Swedish University of Agricultural Sciences
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– A study on glue board planks and finished products

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– En studie på limfog, sågat virke och färdiga produkter

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Summary

We live in a global world with companies that operate in different countries and continents. This globalization creates great opportunities for companies to reach new markets, but also lead to increased competition. This competition makes it essential for companies to constantly work with costs. One important cost for global companies is the logistical costs that arise during transport of goods between countries.

This report was written in conjunction with IKEA. The aim of the study is to investigate how the costs are affected if material or finished products are sent to India. The study was made on container freight for three different wooden products, which were transported by truck and boat to India.

The work begins with a literature review of what previously had been done within the field. The study is a flexible case study that uses both qualitative and quantitative data. The data was collected in interviews by telephone, meetings, and in the form of computer files, and information sent by mail. Data gathering and data processing continued throughout the course of the work.

To achieve the aim of the study, the report investigates the structure of the supply chain and costs was quantified and located. Lead times, supply strategies, and stocks were researched. The report also investigates existing risks in different parts of the chain and which risks that have the greatest influence on the chain. Examples of risks that are treated are the risk that the supply chain fails to supply the department stores, transport risks and control risks.

After the data had been collected, the report presents it with maps, tables and models. These figures give a picture over the chain's different parts, costs and a model is presented that shows the costs and how they affect each other. The model is general, which allows it to be used in other similar cases. On the collected data analyses such as sensitivity analysis and break-even analysis to better describe the effect of different costs.

The conclusions drawn at the end of the work are that it is cheaper to transport planks and glue board instead of finished products. Material cost is the biggest factor that affects the total cost the most, but taxes and fill rates also affect the final cost considerably. The biggest risks in the chain are that the department stores not get the products on time or that accidents occur in the chain. The supply chain is lean and the forecasts are a very important feature for the chain´s efficiency.

Keywords: *activity based costing model, emerging markets, furniture, global, IKEA, international, management, risk, material*

Sammanfattning

Vi lever i en global värld där företag bedriver verksamheter i flera olika länder och kontinenter. Denna globalisering skapar stora möjligheter för företag att nå ut till nya marknader, men den leder samtidigt till ökad konkurrens. Konkurrensen tvingar också företag att ständigt analysera och kontrollera sina kostnader, en viktig kostnad för globala företag är logistikkostnader som uppkommer utmed internationella försörjningskedjor.

Denna rapport skrevs i samarbete med IKEA. Studien undersöka bland annat hur kostnader påverkas av att transportera material till möbler i form av plank och limfog istället för leverans av färdiga produkter. Studien gjordes på containerfrakt för tre olika träprodukter, som fraktades med lastbil och båt till Indien.

Arbetet börjar med en litteraturgenomgång av tidigare studier inom ämnet. Relevanta teorier valdes som stöd för studien. Studien är en flexibel fallstudie, som använder både kvalitativa och kvantitativa data. Datamaterialet samlades in genom intervjuer över telefon, möten samt i form av datauppgifter och annan information som skickades över mail. Datainsamlingen och databearbetningen pågick parallellt under arbetets gång.

För att uppnå målet undersöktes strukturen på försörjningskedjan, kostnader kvantifierades och lokaliserades. Ledtider, försörjningsstrategier och lager undersöktes. Även risker undersöktes som uppstår i olika delar av kedjan samt vilka risker som hade störst inflytande på kedjans prestanda. Exempel på risker som behandlas är leveransstörningar som kan leda till att försörjningskedjan misslyckas försörja varuhusen, men även transport och kontroll risker.

Efter att datamaterialet insamlats visualiseras resultaten med hjälp av kartor, tabeller och modeller. Dessa figurer ger en bild över hur försörjningskedjans olika delar och kostnader. En modell konstrueras som visar var de olika kostnaderna uppkommer samt hur de påverkar varandra. Modellen är generell vilket gör att den kan användas i andra liknande fall. Analyser som känslighetsanalys och break-even analys gjordes på den insamlade datan för att bättre förstå effekten av olika scenarier.

De slutsatser som dras är att det är mer kostnadseffektivt att transportera möbelkomponenter, det vill säga plank och limfog istället för färdiga produkter. Materialkostnaden visar vara den största faktorn som påverkar totalkostnaden mest, men skatter och fyllnadsgrader har också en stor betydelse. De största riskerna i kedjan är att varuhusen inte får produkterna i tid eller att olyckor inträffar i kedjan. Det visar sig att försörjningskedjan är lean och att prognostiseringen är en mycket viktig funktion för att kedjan ska fungera bra.

Nyckelord: *aktivitetsbaserad kostnadsmodell, tillväxtmarknad, möbel, global, IKEA, internationell företagsledning, risk, material*

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Abbrevations

In this work, I have tried to minimize the use of abbreviations to make the text easier to read for people that are not experienced within the field of the study. However, in a few sections of the text there are abbreviations, in these cases there are an explanation right beside the abbreviation.

BAF – Bunker adjusted freight price

SOLAS – Control of containers by weighting them.

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1 Introduction

The first chapter provide an introduction for the study, presenting former research made on the subject. The chapter describes the problem background and the problem. Finally, the aims of the study and delimitations are described and there is a brief description of the studies outline.

1.1 Problem background

We are living in a global world with large multinational companies that are managing complex, cross border product flows. This globalization creates opportunities but also risks for the companies. One opportunity is the possibility to reach new markets and at the same time increase the number of potential customers and thereby increase sales and revenue. But companies that operate in many different markets also need to face and manage supply chains risks, like delays, changed prices on raw material and fluctuating demands (Chopra & Meindl, 2013, pp. 155-188). The increased globalization have according to Jonsson (2010) reduced transport costs for forest products and increased the global trade

The changing business landscape means that companies constantly explore new markets. Companies face new technology and harder competition which has forced many of them to expand worldwide (Zeng & Rossetti, 2003). However, this expansion has also made it harder for companies to manage, track and visualizing their supply chains (Gardner & Cooper, 2003). One reason for the increase in complexity is the fact that many firms when expanding have started to outsource parts of their supply chains. But companies that operate in various markets also face various supply chains risks (Chopra & Meindl, 2013, pp. 155-188). Humprey (2003) argues that although the concept of supply chains is simple. However, to figure out in practice where the products should be assembled and how the supply chain should be coordinated is complicated.

