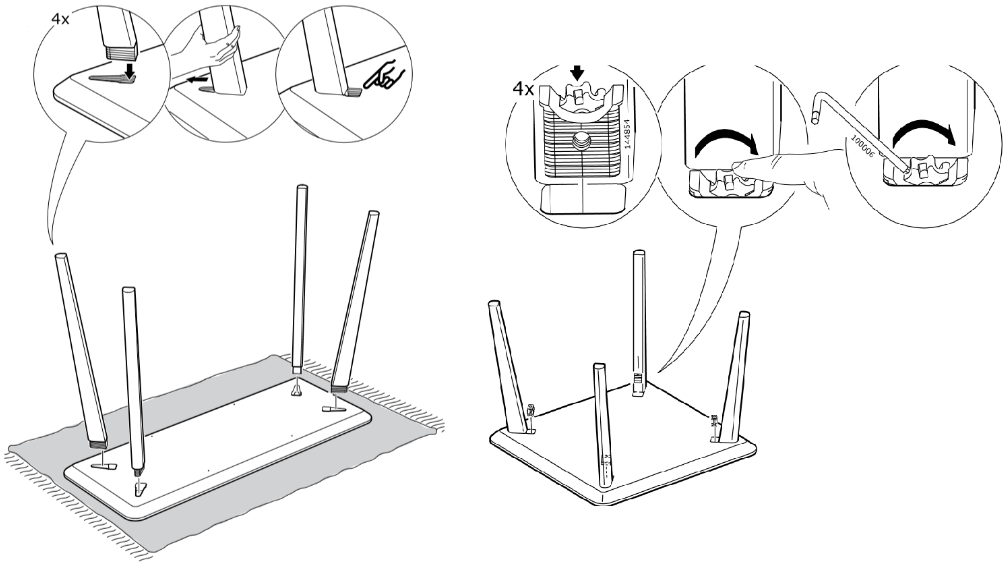



**Figure 4.8:** The Wedge Dowel connection and the Wedge Dowel lock

## 4.5 Differentiation and Commonality plan

In order to create a deeper understanding of the similarities between the tabletops, a combined differentiation and commonality plan was created. Some examples of the created groups are shown below and include attributes such as shape, material, size, thickness, colour and type of interface. The results in this section were one of the bases for the elimination and platform planning.

Group one consists of square tabletops from four different families with different variants when it comes to colour. These product families share characteristics such as shape, interface and have a variance of 1 cm in size as seen in table 4.1. All tabletops are in the dining area.
The second group consists of rectangular tables within the dining and coffee table area. Shares similarities in shape, interface and are similar in size. Four tables are made of pine and one of particleboard as seen in table 4.2
The third group consists of six families within coffee, desk and dining area. With sizes between 118-120 cm in length and 60-70 cm in width. The most common feature is in size but also some common interface, colour and material.

**Table 4.1:** Commonality plan group 1

| | Dining table | | | |
|---|---|---|---|---|
| Group 1 | LERHAMN | INGO | NORRÅKER | MELLTORP |
| **Differentiating attributes** | | | | |
| **Shape** | Square | | | |
| **Material** | Pine | Pine | Birch | Regular particleboard |
| **Size** | 74x74 | 75x75 | 74x74 | 75x75 |
| **Thickness** | 1,8 | 1,8 | 2,5 | 2 |
| **Color** | light antiq stn/whi stn Black-brown | pine | Birch Black | Ash White mosaic patterned white marble |
| **Interface** | Boarder fitting | | | |

**Table 4.2:** Commonality plan group 2

| | Coffee table | Dining table | | | |
|---|---|---|---|---|---|
| Group 2 | HEMNES | INGO | LERHAMN | EKEDALEN | ÖLMSTAD |
| **Differentiating attributes** | | | | | |
| **Shape** | Rectangular | | | | |
| **Material** | Pine | Pine | Pine | Regular particleboard | Pine |
| **Size** | 118x75 | 120x75 | 118x74 | 120x80 | 120x70 |
| **Thickness** | 2,2 | 1,8 | 1,8 | 1,9 | |
| **Color** | dark grey | pine | black-brown lght ant st/wht stn black-brown light antiq stn/whi stn | White | brown-black |
| **Interface** | Boarder fitting | | | | |

## 4.6 Platform planning for potential groups

After analyses of the tabletops, it was possible to find the possible cluster in size and shape to create platforms instead of having separate families. The results of the

**Table 4.3:** Commonality plan group 3

| | Coffee | Desk | | | |
|---|---|---|---|---|---|
| Group 3 | REGISSÖR | KLIMPEN | THYGE | SKARTSTA | BRIMNES |
| **Differentiating attributes** | | | | | |
| **Shape** | Rectangular | | | | |
| **Material** | Plywood | MDF | Regular particleboard | Particleboard | Pine |
| **Size** | 118x60 | 120x60 | 120x60 | 120x70 | 120X65 |
| **Thickness** | 2,2 | 2,8 | 2 | 2,2 | |
| **Color** | Brown | light grey | White | White | Black White |
| **Interface** | Frame | Loose | Frame | Frame | Wedge Dowel |

data and analysis showed that the tabletops with a square and rectangular shape was having the biggest potential to start with for a platform strategy because here there were mostly parables especially many tables of the same size.

The first potential platform consisted of square tabletops in size of 74-75 cm. It includes 12 tables with four different families and all in the dining area. The prospective platform could be combined into one size. The found cluster is shown in table 4.4.

**Table 4.4:** Potential platform family A

| Nr. | Family Name | Length (cm) | Width (cm) | Type | Priceclass |
|---|---|---|---|---|---|
| 1 | LERHAMN | 74 | 74 | Dining | Low |
| 2 | LERHAMN | 74 | 74 | Dining | Low |
| 3 | LERHAMN | 74 | 74 | Dining | Low |
| 4 | LERHAMN | 74 | 74 | Dining | Low |
| 5 | NORRÅKER | 74 | 74 | Dining | Low |
| 6 | NORRÅKER | 74 | 74 | Dining | Low |
| 7 | NORRÅKER | 74 | 74 | Dining | Low |
| 8 | INGO | 75 | 75 | Dining | Breath taking item |
| 9 | MELLTORP | 75 | 75 | Dining | Breath taking item |
| 10 | MELLTORP | 75 | 75 | Dining | Breath taking item |
| 11 | MELLTORP | 75 | 75 | Dining | Breath taking item |
| 12 | MELLTORP | 75 | 75 | Dining | Breath taking item |

The next potential cluster for a potential platform is rectangular tables between 118-120 cm in length and 55-65 cm in width. Consisting of nine tabletops within six families. If the different requirements of office and domestic use are excluded these platform could consider a common size of 120 cm in length and 60 cm in width. If possible the tabletops could consider the office requirements for the whole platform.

The second potential platform is seen in table 4.5.

**Table 4.5:** Potential platform family B

| Nr. | Family Name | Length (cm) | Width (cm) | Type | Priceclass |
|---|---|---|---|---|---|
| 1 | HEMNES | 120 | 55 | Desk | Medium |
| 2 | HEMNES | 120 | 55 | Desk | Medium |
| 3 | HEMNES | 120 | 55 | Desk | Medium |
| 4 | REGISSÖR | 118 | 60 | Coffee | Medium |
| 5 | KLIMPEN | 120 | 60 | Desk | Medium |
| 6 | THYGE | 120 | 60 | Desk | Breath taking item |
| 7 | BRIMNES | 120 | 65 | Desk | Low |
| 8 | BRIMNES | 120 | 65 | Desk | Low |

The third cluster is rectangular tabletops between 118-120 cm in length and 70-80 cm in width, including ten tables with six different families. The prospective platform could consist of tables in 120 cm in length and 75 cm in width. If the requirements do not allow the desk tabletop it could be considered be removed. The third potential platform is shown in table 4.6.

**Table 4.6:** Potential platform family C

| Nr. | Family Name | Length (cm) | Width (cm) | Type | Priceclass |
|---|---|---|---|---|---|
| 1 | SKARSTA | 120 | 70 | Desk | Medium |
| 2 | ÖLMSTAD | 120 | 70 | Dining | Medium |
| 3 | LERHAMN | 118 | 74 | Dining | Low |
| 4 | LERHAMN | 118 | 74 | Dining | Low |
| 5 | LERHAMN | 118 | 74 | Dining | Low |
| 6 | LERHAMN | 118 | 74 | Dining | Low |
| 7 | HEMNES | 118 | 75 | Coffee | Medium |
| 8 | INGO | 120 | 75 | Dining | Low |
| 9 | EKEDALEN | 120 | 80 | Bar | Low |
| 10 | EKEDALEN | 120 | 80 | Bar | Low |

These three potential platforms is a starting point when it comes to implementing a platform development in IKEA's table collection.

## 4.7 Elimination of tabletops

The next step in the project was to suggest tabletops to eliminate with too many similarities. All data based on the collected and compile excel sheet, where 31 tables in 12 groups were decided to work further with in the elimination process, the extended elimination matrix can be seen in appendix 2. The created groups can be seen in 4.9 and the potential elimination groups consisted of:

1. Black square tables 74x74 LERHAMN and NORRÅKER

2. Pine square tables 74x74-75x75 LERHAMN,INGO and MELLTORP
3. White circular tables Ø80 IMFORS and LÖVBACKEN
4. White circular tables Ø90 Kragsta and VEJMON
5. White circular tables Ø103 and Ø105 DOCKSTA
6. Oak rectangular tables L:140 and W:80&79 DAGLYSA and MÖCKELBY
7. Oak rectangular tables L:150&160 W:78&80 ÖVARYD, BEKANT and BEKANT
8. White Rectangular with circular ends tables L:185 W:90 SLÄHULT AND OPPEBY
9. White rectangular tables L:120-128 W:58-80 2xSKARSTA, EKEDALEN, THYGE, LINNMON, MELLTORP, PÅHL
10. Oak Rectangular with rounded corners tables L:140 W:60 BEKANT and LISTERBY
11. White Rectangular with rounded corners L:150-160 W:80-85 NORDMYRA, BEKANT and THYGE
12. Glass circular table Ø78 ALLSTA

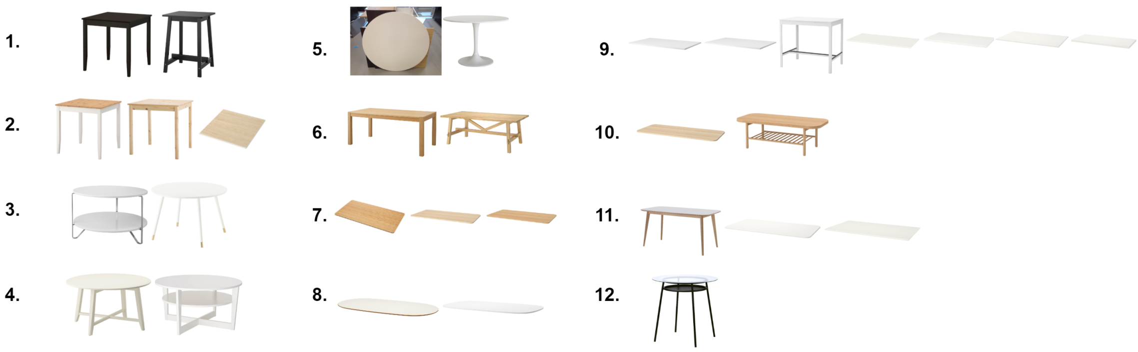



**Figure 4.9:** Groups of suggested tabletops to eliminate

Group 9 was decided to delete in this process but instead consider as a platform further on. Group 10 was decided to keep because of the differences in thickness BEKANT are 1,6 mm and LISTERBY 3,88 mm, these were considered as to different to each other. Group 11 was decided to keep because of the high sales of BEKANT and THYGE and the change in the edge of NORDMYRA. In Group 12 a lonely glass table was decided to be deleted because of the bad sales numbers compared to other circular glass tables.

The analysis continued with group 1-8, seen in figure 4.10. In group 1 two black square tables was compared to each other with similar characteristics but the left table LERHAMN sells three times more than NORRÅKER to the right, the tabletop of NORRÅKER could be eliminated. Group 2 including three tables where LERHAMN to the left was decided to keep and eliminate the other two because of the similarities, sales numbers and they are intended to cease to be sold. The tabletops in group 3 sharing several similarities except for a difference in thickness of 5,5 mm and LÖVBACKEN to the right sells six times less and was decided to be eliminated. In group 4 the differences were in material one created of MDF and the other of particleboard otherwise they are having several similarities and the right table VEJMON sells more than seven times less and could therefore be eliminated. Group 5 was two tables in the same family but a difference of 2 cm in diameter one in 103 and the other 105 cm and one produced with MDF and the other particleboard. The one to the right of MDF and 105 cm in diameter was soled more than two times less and was decided to be eliminated. In group 6 the right tabletop MÖCKELBY was decided to be eliminated because of the lower sales number and similarities between the tabletops. In group 7 the three tables shares several parameters with some small differences in colour scheme, the tabletop to the left BEKANT sells much less than the other two and was decided to be eliminated. In group 8 they are similar in size but the one to the right OPPEBY sells approximately six times less than SLÄHULT and was then considered to be eliminated. In this second selection, the tabletops that are suggested to be eliminated is seen with a red square in figure 4.10.

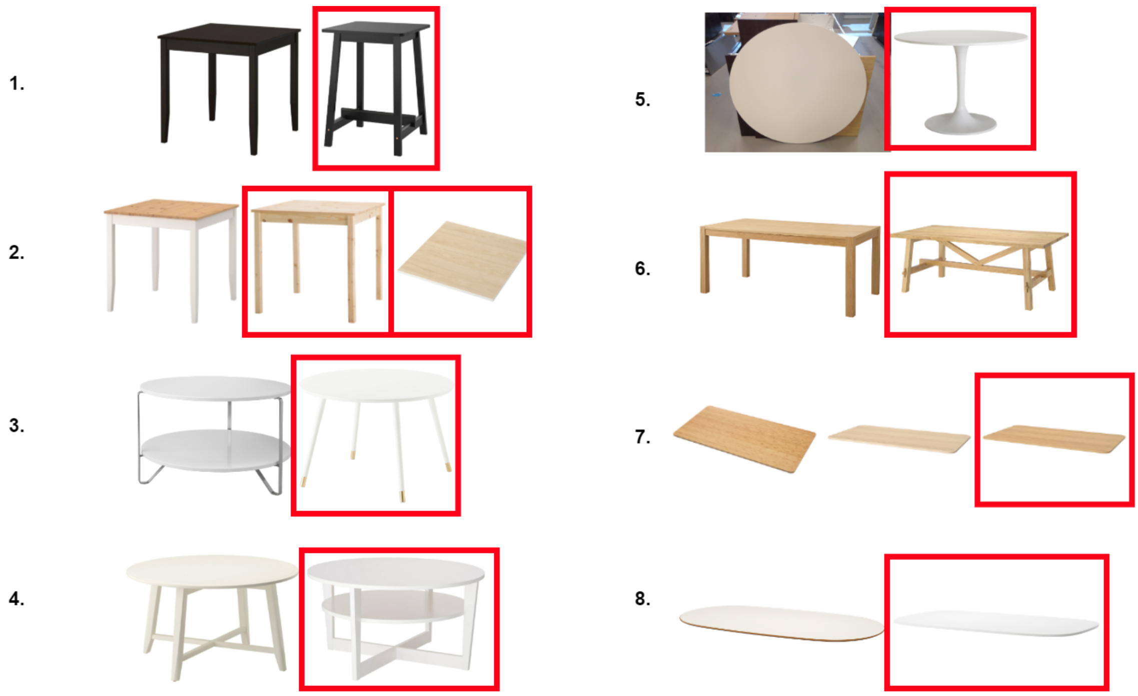



**Figure 4.10:** Chosen tabletops to eliminate

The analysis suggest a total number of ten tabletops that could be eliminated in the analysed portfolio. A simplified elimination matrix is shown in appendix 2.

## 4.8 Estimation of time and reduced cost with a platform strategy

The cost model which was developed by Siddique and Repphum (2001) seen in section 3.3 is used in this paper to calculate the possible time and cost-saving in case of using a platform approach in the development process instead of the IKEA's standard development process. The result is presented below, according to the steps of the cost model.

1. Identify platform strategy

   The platform strategy grid has been based on the price-class and market segment of the tabletop. Whereas three different prices-class have been identified, Breathtaking item, Low and Medium, ranked from the cheapest to the expensive one. The aim of this platform strategy is to increase performance while maintaining the same or lower price-class for the products. The goal was to have a combination of standardized size and interface and a platform strategy. Thus for platform family A, the size was decided to be 75 cm in length and width and use the border fitting interface which is the used interface for all the tables. platform family B, the length has been decided to be 120 cm and a width of 60 cm and using the boarder fitting interface. family C, uses also the same concept in interface i.e. border fitting with the difference in size whereas, the length is 120 cm and width to 75 cm.

2. Develop Activity Hierarchy associated with platform approach development

   To develop the activity hierarchy, the different phases of development were identified first, and then the engineers who are responsible in different areas were identified. One of the main question in the research interviews with engineers at IOS was, "what kind of responsibility do you have in the development process?" which also aided to develop and create the activity hierarchy. The activity hierarchy for the development of a single product is presented in Table 4.7, these activities can be used to develop the activity hierarchy for developing a product family, but according to the interviews with a product design engineer (PDE), the same activities are needed to be performed for each family member. Which means that the number of activities will decrease but very little, almost (20%). Although, if the same shape, material, and size are used and only the aesthetic (colour) is different then it reduces the number of activities by 80% (Time based).

   This means, the development of product platform families for the initial product platform family, will need the same amount of hours for each activity or even more. But the development time for each family member will reduce by 80%.