Gorodnichenko *et al.* (2010) argues that it is important for companies to be innovative and transfer their knowledge within the company to the emerging markets. Nevertheless, in order to have successful supply chains, companies need to be under consistent development and improvements for the multinational companies to stay successful in these new markets. According to PWC (2014) an obstacle in emerging markets can be the lack of labour that makes recruitment. Another challenge is that products need to become cheaper in emerging markets so the people can afford them (Blanco n.d).

Singh (n.d) argues that emerging markets have huge growth potentials and companies around the world cannot afford to miss the opportunity to participate in their growth. One of these emerging markets with a great potential is India. However, management experts around the world have not been able to successfully meet the market of even the urbanized population (I *ibid*.). In India the timber production has slowed down due new laws and many sawmills have been shut down. This has led increased imports on wooden materials (Sood 2014). India is the second most populous country in the world with a growing wood and wooden products market which have increased from 500 million USD annually to 2.7 billion USD over the last decade (*ibid*. p. 1). Sood also mentions that the demand for wooden furniture has increased. This growth raises the important question on how companies should develop their supply chains in order to meet this growing market. India has lacking infrastructure, limitations in technology and complex tax laws. (Singh n.d.). This causes problems when the roads and ports are underdeveloped and customs clearances and paperwork take long time compared to other countries (Deman & Tuyishime 2009).

These limitations in infrastructure mentioned by Deman & Tuyishime (2009) together with the growing demand of wooden furniture in India described by Sood (2014) raise the need to investigate the supply chains to India. It is important that the wooden industries know how to manage the complex logistic chains, so the opportunities of globalization described by Chopra & Meindl (2013, pp. 155-188) can be used.

1.2 Problem

Gardner & Cooper (2003) argues that it is critical for the success of companies to visualize their supply chains so knowledge can be transferred and exchanged between managers and different parts of the organization. If companies fail to visualize their supply chains, forecast will be built upon management behaviour instead of consumer behaviour (*ibid.*). Another important subject to investigate is mentioned in Kouvelis *et al.* (2006 see Rao & Goldsby, 2009). (*ibid.*) argue that it also is important for companies to put resources on trying to quantify and asses' risks in their supply chains. Nevertheless, this act often stain their supply chains efficiency when large global companies start marketing products in developing countries and therefore their profitability (Pagano 2008). This strain in profitability is a problem that needs to be solved.

Chopra & Meindl (2013) argue that many companies have built their success on their management and efficient supply chains, while other companies have failed because they were unsuccessful on building effective supply chains. As mentioned by Pagano (2008) does marketing in emerging markets often strain companies' profitability. The company's logistics become more complex and thus more difficult to control. The improving of supply chains is a constant work and (*ibid.*) therefore recommends continuous work to improve the efficiency and knowledge for supply chains. For this effort to be successful, it is important for companies to integrate their existing logistics chains with the chains built in the new markets of the developing countries. It is also important when a company enters a new market to have good knowledge of local laws and regulations (*ibid.*). If companies shall be successful in emerging markets more research need to be done.

Blanco (n.d) explains that further research needs to be done of the role of suppliers in emerging markets. There need to be guidelines how a company should act if the local supply of goods is not enough to fill the companies need (*ibid.*). The report from Accenture (2014) mentions that the companies with the better performing supply chains are more likely to generate greater growth than companies with less performing supply chains (*ibid.*). The report also argues that companies need to increase their knowledge of key areas in their chain so they can focus investments on these areas.

Jonsson *et al.* (2013) describes how IKEA´s went from decentralized planning to a more centralized planning to make purchasing, logistics and planning more efficient. However, the paper does not describe operational distribution for the supply chains for example transportation and storage. This lack of research is a problem that needs to be filled.

Since IKEA is a very large and successful company it is a good company to investigate deeper and in order to fill the knowledge gap that (Blanco n.d) defined. It is important to investigate wooden product supply chains in India so the potential of the rapid growth described by Sood (2014) is utilized. But also since 20% of the product cost in India comes from logistics compared to only 8% in the United States (Deman & Tuyishime, 2009., p.15), it is extra important to investigate the logistics costs for the growing market of wooden products in India to help decrease the logistic costs. When the costs for logistics are so much higher than some other countries there are great possibilities to decrease this cost.

1.3 Aim and delimitations

The study on IKEA was made to contribute with knowledge how a company can build up a high preforming supply chain and to visualize their supply chains in emerging markets. The report also investigate costs that occur when exporting planks and glue board to India and build a generic model that can be used. The model is a helpful tool when managers decide how to transport wooden products to emerging markets and high light the costs that is important to keep in mind.

The report is a case study in order to be able to investigate a certain chain more deeply. It expand the knowledge shared by (Jonsson *et al.*, 2013), to cover the operational part of the supply chains. The report specially contribute with knowledge how companies should handle their supply chains in emerging market where the local supply of wood are limited, like in India. The report is analysing the different parts of the supply chains and identifies key areas.

The aim of the study is to answering the following questions.

- How could a supply chain for wooden product to emerging markets be constructed?
- Evaluate the costs of producing planks and glue board and send it to emerging countries to be assembled and investigate what factors that influence the cost. Is it cheaper finished wooden products instead?
- Are there any supply chain risks that affect chains in India? For example, supply, process, control or demand risk?
- How are inventories handled in the investigated chain? Are there lead-times? Is the chain lean or agile?

The study is conducted between the sawmill in the start of the supply chain for glue board and planks and warehouse in the glue board and plank chain and then become compared with sending finished products. The main focus is to explain the glue board and plank chain. The report do not investigate the chain before sawmill or after the warehouse. The study investigate three products to see how the price are affected if material instead of finished products are sent.

The study give a good overview of the chain, therefore it do not go deeply into individual processes.

1.4 Outline

The outline of the study can be viewed below in Figure 1. The figure demonstrates how the different chapters interact with each other. The first chapter provides an introduction of the subject. Describing the problem and aim in the study as well as outing the problem in a broader picture. In the second chapter, relevant theories and a literature review is presented. In the third chapter, the empirical background of the study is presented, with a description of furnishing industry as well as India as a market and IKEA. The fourth chapter explains the method. The fifth chapter presents the results and analysis. The results are analysed regarding the theories and literature review and discussed in chapter six. Chapter seven is pinpointing the most important points of the study and presents the conclusions of the study. Proposals on further research are also made.