3. Identify associated time distribution for each activity

   In order to determine the time spend on each activity an interview with product range leader was conducted, the result of the interview is presented in table 4.8. The $\mathrm{Sp}_{DT}$ column represents the time that is spend on the development of a single product, based on the standard process development. The $\mathrm{M}_{DT}$ represents the time that is needed to develop a product that based on a platform approach after the initial platform is developed. The uncertainty was taken into consideration for each activity while estimating the time spent on the product developed based on platform approach an increase of approximately 30%). The testing and verifying activity is included in the time for

**Table 4.7:** Activity hierarchy for the development of a single table

| Level 1 | Level 2 | Product level |
|---|---|---|
| Create ideas | MDE | Creating construction ideas |
| | PSE | Developing packaging concept |
| | PDE | Planning the project |
| | PRE | Setting product requirements |
| Product development | MDE | Creating the 3D models and drawings |
| | PSE | Package design and verification |
| | PDE | Verifying the final design |
| | MDE & PRE | Testing and evaluating |
| | PRE | Verifying product requirements |

MDE & PRE.

**Table 4.8:** Associated time for each activity for a single product

| Level 1 | Level 2 | Product level | $Sp_{DT}$ | $M_{DT}$ |
|---|---|---|---|---|
| Create ideas | MDE | Creating construction ideas | 60 | 30 |
| | PSE | Developing packaging concept | 10 | 5 |
| | PDE | Planning the project | 100 | 12 |
| | PRE | Setting product requirements | 30 | 8 |
| Product development | MDE | Creating the 3D models and drawings | 120 | 30 |
| | PSE | Package design and verification | 50 | 5 |
| | PDE | Verifying the final design | 100 | 50 |
| | MDE & PRE | Testing and evaluating | - | - |
| | PRE | Verifying product requirements | 100 | 30 |

4. Perform cost model simulation to approximate development time The calculation of formulas

   The "formula" function in Excel was utilized to calculate and estimate the saving time of development process while using a platform based approach in the development process. The table 4.9 represents the results of the calculation which are based on the models developed by Siddique and Repphum(2001) which are presented in section 3.3.

**Table 4.9:** The result of calculation based on the estimation models

| Platform family | $F_{DT}$ | $P_{DT}$ | $M_{DT}$ | n | $S_{DT}$ | $Sp_{DT}$ | Saving Time | Saving percentage |
|---|---|---|---|---|---|---|---|---|
| A | 3330 | 1290 | 170 | 12 | 7410 | 570 | 4080 | 55 % |
| B | 2820 | 1290 | 170 | 9 | 5700 | 570 | 2880 | 50 % |
| C | 2990 | 1290 | 170 | 10 | 6270 | 570 | 3280 | 52 % |

**Table 4.10:** The results from calculation of the estimating model

| Norm. Sim | S.D. $P_{DT}$ | S.D. $M_{DT}$ | S.D. $Sp_{DT}$ | Mean($F_{DT}$) | Mean($P_{DT}$) | Mean($M_{DT}$) | n |
|---|---|---|---|---|---|---|---|
| Fam.A | 170 | 30 | 60 | 3003 | 1233 | 147 | 12 |
| Fam. B | 170 | 30 | 60 | 2716 | 1232 | 164 | 9 |
| Fam. C | 170 | 30 | 60 | 2589 | 1164 | 142 | 10 |

**Table 4.11:** The continues of table 4.10

| Norm.Sim | Mean($S_{DT}$) | M($Sp_{DT}$) | Mean(saving time) | Mean(Percentage savings) |
|---|---|---|---|---|
| Fam.A | 7813 | 601 | 4810 | 61 % |
| Fam.B | 6403 | 640 | 3686 | 57 % |
| Fam.C | 7043 | 640 | 4454 | 63 % |

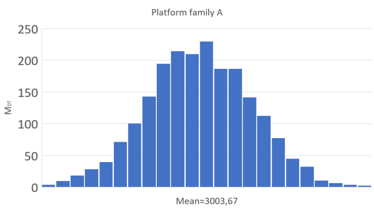



**Figure 4.11:** Platform family A

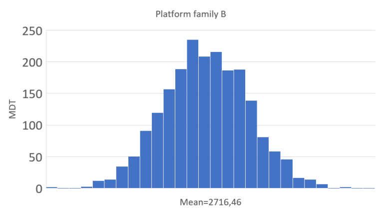



**Figure 4.12:** Platform family B

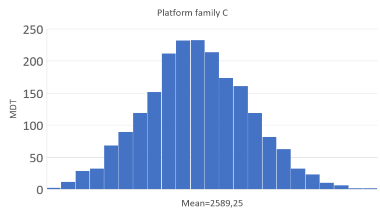



**Figure 4.13:** Platform family C

5. Determine if platform approach will provide significant financial gains

The goal with the estimation was to find out if implementing a platform strategy in development process of tabletops will affect the development time. The calculation conducted in step four shows significant time savings in the development process, but it is necessary to calculate the confidence level of these calculation. Hence, a Hypothesis test for normal

By using the Hypothesis test method and data from statistical table 4.13, 4.14, and 4.15, The $Z_{platformfamilyA}$= 89.2, $Z_{platformfamilyB}$= 90.5, $Z_{platformfamilyC}$ = 95.6 and from statistical tables, $Z_0.1 = 1.282$ which is the hypothesis test for 90% confidence level, i.e. Z> $Z_0.1$. Hence, the platform approach will save approximately 50% time in the development process with 90% confidence level.

**Table 4.12:** Simulation model for entire platform family A

| | Total $S_{DT}$ | Total $F_{DT}$ | Total time Savings |
|---|---|---|---|
| Mean | 7813 | 3003 | 4810 |
| Standard deviation | 720 | 360 | 360 |

**Table 4.13:** Simulation model for entire platform family B

| | Total $S_{DT}$ | Total$F_{DT}$s | Total time savings |
|---|---|---|---|
| Mean | 6403 | 2716 | 3687 |
| Standard deviation | 720 | 360 | 360 |

**Table 4.14:** Simulation model for entire platform family C

| | Total $S_{DT}$ | Total $F_{DT}$ | Total time savings |
|---|---|---|---|
| Mean | 7043 | 2589 | 4454 |
| Standard deviation | 720 | 360 | 360 |

## 4.9 The costs of activities of the existing product portfolio

There are seven different costs in the existing product portfolio, from creating the ideas for a new product until it is in the hand of customer. Customs and environmental fees, extra ordinary, inventory cost, overheads, purchasing, quality, recovery to stock, retail selling operations, and transport to the IKEA stores. The costs for each activity is estimated and calculated with the help of supply chain leader at IKEA, who is very experienced and is responsible for calculating these costs for tabletops.

**Table 4.15:** The cost of activities for the existing products

| | |
|---|---|
| Total | 100 % |
| Customs and environmental fees | 2 % |
| Extra ordinary | 1 % |
| Inventory cost | 6 % |
| Overheads | 2 % |
| Purchasing | 78 % |
| Quality | 2 % |
| Transport | 9 % |

# 5
# Discussion

The following sections presents other important discoveries during conducting this thesis for instance a new development process which was also developed for IKEA's HFB department, which is presented below.

## 5.1 The effect of platform and modularization approach on the products

Implementing a new platform will have numerous effect on the cost of development, production, and supply chain of tabletops. The effect on the development process has been estimated by the model developed by Siddique & Repphum (2001), and it showed that the development process time could be decreased by at least 50% based on the estimation which is presented in table (4.10 and 4.11)

The production and supply chain cost of the existing portfolio was calculated using IKEA's method which is used to estimate for the products at IKEA, which is presented in table 4.15.The literature study showed that the existing methods for estimation of cost for production and logistics when implementing a platform and modularization approach, can not be used to in case of IKEA. That is because the economy of scale works differently at IKEA. One of the advantages of developing products based on platforms is that it leads to the manufacturing of the same tabletop for different use and different colours. However, in the case of IKEA, each product needs to be produced at full-time in one or more production facility in order to make that one product available for the customers in the stores.

But these costs were discussed with the supply chain leader who is responsible to calculate these costs for a product in the development process, and it was decided to point out which of the activities in each process is affected. The interview resulted in an activity table and how they are affected in the case of implementing a platform and modular approach. In table 5.1 the +, -, and 0 are used to show if the activities are affected positive, negative or not affected at all.

The production cost is divided into 6 different costs that are presented in table 5.1, where the material cost is the highest cost for the products. Implementing a platform approach will result in producing more of the same product of the same material, and it will help on decreasing the material cost.

The size of tabletops are mostly based on customer requirements but also based on the sizes that are possible in the production and the sizes that are the fittest for transportation. Hence, The initial platform needs to be in a manner that fulfils customers requirements, production and logistics in the best way possible. In that way the transportation and inventory cost will decrease i.e. it will have a positive effect on the logistic cost.