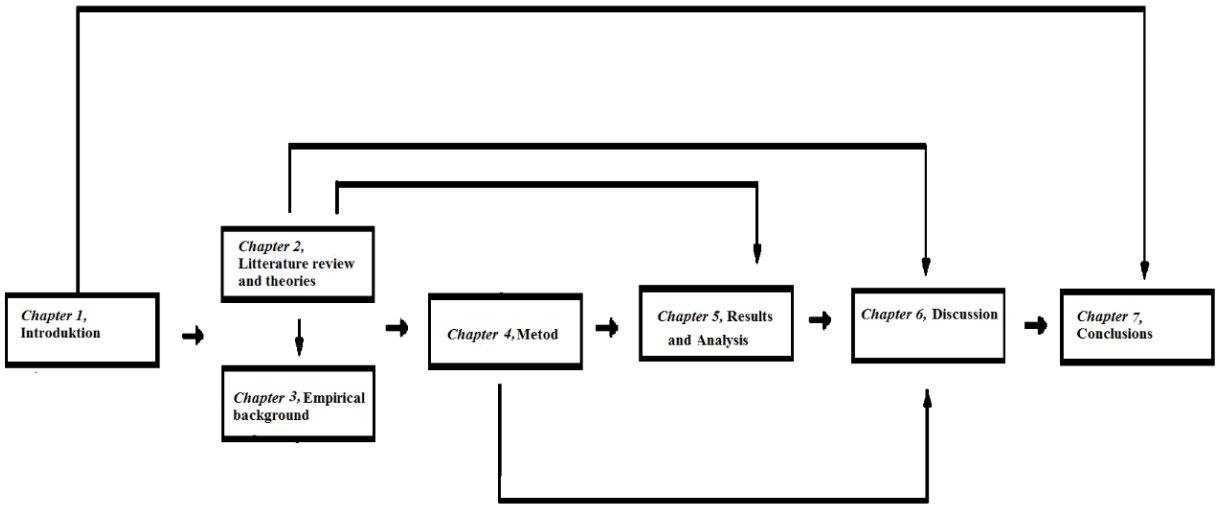

Figure 1. The outline of the study.

This is the end of the introduction, in the following chapter a literature review is presented together with a theoretical perspective.

2 Literature review and theoretical perspective

This chapter provide a literature review explaining the theories used in order to be able to reach the aim of the study. The first part of the chapter describes the concept Supply chain mapping and how it is used to reach the first aim of the study. After the mapping theory, I describe theories used to reach the second aim of the study which is to increase the knowledge of the costs in the chain and building a model. The third section contains theories about risks used to reach the third aim of the study. The last section of the chapter help answer the last aim of the study which is to describe the supply chain management and strategies. Theories about essential parts and phenomena within the chain as lead time, inventories, bullwhip effect and bottlenecks are also presented.

2.1 Supply chain mapping

There are two main forms of mapping in the analysis of operations, supply chain mapping which is used in this work, and process mapping (Gardner & Cooper, 2003). The supply chain mapping is external which means both the company investigated and external actors are analysed. Process mapping focus on internal processes of the company. Supply chain mapping has an overall perspective focusing more on volume, costs, and lead times. With supply chain mapping you also tries to understand how different companies interact with each other. The supply chain mapping has a strategic purpose aiming to help create a supply chain strategy to ensure the present strategy is fulfilled.

This work investigated supply chains therefore used supply chain mapping to understand how the whole chain works, and not only certain processes. This approach is more appropriate for addressing the aim of the study to understand the supply chains to India mainly from Europe for wooden products. Another aim of the study is to understand the risks, of the chain. By visualizing the chain, it was easier to identify and these risks and where they occur. Other reasons for mapping, based on Gardner & Cooper (2003) are mentioned below.

The reason Gardner & Cooper (2003) mentions is.

- Maps help companies in their supply chain strategy. It enhances the strategy planning process. The key to make a good map is to cooperate the strategic purpose with the map building process.
- Another reason why to map is that maps ease the distribution of information and help alert planners of constraints. This can lead to detection of bottlenecks.
- When a map is created, it can be used as a base to modify and redesign the supply chain. The map can show inefficiencies that are hard to find unless you have a good view of the supply chain. When the map is done, it helps to visualize problems which in turn help managers and others to find out ways to improve the chain. The improvements can for example be changed assemble locations and transports.
- Maps can help display dynamics in the supply chain. Like size of different flows and evaluate the relative importance of different parts of the chain.
- The process of building a map itself is good, since thoughts about the supply chain will emerge and new ideas to improve the chain might emerge.
- When building a map, the overall understanding about the supply chain will increase.
- Maps are also great tools to communicate between firms and functions inside of a company. However, the information that is distributed need to be carefully constructed so the map does not give away corporate secrets.

- A map can be a great tool to evaluate the progress of certain goals.
- The map can help educate members or individuals to get a grip of the chain.
- Finally, a good map can help improve supply chain management procedure since good documentation is a key to success. Improvements can easily be monitored and evaluated.

By using supply chain mapping companies' can improve efficiency in many different industries (Haartveit et al., 2010). In the forest products industries, these improvements mainly have come from increasing throughput and reduced inventories. The gains of supply chain mapping are greater if it is done wide, between companies in the supply chain according to *(ibid.)*.

2.2 Supply chain costs

To acquire knowledge of costs in wooden products supply chains to India, Mattsson's (2002) definitions of costs (described below) was used. The study investigates how the end price is affected if these costs are changing and how big proportions of the final cost they are.

There are several kinds of logistic costs that are important to consider. Some of these costs are transportation and handling, storage, delay and administrative costs (Mattsson, 2002). The costs mentioned by (*ibid*.) was investigated in this work to get more knowledge about them. These costs mainly belong to the following categories.

2.2.1 Transportation and handlings costs

These costs occur when the goods need to be moved and when the company need to acquire tools to move cargo. Examples of these costs are loading and unloading of vessels and trucks and transportation costs.

2.2.2 Storage costs

Storage costs can be divided into three groups, capital, storage and deprecation cost. Capital cost occurs when value is locked in inventory. The storage cost is can be storage house rent and deprecation cost that occurs if products become damaged or outdated and therefore lose value.