**Table 5.1:** Activity hierarchy and the effect of a platform and modular development process

| **Development process** | | **Production phase** | | **Logistic** | |
|---|---|---|---|---|---|
| Idea Creation | 0 | Material | + | Transport | + |
| Design phase | ++ | production cost | 0 | Inventory | + |
| Testing and prototype | + | Cost of facilities | 0 | | |
| 3D Modelling | + | Labour cost | 0 | | |
| Certificate and administration | + | Spare part | + | | |
| | | Tooling cost | + | | |

## 5.2 Development process

The activity hierarchy that is presented in table 4.8, developed in close collaboration with the staff at IKEA's development office. As seen in the development process there are no clear activities planned to compare the created idea with already existing products. This is an important activity in the new development approach which has been added in the already existing development process. The modified development approach has 4 new steps which allow the designer to compare the new idea to the already existing. This activity might take more time in the creative idea step but saves more time in the product development step.

The limited parameters that are available for the products in the PLM-systems, makes this activity a very time-consuming step. But with implementing the comparison method developed during conducting this thesis, and completing the necessary parameters for the tabletops, it is possible to compare a newly developed product to all existing products under 1 hour. This is the time that needs to be invested in improving the data aggregator (Qlikview) in order to have a better and efficient development process(Improving the way they aggregate data).

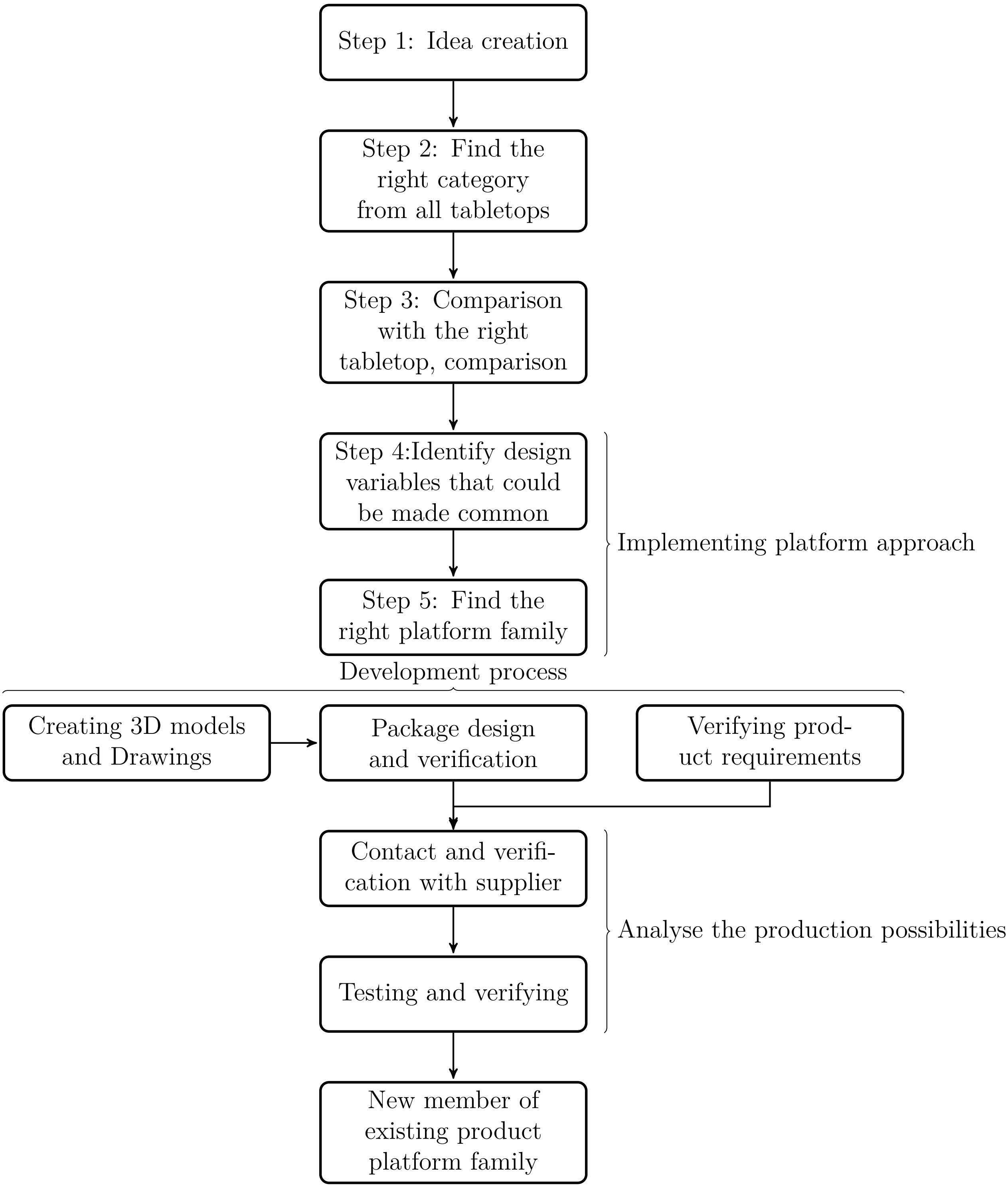



**Figure 5.1:** The new development process

## 5.3 Roadmap

A roadmap was developed to visualize the implementation of the improved strategy and consists of six steps with a time frame from now until IKEA reaches their sustainability goals that are targeted by 2030 (IKEA, 2020). What IKEA means with sustainability is one of their keywords **Caring for people and planet** (Kamprad, 2001) with other words create a better life for more people. The goal for IKEA until 2030 is to become circular and climate positive (IKEA, 2018). Creating a platform and modularization development for the tabletops is one step in the right direction towards the sustainability goals. The created roadmap is seen in figure 5.1.

The first step is to develop the initial platform family and as suggested in the results the recommended platform to start with could consist of square tabletops of 75 cm, rectangular tabletops with 120 cm in length and 60 cm in width and the last proposed platform rectangular tabletops with 120 cm in length and 70 cm in width. The next step is to reduce the number of tables in the collection, ten tabletops are proposed to eliminated in the results but IKEA could look for more similarities in their whole tabletop collection, or a plan for the tabletops with an set end date to be able to implement new tables. The third step is to implement the new platform family in a smaller scale, e.g only in Sweden to start with. The Fourth step is to evaluate how the market react to the new platform family. The fifth step depending on the previously steps evaluation is to implement the platform in a bigger scale e.g in the whole IKEA worldwide. The sixth step is to find similar solutions in other products. This is one step in the right direction for IKEA for achieving the goals that are set for 2030.

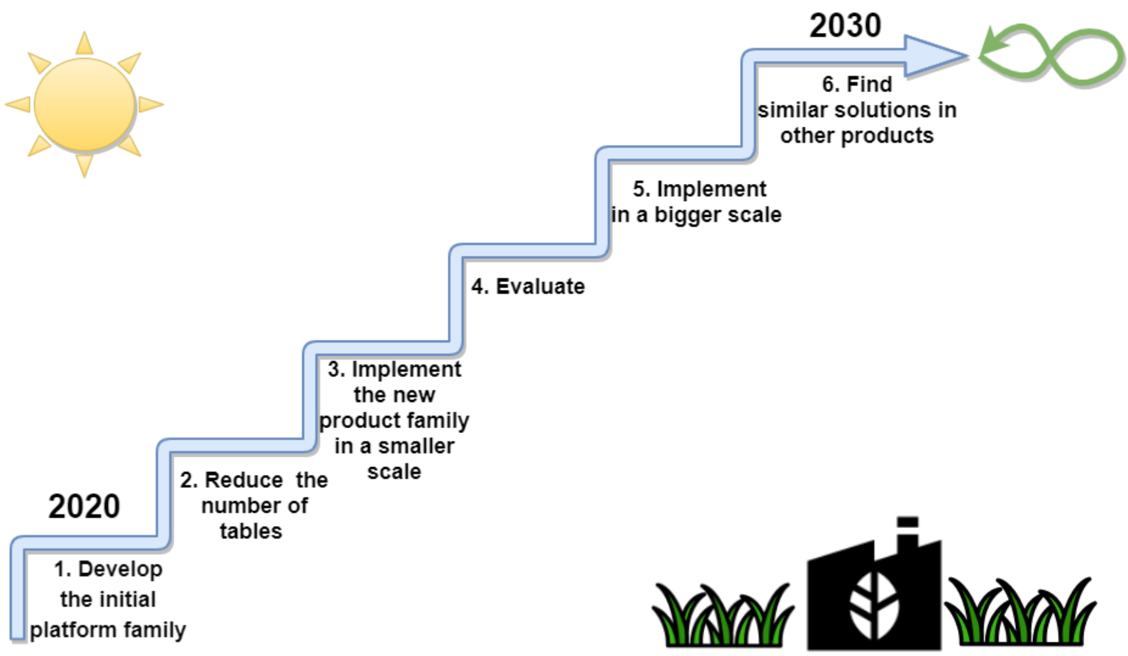



**Figure 5.1:** Roadmap

## 5.4 Research Questions & discussion

In the following sections, the initial research questions which have been investigated through the work is answered. These questions set base of the methods and the thesis, i.e. the work was done in around these questions.
***1.*** *What are the major factors (organizational, cost, development process, logistic, production) in current IKEA's tabletops strategy (not platform-based)? What needs to be changed (in IKEA's lean development process) to move towards a more platform-based approach?*

One of the main goals with this thesis was to discover the reasoning behind why the existing portfolio is not platform-based or why there so many similar tabletops. The research interviews were used as a method to gather more information with regards to the development process, production and logistics of the products. Hence, a questionnaire template (Appendix 1) was utilized to find the reason behind having so much similarities in tabletops by questioning around three main topics, ***Communication***, ***PLM-system*** , and ***Standardized sizes of tabletops***.