2.2.3 Delay and shortage cost

These costs occur when a needed product are not delivered in time because of for example low storages or delivery delays. This can lead to lost sales or goodwill, as well as delay fees and maybe costs for extra transports.

2.2.4 Administrative costs

When planning, and managing it occurs administrative costs. Other examples of costs are follow up costs, billing, accounting and the work cost to acquire needed material, machines and infrastructure.

2.2.5 Transactions costs

To further investigate transaction costs Schmalensee & Willig (1989) theory described below was used. This theory helped shed light how contact between IKEA and other actors are handled and how to evaluate the transaction costs.

Transactions cost occur when goods or services change owners (Schmalensee & Willig, 1989). The less transaction cost the better. (*Ibid*.) argues transaction costs occur because they help companies analyse the transaction. Companies and institutions need to analyse contracts and to develop their assets and therefore the costs occur.

These are the main costs investigated in this work.

2.3 Activity based costing

To make a model this report used cost modelling theory. More specific activity based costing theory that is explained below. The report for example investigate how the number of containers affect the m3 price, and how material cost affect production and taxation cost but also several different parameters.

Activity based costing is a calculation technique that translates costs into appropriate activities for example production or packaging. These activities can for example be quantified as packaging one product or packaging an entire truck load of products or something else, depending on what is fitting for the calculation (Andersson, 2008). This report investigates how different logistical solutions affect the price of three different products, but also container loads, therefore Activity based costing is a good theory to use.

In order to be able to use activity based costing the calculator need to identify the cost driver, which is the main subject that drives up cost. Cost drivers can be time, units and other factors. As mentioned before is activities of high importance in activity based costing, therefore it is important that the chosen activities are homogenous so the calculation becomes right. Andersson (2008) argues that it is important for the costs to be accounted for in the model as direct costs and that you distribute the indirect cost to the products or units see Figure 2, below.

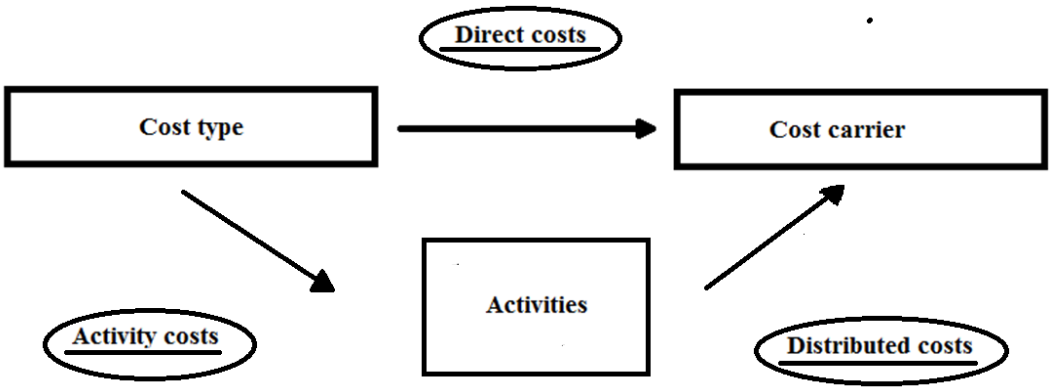

Figure 2. Overview of the ABC costing principle.

Activity based costing model is conducted in six steps (Andersson 2008., p. 71).

1. The first step is to decide the goal of the model, what situations it should be used for.
2. When the goals are defined you have to identify activities and chose those that are needed for the model.
3. The costs of the different activities alsoneed to be examined. If several activties use the same resource a ratio need to be created to divide the resources between the different activities.
4. When the costs and resources are dividied between the different activties the cost drivers need to be identified.

5. Build the model.
6. The final step is to create a system how to use the information and gather new data that might be needed.

Edwards (2008) mean that activity based costing is a useful tool for many organisations for calculating accurate costs for services and products. The approach also gives a deeper understanding about overhead costs and why they might occur. The method makes non-value processes and activities more visible so resources and improvements can be allocated. Finally activity based costing support several management techniques that improve performance (*ibid.*).

However there is also some weakness associated with activity based models. It can be difficult, costly and time consuming to collect the needed data and it may also be expensive to maintain an activity based costing systems. Even if the model is great for dividing overhead costs it can be hard to distribute the costs correct (Edwards, 2008).

2.4 Risks

Since one of this report´s aims are to better understand the risks in the chain the report describe different types of risks below. These are used to analyse the supply chain and see if similar risks exist in IKEA´s supply chain.

Christopher (2005., pp. 231-258) argues that risk is an important factor to analyse in supply chains and divides the risks in five different categories (*ibid.*). You can see the five different categories listed below.

- Supply risk, are the risk that the suppliers will not be able to deliver as planned, risks increase with few suppliers and global sourcing.
- Demand risk, are present if the demand is volatile and if there are bullwhip effect presence in the supply chain.
- Process risk, to asses this risk you need to understand how resilient the processes are. For example, where is the bottlenecks and if the manufacturers are manufacturing without any additional capacity or if they produce more than needed? The company also needs to know if the production is stable or not.
- Control risk, are there problematic policies and rules within the company that make the chain harder to manage? Is the control within the company so hard it is difficult to manage the chain in the best way?
- Environmental risk, are there external forces that can be hard to forecast that severely can damage the supply chain?

Trkman & McCormack (2009) expands the risk framework and argue there are two different types of external risks, continuous risks and discrete risk. Continuous risks are continuous and easier to predict. For example, if the prices of raw materials increase for a company the profit margin probably will decrease with a certain amount. Other continuous risks are changed interest rates, changes in consumer price index and gross domestic product. Discrete risks consist of events that are unlikely to occur but high impact if they do. Examples on discrete risks are natural disasters, terrorism or major political changes (*ibid.*). This work mainly focused on continuous risks and the first four risks mentioned by Christopher (2005., pp. 231-258).

2.4.1 Risks in emerging markets

Since this report investigates the supply chains risks in India, we also consider a specific aspect of such markets report by Deloitte (2013) describes key risk factors in emerging markets.

- Difficult and unclear regulations can make it challenging to understand the laws.
- Lacking infrastructure, many developing countries have lacking infrastructures that can increase logistics costs.
- Intellectual property theft, patents and product design could be stolen.
- Increased chance of natural disasters, earthquakes, tsunamis and other natural disasters can occur.
- Child labour, if used in the supply chain can damage the reputation of the company.