Regarding the communication, the interviewees mainly brought up that the communication within each team is good. However, according to the interviewees, there are no clear communication or collaboration between the teams of the same department during the development process which increases the risk of developing two or even more similar products. For instance, the tables for dining, outdoor, and workspace (different market segments) are developed within the same department, and different teams are developing different market segments, and since there is no collaboration between these teams two similar products can be developed simultaneously. The organizational aspect is one of the most important factors while implementing a platform approach, and the knowledge of existing and previous needs to be passed on to the new team members while developing a platform family.

Each three PLM-system at IKEA are used with different purpose, which are presented in results section 4.1. After the first few interviews, it was clear that there are some issues with the two PLM-systems which are used during the development process, PIA and PLUS. It was necessary to use PIA to gather specific information to be able to categorize the tabletops. While using PIA we experienced some difficulties and issues, such as missing parameters for some products. The initial list of products that were analyzed was gathered through Qlikview, which is a very helpful system, that allows the user to gather a Microsoft Excel list of the desired products with desired parameters. Although in order to be able to compare the products to one another, there is a need for more essential parameters, such as shape, material, price, and price class. These parameters can be collected through PIA, and gathering the information for one product takes approximately 5 minutes. But to collect the data for a large number of products, for instance, 300 tables (same number as this thesis) is a very time-consuming product and a repetitive job. Hence, Qlikview needs to be updated with more parameters regarding a product, that is because Qlikview offers already most of the necessary parameters for comparison.

Size of a table is one of the important parameters both for the customers and from the design perspective. IKEA is offering a huge variety of different sizes to target all the possible market segments and customers. The size difference in some of the similar tables are very small for instance, from the tables that are suggested to be eliminated; Docksta (103) and Docksta (105) with a thickness of 1.8 Cm. These parameters might be very important from a designers point of view but not from a customers perspective. Hence, the platform-based approach is suggested to have some standardized sizes that have as little material waste, fulfils all the regulations and requirements.

***2.*** *What are the cost factors (development, production, and logistics) in today's product portfolio in tabletops and how could a platforming strategy affect these factors?*

The question was raised at the start of the project, considering it is essential to know the consequences of a new development approach to determine if it is beneficial for the organizations. The cost of the development process is determined by the activities that are conducted by engineers to develop a product. These activities have been identified and presented with the number of hours each activity cost to develop a product (table 4.8). By using the methods presented in section (3.3) it was possible to calculate how a platform approach could affect the development process. After the calculation, it was shown that it is possible to decrease the lead time by at least 50% when implementing a platform approach.

The cost factors for production and logistic were also discussed to be identified and analyzed in comparison with the new development approach. The cost activities in regards to production and logistic were identified for the existing portfolio. However, no evaluated method was found to estimate these costs when implementing a platform approach. And after discussion with supply chain leader at IKEA, he introduces the activities that could be affected positively by implementing a platform approach into production and logistics.

***3.*** *How to calculate the supply cost of today's product portfolio compared to a platform-based approach portfolio?*

The supply cost of a product of today is calculated by the methods that are used by IKEA, these are presented in table 4.15. Except for the actual cost, the effect on how the activities will be affected was evaluated, based on the research interviews with Supply chain leader, and the result is presented in table 5.1.

***4.*** *How to analyse (calculate complexity and standardization) the current products (Tabletops) in an efficient way to develop the right standard procedure for other products (beyond tabletops)?*

At the of the project, we received a list of 92 tabletops from IKEA to go through, compare the products to one another with the purpose to find a similar tabletop. Several methods were discussed to develop the most efficient method, for the comparison of products. The tabletops were divided into 10 subgroups based on different parameters that set the base of the product, such as shape, size, material, etc. These parameters are essential to carry out the comparison process, and for this thesis were the parameters were produced from two different PLM-system (PIA, and Qlikview).

Later on in the thesis, the method was evaluated by carrying out on 304 different products. The result was the same after categorization, each product could be compared to the rest of the group by using the filter function in Microsoft Excel. The steps are described thoroughly in section (3.2.5) categorization of tabletops.

***5**. What metrics exist that shows the trade-off of internal complexity vs customer options? How can it be used to evaluate the current range and compare future scenarios?*

The objective of this question was to gather more information regarding the consequences of offering more variety to the customers by implementing a platform approach in the development process. Commonality plan and differentiation plan, two information system which is described by Ulrich (2012), were used to plan the potential platform family groups. These plans were later on combined to identify both the similarities and distinction between the products. This allows the designer to identify design parameters that be made in common and what requirement need to be fulfilled by the initial platform.

The cost estimation model developed by Siddique and Repphum (2001) was used to demonstrate the beneficial time savings in the development process which decrease the complexity in the development process. This method showed that there is a possibility of saving at least 50 % during the development process with 90% confidence level. The results are presented in subsection 4.8, step 5. The result was similar to the one which was used in the paper.

# 6

# Conclusions and further research

Based on the theory, result, and interviews with engineers at IKEA some important aspect of the thesis has been discussed and numerous conclusion have been made that are stated and described in this chapter.

There are numerous market advantages to offer a wide variation of products with a high degree of distinctiveness from a customer point of view based on the literature search some of which are targeting more market segments, and being able to offer more exotic models to attracts customers. Based on the studies that are presented in chapter two, one way of offering a wide variety of products is by implementing a platform and modularization strategy. In addition to the market advantages, there are other benefits especially in the case of IKEA which is described below.

- Economy of scale in process development and production

  One of the main benefits of implementing a platform and modularization strategy in the process development is the economy of scale in the production. This is because the products will share many components such as the base of the tabletop, the interface which is the surface connections between the leg or the frame to the tabletop, and spare parts such as screws, bolts, etc. However, the economy of scale in case of IKEA is different considering they are one of the biggest retailers in the world. Each production is responsible for producing one product in case of the standard products, i.e. the products that are sold the most within a category for example the BILLY bookshelf. Hence the economy of scale can be implemented during the development of the products by saving time during the development of members of the platform family and using that time to develop more new models.

  However, by developing an optimized interface that can be used in the potential groups (circular, square, rectangular and rectangular with rounded corners), the same spare-parts will be used to assemble the tables. This will decrease the price for the spare-parts and also allow the customers to choose between different legs, frame and tabletops, i.e. even more variation to the customers but with the parts that already exist. This gives more variation without the development of new products.

- IKEA have a limitation of 10 000 products in their stores which is offered to the customers and every year 20% of these products are replaced by new, or upgraded products. The products that have been eliminated by conducting this thesis had a too high degree of similarities with each other. By eliminating more similar products, there will be more "space" for exotic products to attract more customers or target new market segments, for example, IKEA started their collaboration with "ASUS Republic of gamers" to develop gaming furniture.

The improved development process which is presented in section (5.2), prevents engineers to develop similar products, which means that the elimination of similar products will not be necessary for the future. In addition to that, the approach will decrease the development time which is shown by the calculation that is presented in chapter 4.

- An optimized and common interface which is developed for the potential groups (circle, square, rectangular and rectangular with rounded corners) allows sharing the spare parts and legs and base of the table. In addition to that, it allows the customers to use the tables for more than the actual lifetime of a product. According to (Ulrich & Eppinger, 2012) there are different reason to change a physical part of a product. In the case of tabletops, the physical part could be, a drawer, a broken table-leg, or even the tabletop, and the reasoning could be if a part is broken or needs to be upgraded. The modular architecture allows the customer to buy the broken part, to continue using the table. In other words, the modular architecture allows the products to be repaired, reused, or re-manufactured. IKEA is planning to have a circular economy within the products by 2030 and based on the presented theories, reusing, or re-manufacturing products are one of the methods to have a more sustainable product. Thus, implementing a modular interface in tabletops is a step towards developing products that can be repaired and reused easier in the future.

- As mentioned in the background IKEA's development department is divided into Business areas which itself are divided into different Home Furnishing departments such as workspace, dining, outdoor, living-room, etc. that are working separately with little collaboration. These HFB's needs to start collaborating to have a successful platform and modular-based development process and products in the future. Considering the organizational aspect of the developed approach it is of utmost importance to consider alternate communication and meeting system.

- After working and collecting information in the different PLM-systems at IKEA we saw the potential for improvements. Above all, it is very slow to work with and it could be more user-friendly. Especially PIA that seems to be an old system that could need an update.

## 6.1 Further research

The goal with this project was to find the reasoning behind the similarities of the existing portfolio, analyze the products, and find the potential products that can be within the same platform family groups. By answering the research questions, developing a new process development, developing the platform family groups, and developing a roadmap for the future, we have reached and concluded more than the project aim. The subjects that are described below are important to be studied deeper to achieve an optimal platform and modular-based development process.

- How the platform strategy will affect the packaging and compare quality issues (COPQ) figures.

  In the middle of the project, we had a reconciliation with engineers at IKEA, where we presented our work, after the presentation we received some feedback on how we could go on with project as well as some new research question one of which was regarding the packaging and quality issues. The packaging is also one of the factors that affect the logistic cost, thus this subject is important and should be taken into consideration while developing the new platform families.

- How will the implementation of platform strategy affect customers choice.

  The platform and modularization approach will aid in offering more variety to the customers with the same standardized sizes in tabletops. This might confuse the customer while choosing a product, hence this question should also be taken into consideration during the development process.

- What is the optimal ratio between exotic and platform and modular-based products.

  As mentioned in the discussion, The new development approach will allow the IKEA catalogue to have more room for exotic models of tabletops by eliminating the ones that have a low degree of distinctiveness. However, there should be a balance between standard models (based on size, colour, shape, etc.) and exotic models that attract the customers to IKEA.
- The performance measurement of a modular product platform approach

  The performance measurement indexes that are identified and presented in chapter two might be worth to look into. These indexes could clarify questions that could help in the decision making of the developed approach in this paper. This questions can be for instance "the optimal ratio between the exotic and standardized models", and the answer could be essential in the decision making phase.

# References

Agarwal, S., & Garg, A. (2012). The importance of communication within organizations: A research on two hotels in uttarakhand. *IOSR Journal of Business and Management*, *3*(2), 40–49.

Alessandra, T. (1993). *Communicating at work*. Simon and Schuster.

Blackenfelt, M. (2001). *Managing complexity by product modularisation* (Unpublished doctoral dissertation). Maskinkonstruktion.

Bostrom, R. P. (1989). Successful application of communication techniques to improve the systems development process. *Information & Management*, *16*(5), 279–295.

Brundtland. (1987). Our common future. *New York*, *8*.

Cameron, B. G., & Crawley, E. F. (2013). Crafting platform strategy based on anticipated benefits and costs. *Advances in Product Family and Product Platform Design July 2013*, 49-70.

Denscombe, M. (2014). *The good research guide: for small-scale social research projects*. McGraw-Hill Education (UK).

Ellen-MacArthur-foundation. (2020a). Ellen MacArthur foundation. Retrieved 2021-01-31, from https://www.ellenmacarthurfoundation.org/our-story/our-network/strategic-partners/ikea

Ellen-MacArthur-foundation. (2020b). *Sustainability.* Ellen MacArthur foundation. Retrieved 2020-11-07, from https://www.ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy

Encarnação, J., & Schlechtendahl, E. G. (1983). Implementation methodology. In *Computer aided design* (pp. 149–217). Springer.

Helmer, R., Yassine, A., & Meier, C. (2010). Systematic module and interface definition using component design structure matrix. *Journal of Engineering Design*, *21*(6), 647–675.

Heylighen, F. (1999). The growth of structural and functional complexity during evolution. *The evolution of complexity*, *8*, 17–44.

Hölttä-Otto, K., Tang, V., & Otto, K. (2008). Analyzing module commonality for platform design using dendrograms. *Research in Engineering Design*, *19*(2-3), 127.

IKEA. (2018, 7). People & planet positive 2030 [Computer software manual]. IKEA Sustainability Strategy.

IKEA. (2020). IKEA website. Retrieved 2021-01-31, from https://www.ikea.com/se/sv/this-is-ikea/sustainable-everyday/

Kamprad, P. J. M., Ingvar. (2001). *Ikea key values.*

Kraut, R. E., Fish, R. S., Root, R. W., & Chalfonte, B. L. (1990). Informal communication in organizations: Form, function, and technology. In *Human reactions to technology: Claremont symposium on applied social psychology* (pp. 145–199).

Landahl, J. (2018). *Platform design for producibility: Early-stage modeling and assessment support*. Chalmers Tekniska Hogskola (Sweden).

Lehnerd, A. P., & Meyer, M. H. (1997). *The power of product platforms*. Simon and Schuster.

Mallett-Hamer, B. (2005). Communication within the workplace.

McGrath, M. E. (1995). *Product strategy for high-technology companies: how to achieve growth, competitive advantage, and increased profits*. Irwin Professional Pub.

Meyer, M. H., & Utterback, J. M. (1992). The product family and the dynamics of core capability.

Robertson, D., & Ulrich, K. (1998). Planning for product platforms. *Sloan management review*, *39*(4), 19.

Saaksvuori, A., & Immonen, A. (2008). *Product lifecycle management*. Springer Science & Business Media.

Schuh, G., Rudolf, S., & Vogels, T. (2014). Performance measurement of modular product platforms. *Procedia CIRP*, *17*, 266–271.

Shaik, A. M., Rao, V. K., & Rao, C. S. (2015). Development of modular manufacturing systems—a review. *The International Journal of Advanced Manufacturing Technology*, *76*(5-8), 789–802.

Siddique, Z., & Repphun, B. (2001). Estimating cost savings when implementing a product platform approach. *Concurrent Engineering*, *9*(4), 285–294.

Smith, R. P. (1997). The historical roots of concurrent engineering fundamentals. *IEEE Transactions on Engineering Management*, *44*(1), 67–78.

Stark, J. (2020). Product lifecycle management (plm). In *Product lifecycle management (volume 1)* (pp. 1–33). Springer.

Szerakowski, C. (2017). *Transitioning ikea towards a circular economy: A backcasting approach* (Unpublished master's thesis).

Takeuchi, H., & Nonaka, I. (1986). The new new product development game. *Harvard business review*, *64*(1), 137–146.

Tonnquist, B. (2018). *Project management*. Sanoma Utbildning.

Ulrich, & Eppinger. (2012). *Product design and development 5th ed.* New York: McGraw-Hill Higher Education.

Ulrich, K. (1995). The role of product architecture in the manufacturing firm. *Research policy*, *24*(3), 419–440.

UN. (2021). *The sustainable development agenda*. UN website. Retrieved 2021-02-19, from `https://www.un.org/sustainabledevelopment/development-agenda/`

# A

# Appendix 1

## A.1 Interview template

**Ask if it's okay to record the meeting/interview**

Describe the thesis Our primary goal is to develop a Modular-based approach, which can be in form of a PDM-system or a matrix. The goal with the system is to help the engineers in the future, where they can compare a new concept with the already existing concept, or concepts in other departments. This will be done by reducing the number of tabletops, by finding synergies of tabletops from the same categories. Reducing the number of tabletops leads to reducing the number of accessories (such as screws, add-ons). This itself leads to less suppliers and reducing the internal complexity in the organization and IKEA system. The result can lead to decreasing the production cost, development cost, supply chain cost, etc. A futuristic goal could be to develop an approach which could be used for other products as well.

**Tell what we know**

- We have an excel file with all the tabletops, where the products are divided based on the family names, size and colour.
- We heard that 20 % of the tabletops gets out of the system and 20 % new comes in every year.

**General questions**

- Would you like to tell us a little about your responsibilities?
- Why do you think there are tabletops that have a lot of similarities but still are two different items?

**Questions regarding the tabletops**

- What are the steps while developing a new concept of tabletops?
- Is there any sales reports per tabletops regarding the:
- Quantity
- Profit

**Questions regarding the database system and communication**

- How is the communication between different departments while developing new products?

- How is the winner concept chosen?
- What requirements should it fulfil?
- How does the elimination system work?
- How do you compare the new concept to the ones that already is in sales?

**Regarding IKEA's product data management system**

- Are you using a PDM-system today to store all information about the table-tops?
- What is included in the system? CAD files, drawings, pictures?
- What kind of PDM-system is used while developing new products?
- What's missing in the current database system?
- What parameters do you think should be included in the system?