It's important to asses' supply chain resilience and knows potential risks so they can be analysed. The company needs to know the risks and be able to prioritize these risks (Deloitte, 2013). (*Ibid.*) list of risks was interesting to investigate in IKEA´s supply chain, this report mainly focused on the first two risks mentioned.

2.4.2 Handling risks

Four main management aspect needs to be considered when supply chain risk is handled (Juttner *et al.,* 2003, see Rao & Goldsby, 2009). This report investigated if IKEA handle risks similar to (*ibid.*) advices.

- The first step is to assess the different risks source that exists within the supply chain.
- Effects of this risk should then be assessed.
- The third step is to identify why these risks exists, or in other words identify what the risk drivers are.
- Finally the managers within the chain with this knowledge acquired should work to reduce or remove these risks

Managing risks has become more challenging due to greater uncertainty in demand and supply due to the globalization of markets (Christopher & Lee, 2004, see Rao & Goldsby, 2009). (*Ibid.*) also argue that risk management should become an integrated part of supply chain management.

2.5 Definition of supply chain management

In this work, Mattsson (1999, see Haartveit *et al.*, 2010) definition of a supply chain as a network of physical actors that handle cash, information and material flows was used. This definition is described below together with other definitions. The reason behind this decision is that the report investigates material flow between different actors in this work. Which is a physical flow just as (*ibid.*) is defining it.

The term supply chain has been used a lot but there has been unawareness of what the term actually means (Cooper *et al.*, 1997, see Haartveit *et al.*, 2010). The most common definition of a supply chain is as a network of actors which produce products and then deliver these to customers (Lee & Billington, 1992, see Haartveit *et al.*, 2010).

It is preferable to define a supply chain as a network of physical actors (Haartveit *et al.*, 2010). Supply chains is a physical network consisting of materials, information and cash flow.

Often when actors define their supply chain they define the chain to their immediately upstream suppliers and their immediately downstream customers (Lehtonen, 1999, see Haartveit *et al.*, 2010). However, all actors add value and contribute to the supply chain and thereby should be considered as a part of supply chains (Handfield & Nichols, 1999, see Haartveit *et al.*, 2010). Researchers should start their work to define what definition of supply chains they are going to use (Haartveit *et al.*, 2010).

Even if the supply chain is very complex with several actors, it is sometimes necessary to narrow the scope (Scott & Westbrook, 1991, see Haartveit *et al.*, 2010). By narrowing the scope relevant information is lost, but the researcher has to do a trade-off between a detailed analysis of a part of the supply chain or ability to manage complexity. The report have been narrowed between the sawmill and warehouse but the main focus between sawmill and Indian manufacturer in order to catch more details.

Supply chain management consists of management and control of information and material flow, but also of integration, coordination of material flows, services and production development (Mattsson, 1999, see Haartveit *et al.*, 2010). The objectives with supply chain management are to improve competitiveness and profitability. By building win-win situations where all actors get benefits (Persson, 1995, see Haartveit *et al.*, 2010). To achieve this, it is important to improve accessibility of information about sales and inventories (Macbeth & Ferguson, 1994, see Haartveit *et al.*, 2010). This report investigated how IKEA handle, inventories, information flows and lead times.

Haartveit argue that the performance of the supply chain is affected by all actors in the chain. Therefore, it's important to extend analysis of operations outside the targeted firm. This report focused on IKEA, suppliers and transporters.

2.6 Supply Chain Management

The supply chain management could be divided into three related elements. These are: The supply chain network structure, business processes and management. These three elements are investigated in this report to give a good overview of the chain and give more knowledge how IKEA´s supply chain is handled and are working. How they was used are described in the three text sections below. (Lambert & Cooper, 2000)

There are several factors that affect the supply chains structure. Examples on factors that affect are complexity of the product, availability to materials needed and number of suppliers available. The length of the chain also has an impact on the structure together with number of customers and suppliers. Most firms are participating in several supply chains; these chains have special attributes and therefore needs to be handled adjusted to the specific chain. Lambert & Cooper (2000) argue it is important that the company have knowledge about the members of the supply chain, how the structural dimensions are set up in the network and the different types of processes within the supply chain. This report investigated the length of the chain and how the material is transported from the sawmill to the warehouse.

Lambert & Cooper (2000) also argue that it is important companies manage functions so they are integrated with the supply chain. This is a factor that's important both in downstream and up stream flows. However, certain processes are sometimes disconnected from other processes leading to sporadic flows of information or no information at all between different

sectors over a certain time. In order for a chain to work at its best capacity there need to be a continuous information flow between different actors and processes. For this to be successful there need to be a good and quick system that is used within the chain. So, the company for example, are able to respond to fluctuating customers demand. With a good information system, the manufacturing could be adjusted and forecasted could become more accurate so the products needed are produced at the right time and not to early or too late. This report focused on how the integration is working between different actors, and how forecasting is made within the chain. The report also investigated if there are fluctuating demand, and if so how it is handled.

In the third element, management Lambert & Cooper (2000) argue that it is important to have joint planning for a well working and efficient supply chain and that it is important that different processes are integrated within the chain. It is also important that there is a good information flow between different part of the chain, so inventories and other aspects are handled well, and certain actors don't have too large or too small inventories. This work investigated how the communication is working between different actors.

2.6.1 Lean and agile chain

This report investigated how IKEA´s supply chains to India are constructed. Christopher (2011) are describing two main strategies, lean and this report investigate what type of chain IKEA operate.

A lean chain tries to minimize stock components that are being processed at the same time the chain is trying to finish and deliver the products exactly when it is needed (Christopher 2011., pp. 99-119). These chains are often built upon forecasted volumes. A more agile chain does not rely heavy on forecast and focus on demand and therefor need to be more responsive. Lean chains are usually used when there are big volumes and a steady demand which are easy to forecast. Agile chains are used in more unpredictable environment's where demand can vary greatly and fast deliveries are of great importance.

Many chains are a mix between agile and lean supply chains and can have a de-coupling point. See Figure 3, below.