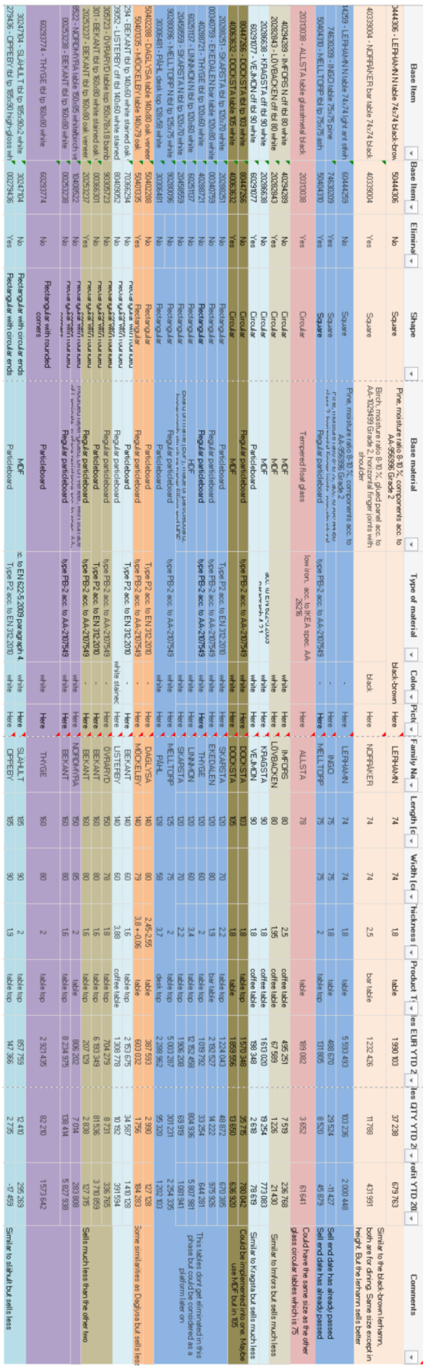
**Questions regarding the customer voice**

- How do you collect data in order to make a requirement-specification?
- How is the requirement-specification used to design a product which satisfy all the needs?
- Do you compare the product requirement for a new concept with already existing products or concepts from other departments?
- If yes, how will you analyse the result and use it?
- If No, then maybe we should look into it.
- How does IKEA translate customer needs into?
- Requirements?
- Design?
- What does customer realize is the most important factor while choosing a tabletop?

# B

# Appendix 2

## B.1 Elimination Matrix



| Base Item | Base Item | Eliminal | Shape | Base material | Type of material | Colo | Pict | Family Na | Length (c | Width (c | Thickness | Product T | les EUR YTD 2 | les QTY YTD 2 | rofit YTD 20 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 444306 - LERHAMN N table 74x74 black-brow | 50444306 | No | Square | Pine, moisture ratio 8-10 %, components acc. to AA-956996 Grade 2 | | black-brown | Here | LERHAMN | 74 | 74 | 1,8 | table | 1 990 103 | 37 238 | 679 763 | |
| 40339004 - NORRÅKER bar table 74x74 black | 40339004 | Yes | Square | Birch, moisture ratio 8-10 %, glued panel acc. to AA-1029499 Grade 2, horizontal finger joints with shoulder | | black | Here | NORRÅKER | 74 | 74 | 2,5 | bar table | 1 232 426 | 11 788 | 431 991 | Similar to the black-brown lerhamn, both are for dining. Same size except in height. But the lerhamn sells better |
| 4259 - LERHAMN N table 74x74 light ant st/wh | 60444259 | No | Square | Pine, moisture ratio 8-10 %, components acc. to AA-956996 Grade 2 | | - | Here | LERHAMN | 74 | 74 | 1,8 | table | 5 593 493 | 103 236 | 2 000 448 | |
| 74630209 - INGO table 75x75 pine | 74630209 | Yes | Square | [illegible] | | - | Here | INGO | 75 | 75 | 1,8 | table | 488 670 | 29 524 | -11 427 | Sell end date has already passed |
| 50404310 - MELLTORP tbl tp 75x75 ash | 50404310 | Yes | Square | Regular particleboard | type PB-2 acc. to AA-2107549 | - | Here | MELLTORP | 75 | 75 | 2 | table top | 131 805 | 8 520 | 45 879 | Sell end date has already passed |
| 20313038 - ALLSTA table glass/metal black | 20313038 | Yes | Circular | Tempered float glass | low iron, acc. to IKEA spec. AA-26216 | | Here | ALLSTA | 78 | | | table | 189 082 | 3 652 | 61 641 | Could have the same size as the other glass circular tables which is 75 |
| 40294289 - IMFORS N cff tbl 80 white | 40294289 | No | Circular | MDF | | white | Here | IMFORS | 80 | | 2,5 | coffee table | 495 251 | 7 519 | 236 768 | |
| 20282843 - LÖVBACKEN cff tbl 80 white | 20282843 | Yes | Circular | MDF | | white | Here | LÖVBACKEN | 80 | | 1,95 | coffee table | 67 589 | 1 226 | 21 430 | Similar to Imfors but sells much less |
| 20286638 - KRAGSTA cff tbl 90 white | 20286638 | No | Circular | MDF | [illegible] | white | Here | KRAGSTA | 90 | | 1,8 | coffee table | 1 613 020 | 19 254 | 773 083 | |
| 60291077 - VEJMON cff tbl 90 white | 60291077 | Yes | Circular | Particleboard | | white | Here | VEJMON | 90 | | 1,8 | coffee table | 198 348 | 2 618 | 78 619 | Similar to Kragsta but sells much less |
| 80447266 - DOCKSTA tbl tp 103 white | 80447266 | No | Circular | Regular particleboard | type PB-2 acc. to AA-2107549 | white | Here | DOCKSTA | 103 | | 1,8 | table top | 1 570 348 | 35 715 | 780 042 | Could be implemented into one. Maybe use MDF but in 105 |
| 40063632 - DOCKSTA table 105 white | 40063632 | Yes | Circular | MDF | | white | Here | DOCKSTA | 105 | | 1,8 | table | 1 859 556 | 13 650 | 636 920 | |
| 20288251 - SKARSTA tbl tp 120x70 white | 20288251 | No | Rectangular | Particleboard | Type P2 acc. to EN 312:2010 | white | Here | SKARSTA | 120 | 70 | 2,2 | table top | 1 224 043 | 48 872 | 670 385 | |
| 00340759 - EKEDALEN bar table 120x80 white | 00340759 | No | Rectangular | Regular particleboard | type PB-2 acc. to AA-2107549 | white | Here | EKEDALEN | 120 | 80 | 1,9 | bar table | 2 192 527 | 14 222 | 975 926 | |
| 40288721 - THYGE tbl tp 120x60 white | 40288721 | No | Rectangular | Regular particleboard | type PB-2 acc. to AA-2107549 | white | Here | THYGE | 120 | 60 | 2 | table top | 1 019 792 | 33 254 | 644 281 | |
| 60251137 - LINNMON N tbl tp 120x60 white | 60251137 | No | Rectangular | HDF | | white | Here | LINNMON | 120 | 60 | 3,4 | table top | 12 152 458 | 804 936 | 5 807 981 | This tables don't get eliminated in this phase but could be considered as a platform later on |
| 20458559 - SKARSTA N tbl tp 120x70 white | 20458559 | No | Rectangular | [illegible] | | white | Here | SKARSTA | 120 | 70 | 2,2 | table top | 1 906 208 | 69 919 | 1 081 941 | |
| 90280096 - MELLTORP N tbl tp 125x75 white | 90280096 | No | Rectangular | Regular particleboard | type PB-2 acc. to AA-2107549 | white | Here | MELLTORP | 125 | 75 | 2 | table top | 5 003 287 | 301 231 | 2 254 335 | |
| 30306481 - PÅHL desk top 128x58 white | 30306481 | No | Rectangular | Particleboard | | white | Here | PÅHL | 128 | 58 | 3,7 | desk top | 2 288 962 | 95 320 | 1 202 103 | |
| 50402288 - DAGLYSA table 140x80 oak veneer | 50402288 | No | Rectangular | Particleboard | Type P2 acc. to EN 312:2010 | - | Here | DAGLYSA | 140 | 80 | 2,45-2,55 | table | 387 593 | 2 990 | 127 128 | |
| 50401335 - MÖCKELBY table 140x79 oak | 50401335 | Yes | Rectangular | Regular particleboard | type PB-2 acc. to AA-2107549 | - | Here | MÖCKELBY | 140 | 79 | 3,8 +-0,06 | table | 603 032 | 1 756 | 184 283 | Some similarities as Daglysa but sells less |
| 294 - BEKANT tbl tp 140x60 white stained oak | 70366294 | No | Rectangular with rounded corners | Particleboard | Type P2 acc. to EN 312:2010 | - | Here | BEKANT | 140 | 60 | 1,6 | table top | 2 153 675 | 34 587 | 1 410 128 | |
| 09052 - LISTERBY cff tbl 140x60 white stained | 80409052 | No | Rectangular with rounded corners | Regular particleboard | | white stained | Here | LISTERBY | 140 | 60 | 3,88 | coffee table | 1 308 778 | 10 192 | 391 594 | |
| 305723 - ÖVRARYD table top 150x78x18 bamb | 90305723 | No | Rectangular with rounded corners | Regular particleboard | type PB-2 acc. to AA-2107549 | - | Here | ÖVRARYD | 150 | 78 | 1,8 | table top | 704 279 | 8 731 | 336 765 | |
| 301 - BEKANT tbl tp 160x80 white stained oak | 00366301 | No | Rectangular with rounded corners | Particleboard | Type P2 acc. to EN 312:2010 | - | Here | BEKANT | 160 | 80 | 1,6 | table top | 6 193 349 | 81 536 | 3 710 859 | |
| 20253237 - BEKANT tbl tp 160x80 oak veneer | 20253237 | Yes | Rectangular with rounded corners | Regular particleboard | type PB-2 acc. to AA-2107549 | - | Here | BEKANT | 160 | 80 | 1,6 | table top | 207 129 | 2 838 | 127 315 | Sells much less than the other two |
| 8522 - NORDMYRA table 150x85 white/birch ve | 10408522 | No | Rectangular with rounded corners | [illegible] | | white | Here | NORDMYRA | 150 | 85 | 2 | table | 806 202 | 7 014 | 283 808 | |
| 00253238 - BEKANT tbl tp 160x80 white | 00253238 | No | Rectangular with rounded corners | Regular particleboard | type PB-2 acc. to AA-2107549 | white | Here | BEKANT | 160 | 80 | 1,6 | table top | 8 234 975 | 138 414 | 5 827 938 | |
| 60293774 - THYGE tbl tp 160x80 white | 60293774 | No | Rectangular with rounded corners | Particleboard | | white | Here | THYGE | 160 | 80 | 2 | table top | 2 921 435 | 82 210 | 1 573 642 | |
| 30247104 - SLÅHULT tbl tp 185x90x2 white | 30247104 | No | Rectangular with circular ends | MDF | c. to EN 622-5:2009 paragraph 4. | white | Here | SLÅHULT | 185 | 90 | 2 | table top | 857 759 | 12 410 | 295 269 | |
| 279436 - OPPEBY tbl tp 185x90 high-gloss wh | 00279436 | Yes | Rectangular with circular ends | Particleboard | Type P2 acc. to EN 312:2010 | white | Here | OPPEBY | 185 | 90 | 1,9 | table top | 147 366 | 2 735 | -17 459 | Similar to slåhult but sells less |