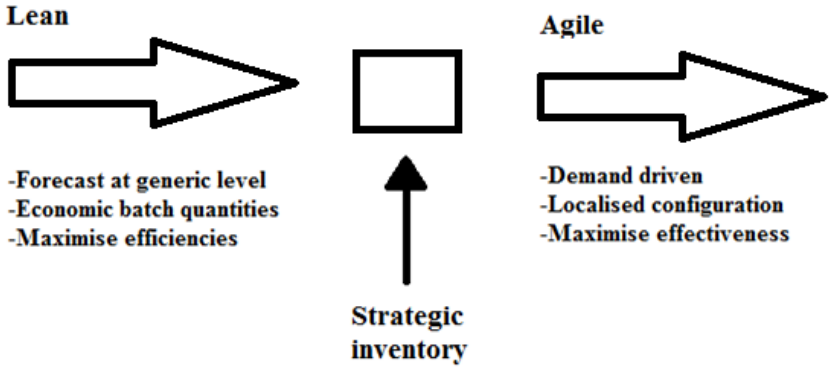

Figure 3. The supply chain is lean to a certain point where a strategic inventory is localized and then become agile. Inspired by (Christopher 2011., p. 102).

The supply chain can be lean and very cost effective early in a supply chain to then become agile and responsive closer to the customers thanks to the strategic inventory (Christopher, 2011). To understand if IKEA´s supply chain is lean, agile or maybe a mix was an important part of this work. Because it give a deeper understanding how the supply chains are working.

2.6.2 Lead time

Lead time is an important factor of mapping but also supply chain management. One of this study´s aim is to increase the knowledge in both these fields and therefore it is important to understand the definition of lead time.

The great majority of organizations face a similar problem, which is lead time. Customers have a maximum amount of time they are willing to wait for a product or service. If the time is longer than the customer is ready to wait, the customer is not interested. Therefore, many companies begin their production before the customers have set their order which is illustrated as the lead time gap in Figure 4, below (Christopher 2011., pp. 83-99). However, this report did not focus on the lead time gap between manufacturer and customers, but on the logistics lead time inside the supply chain.

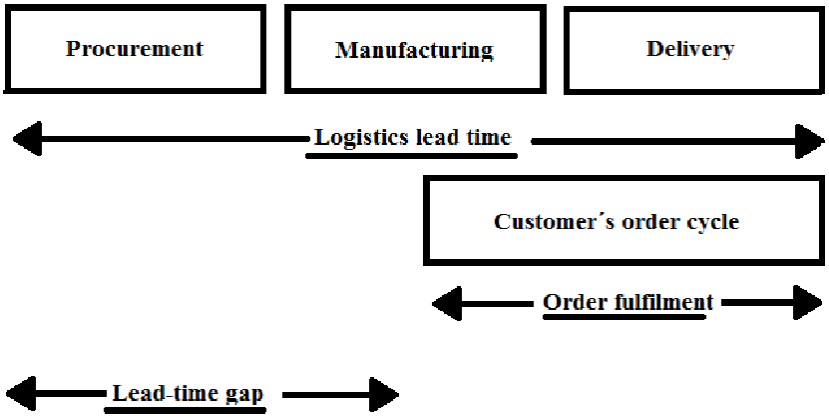

Figure 4. Lead time within supply chains. Inspired by (Christopher 2011., p. 84).

Krajewski & Ritzman (2013., pp. 66-71) writes about a statistic way to analyse supply chain risk in term of time, where you use 3 different estimates.

- Optimistic time (a) which is the regular time you achieve an activity.
- Most likely time (m) the fastest time possible required the complete the activity.
- The most pessimistic time (b) the longest time you can estimate the activity can take.
- Expected time (t_e) is the calculated time for the supply chain activity.

$$t_e = \frac{a + 4m + b}{6}$$

Calculate formula for supply chain time, to give a better understanding of the lead times in the supply chain.

2.6.3 Inventory

Since one aim of the study is to understand how inventories are handled in the chain it is important to read some theory why they exist and how they can be improved. It is also interesting to investigate if there is a correlation between the risks in the chain and the occurrence of inventories.

Inventory costs exist in supply chains because demand and supply are not in perfect correlation to each other which leads to a mismatch. This mismatch is often intended because companies might sell products in large lots, or need a security to minimize the risk of running

out on products because their customers expect responsiveness. Inventories can also allow organizations to utilize economies of scale by allowing them to order bigger deliveries (Chopra & Meindl, 2010., pp. 264-304).

When holding an inventory, you need to decide how frequent and in what quantities you should replace sold or moved units (Chopra & Meindl, 2010., pp. 264-304). To decide the optimal order size (EOQ) you need to know 4 different factors.

- The annual usage of the product (D).
- The ordering cost for deliveries, for example planning and transportation costs (S).
- Inventory carrying cost, which is calculated with the product value (C) and storage cost per year (h).
- EOQ is the optimal order size.

The formula for the calculation is seen below.

$$EOQ = \frac{\sqrt{(2 * D * S)}}{C * h}$$

Calculate formula for optimal storage level.

Inventory is a form of capital binding (Mattsson, 2002). This binding entails a cost of capital and therefore it should be minimized (Krajewski & Ritzman, 2013., pp. 309-325). The value locked in inventories should be compared to the return of the firm's stock equity and debt interest to receive the capital cost. (*Ibid.*) also argues that this capital cost usually is the largest cost for holding and inventory there are other costs for holding and inventory like tax, insurance and shrinkage. Companies need to pay more tax if they have high inventories and need to insure greater values, which lower the profit margin for the company. There can also be shrinkage of product value in inventories if the goods are not sold in time or goods are damaged in the inventory (*Ibid.*).

However, there are reasons to have large inventories according to Krajewski & Ritzman (2013) these can be viewed below.

- Customers might expect quick service and deliverables of products. In order to not lose customers, this can force suppliers to have large inventories so products always are available.
- High ordering costs could lead to larger orders and therefore greater inventories.
- In production, there are "Setup Costs" that occur when machines or labour need to be redirected when the company is going to produce something new. If this cost is high, it might be favourable to produce large batches which might result in large inventories.
- Inventories can be good to maximize utilization large, since less order changes creates less unproductive setups. Inventories also decrease the chance that the companies need to reschedule something which costs money and time. Last large inventories can help stabilize cyclic or seasoning fluctuations helping the production.
- Sometimes companies can save money on transporting large quantities and therefore build larger inventories.
- Enterprises can receive quantity discounts and therefor buy larger batches resulting in larger inventories.

The report used Krajewskis & Ritzman (2013) as well as Chopra & Meindl (2010) theories and formulas to explain why IKEA handle inventories the way they do.

2.6.4 Bullwhip

In order to understand why IKEA handle their inventories as they do it was interesting to investigate bullwhip effect to see if it exists, which is described below by Lee *et al.* (1997) in their supply chain. It is also was a process risk worth investigating.

The bullwhip effect is a common phenomenon that exists in many supply chains (Lee *et al.*, 1997). The further down in the supply chain the greater difference in order quantities occur. Even if the retailer's sales to customers only vary a little the orders in the beginning of the supply chain fluctuate greatly. The bullwhip effect hurt the efficiency of supply chains and therefore the profitability. (*Ibid.*) defines 4 main reasons why this bullwhip effect occurs.

- There can be lead times for actors to get the material or products. In order to plan they need to have a safety margin and order more than they actually believe they need.
- Companies can order in large batches to save money, but this lead to great order differences.
- There can be fluctuations in price that encourages actors to buy big batches from time to time and sometimes buy very small or no batches at all.
- Bullwhip effect could be a product of rationing and shortage gaming. For example, if there is a shortage of the needed product and the customers only receive 50% of what is ordered. Customers can exaggerate the need and then when the shortage ends cancel parts the order.

Forecast of needed quantities should be shared between actors in the chain and be encouraged to order smaller batches at a steady pace, by making ordering costs smaller and more even. To avoid shortage gaming suppliers should take on policies that give buyers a proportion of their usual orders when the offer is low (Lee *et al.*, 1997).

2.6.5 Bottlenecks

Since one aim of the study is to gather more knowledge how supply chains of wooden products should be constructed, it was essential to acknowledge bottlenecks.

In a report Lawrence *et al.* (1994, see Saeed n.d.) summarizes the 3 most common definition of a bottleneck of a resource.

- The demand exceeds the capacity in short term.
- The inventory is filled to the breaking point.
- Capacity utilization is max in a process.

There are two definitions of a bottleneck in a service process. (1) The bottleneck is the workstation with the longest process time or (2) the workstation with highest average utilization is the bottleneck (Krajewski & Ritzman, 2013., pp. 247-261). The slowest section in a chain limits the pace of all other parts in the chain (Christopher, 1998). The chain cannot process faster than its slowest link. If a company improve a "non-bottleneck" this will not lead to any improvement, since the only effect will be that the company get bigger build up at the bottleneck. It is important to try to make the bottleneck more efficient and process larger quantities so less set up time is needed. Non-bottlenecks on the other hand should focus on smaller batch sizes even if more set-ups are needed because it helps the bottleneck to move more smoothly (Christopher, 1998).

Krajewski & Ritzman (2013., pp. 247-261) mentions the "Theory of constraints" which base concept is to maximize efficiency in bottlenecks, and mentions 7 key principles.

- *The focus is to balance the flow to the bottleneck not balancing capacity.*
- *Maximizing the efficiency and output on every part of the chain might not increase the output of the entire system.*
- *If one hour is lost or gained in the bottleneck one entire hour is lost or gained for the entire chain.*
- *The only place where inventory is needed is in front of the bottleneck, inventory in other parts of the chain should be avoided.*
- *Information, resources and materials should only be released in the chain in the pace the bottleneck needs it.*
- *It is not possible to improve the output or the financial result of the entire system by improving a non-bottleneck.*
- *All investments should consider the entire chains overall output, costs and inventory.*

Krajewski & Ritzman (2013., pp. 247-261) argues that you first need to identify the bottleneck to be able to use the 7 key principles and then maximize utilization of the bottleneck. All other processes should adapt to the bottleneck. It is important to reassess bottlenecks since improvements of the bottleneck can move the bottleneck to another process of the chain. In service processes the bottleneck is the process with the longest processing time. It is also important to have in mind that the bottleneck can be floating, which means it might move between different processes as time pass.

Lawrence *et al.* (1994) Christopher´s (1998) and Krajewski & Ritzman´s (2013., pp. 247-261) knowledge are used to try to figure out the most essential parts of the supply chain to India, and thereby identify where resources should be allocated.

2.7 Theoretical model used to answer research questions

The report use Gardner & Cooper (2003) instructions of supply chain mapping as a base for the study. Then I locate the costs described by Mattsson (2002) and Schmalensee & Willig (1989) and use these costs to do an activity based costing model described by Andersson (2008) and Edwards (2008).

To be able to answer the research question regarding risk the report use the different risks categories mentioned by Christopher (2005) in to account. When the risks categories are clear, they are defined as internal or external and continuous and discrete risks according to Trkman & McCormack (2009) definition. The report also investigates risks in emerging markets and highlights these, Deloitte (2013) list of potential risks to see if they exist in the investigated chain was used. Then the report use the authors that Rao & Goldsby (2009) refers to see if IKEA handle the risks after their recommendations.

When the potential risks have been handled, the report investigates how the chain is managed to be able to answer the last research question which is how different factors within the supply chain are handled. To do this the authors mentioned by Haartveit *et al.* (2010) was used to help define the meaning of supply chain management. When the definition is set, the report use Lambert & Copper (2010) categories, to divide different types of management and how supply chains should be operated. The report then investigates if the chain is handled lean or agile as described by Christopher (2011). When the overall management has been described the report investigates lead time described by Christopher (2011) and then uses Krajewski &

Ritzman (2013) formula to analyse the lead time. After the lead times are explored the inventory described by Chopra & Meindl (2010) is investigated. The report also investigates if the reasons behind inventory fit Krajewski & Ritzman (2013) explanation why companies hold inventories. I also investigate if bullwhip effect described by Lee *et al.* (1997) exists within the chain. Finally, the report investigates if there are any bottlenecks in the chain as described by Lawrence *et al.* (1994), Christopher (1998) and Krajewski & Ritzman (2013).See Table 1 below.