**Figure B.1:** Elimination matrix

## B.2 Simplified elimination matrix

| Base Item | Eliminate | Shape | Base material | Length | Width | Thickness | Comments |
|---|---|---|---|---|---|---|---|
| LERHAMN black-brown | No | Square | Pine | 74 | 74 | 1,8 | |
| NORRÅKER bar table black | Yes | Square | Birch | 74 | 74 | 2,5 | Similar to the black-brown lerhamn, both are for dining. Same size except in height. But the lerhamn sells better |
| LERHAMN lght ant st/wht stn | No | Square | Pine | 74 | 74 | 1,8 | |
| INGO pine | Yes | Square | Pine | 75 | 75 | 1,8 | Sell end date has already passed |
| MELLTORP ash | Yes | Square | Regular particleboard | 75 | 75 | 2 | Sell end date has already passed |
| IMFORS white | No | Circular | MDF | 80 | | 2,5 | |
| LÖVBACKEN white | Yes | Circular | MDF | 80 | | 1,95 | Similar to Imfors but sells much less |
| KRAGSTA white | No | Circular | MDF | 90 | | 1,8 | |
| VEJMON white | Yes | Circular | Particleboard | 90 | | 1,8 | Similar to Kragsta but sells much less |
| DOCKSTA white | No | Circular | Regular particleboard | 103 | | 1,8 | Could be implemented into one. Maybe use MDF but in 105 |
| DOCKSTA white | Yes | Circular | MDF | 105 | | 1,8 | |
| DAGLYSA oak veneer | No | Rectangular | Particleboard | 140 | 80 | 2,45-2,55 | |
| MÖCKELBY oak | Yes | Rectangular | Regular particleboard | 140 | 79 | 3,8 +-0,06 | Some similarities as Daglysa but sells less |
| ÖVRARYD bamboo | No | Rectangular with rounded corners | Regular particleboard | 150 | 78 | 1.8 | |
| BEKANT white stained oak vene | No | Rectangular with rounded corners | Particleboard | 160 | 80 | 1,6 | |
| BEKANT oak veneer | Yes | Rectangular with rounded corners | Regular particleboard | 160 | 80 | 1,6 | Sells much less than the other two |
| SLÄHULT white | No | Rectangular with circular ends | MDF | 185 | 90 | 2 | |
| OPPEBY high-gloss white | Yes | Rectangular with circular ends | Particleboard | 185 | 90 | 1,9 | Similar to slähult but sells less |

**Figure B.2:** Simplified elimination matrix

# C
# Appendix 3

## C.1 Planned Gantt-Chart

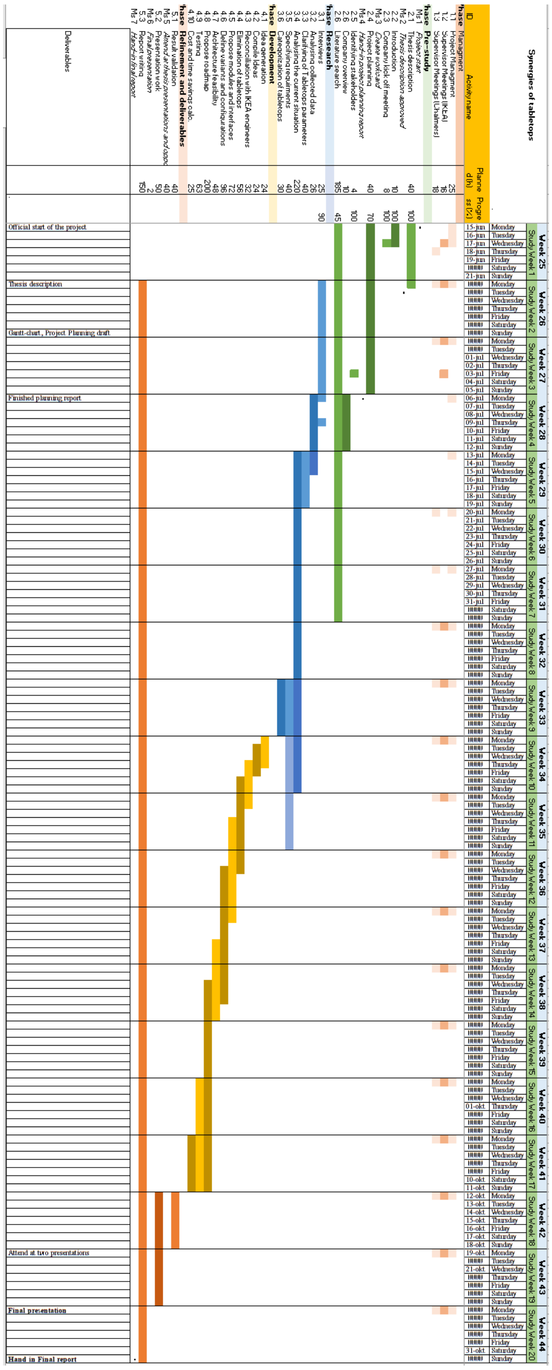




**Figure C.1:** Planned Gantt-Chart

## C.2 Actual Gantt-Chart

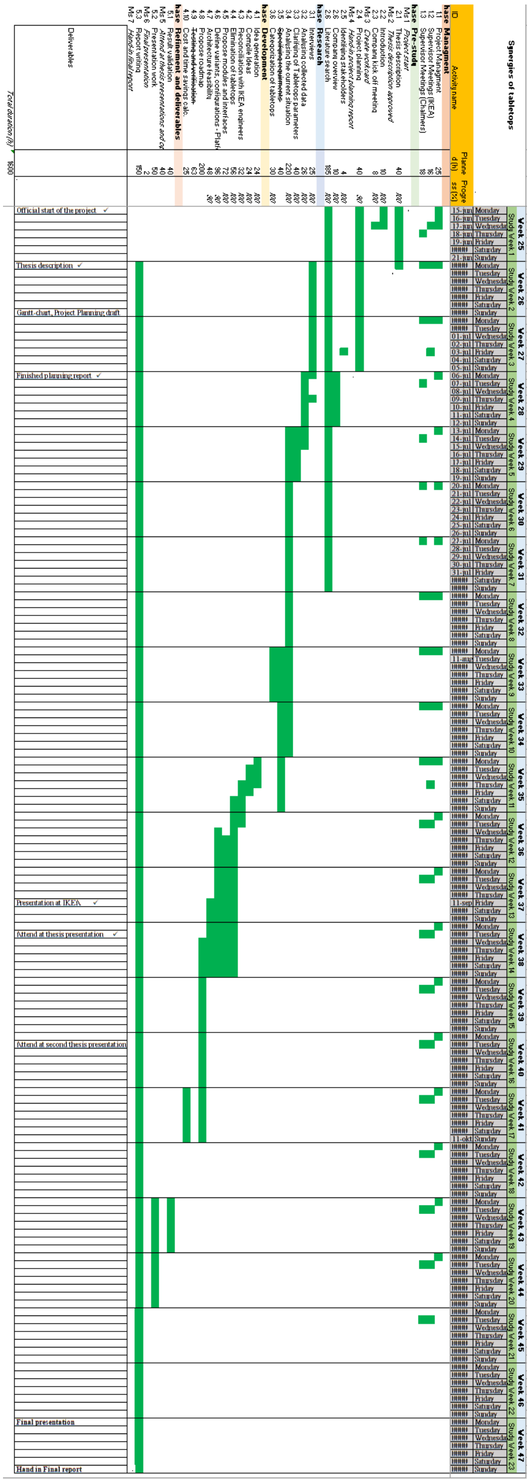


**Figure C.2:** Actual Gantt-Chart