Table 1. Description of theoretical framework

Category/ theory	**Authors used**
Main theories used for research questions 1 and 2	
Supply chain mapping	(Gardner & Cooper, 2003)
Costs	(Mattsson, 2002) and (Schmalensee &Willig, 1989)
Activity based costing	(Andersson, 2008) and (Edwards, 2008).
Main theories used for research question 3	
Risks	(Christopher, 2005)
Internal, external and continuous risks	(Trkman & McCormack, 2004)
Risks in emerging markets	(Deloitte, 2013)
Handling of risks	(Rao & Goldsby, 2009)
Main theories used for research question 4	
Definition of supply chain	(Haartveit *et al.*, 2010)
Supply chain management	(Lambert & Cooper, 2000)
What define a lean or agile chain?	(Christopher, 2011)
Lead time	(Christopher, 2011)
How to analyse lead time	(Krajewski & Ritzman, 2013)
Inventory, and why they exist	(Chopra & Meindl, 2010) and (Krajewski & Ritzmam, 2013)
Bullwhip effect	(Lee *et al.,* 1997)
Definition of bottlenecks	(Lawrence et al., 1994), (Christopher, 1998) and (Krajewski & Ritzaman, 2013).

This is the end of the literature review, in the following chapter the report present the empirical background of the study.

3 Empirical background

This chapter gives an empirical background of the study. First the global furniture sector is described to bring the reader further knowledge in the business environment IKEA is operating in. Then supply chains in emerging markets and India are described. A brief overview of the infrastructure and taxation in India is presented. When India and the market conditions there have been cleared, a brief overview of IKEA and how the company manage their supply chains are described.

In the last part of the chapter a short explanation about different shipment types and cargo type is presented. There is also an explanation about SOLAS and BAF which is two important shipment definitions in this work.

3.1 Global furniture sector

The furniture business is a large market in the world and in year 2000 it was the greatest low tech industry in the world (Kaplinsky *et al.*, 2003), with Italy, Canada, China, Mexico and Poland as the biggest exporters. The total world gross export worth was 57, 388 USS millions (*ibid.*, p. 2). The industry is also fast growing and between 1995 and 2000 the global trade increased by 36% (*ibid.*, p. 1). Furniture industry has historically been labour intensive, but new techniques have allowed mass production, for example of parts ready to be assembled after transport. This growth combined with the new techniques has increased the competition within the industry and the wood furniture prices have fallen.

The value chain of the general wood furniture business starts with forestry that grows the lumber and then sawmills and furniture factories further refined the product (Kaplinsky *et al.*, 2003). The furnitures are then sent over to the buyers that distribute it to the end customers. For full view of the chain see Figure 5, below.

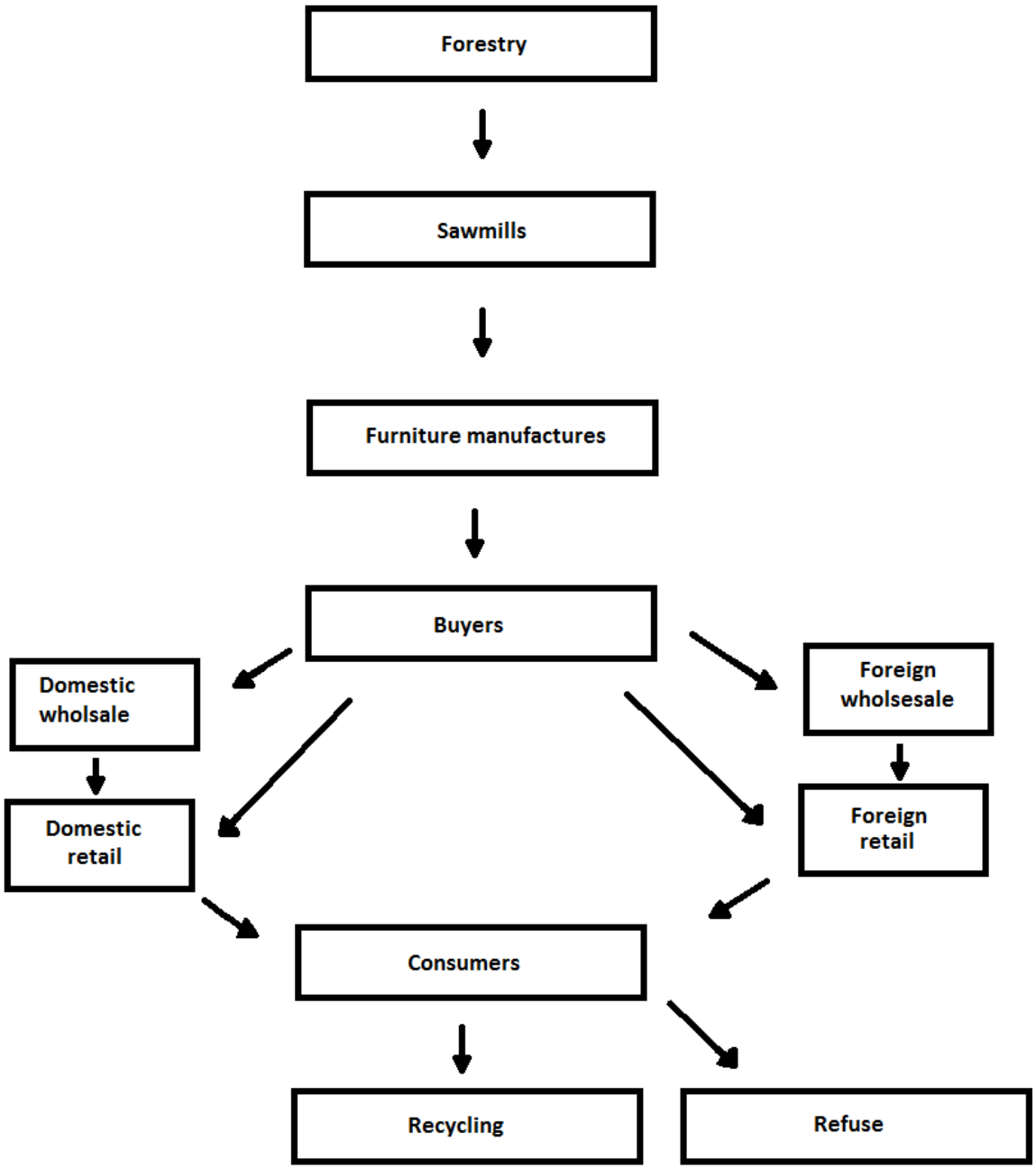

Figure 5. Illustration of wood furniture value chain, inspired by (Kaplinsky et al., 2003, pp. 6).

The figure shows how the chain first start at the forest and how the timber is then refined at the sawmill. The material is then sent to the furniture manufacturers that sell products to buyers that distribute the finished products to either foreign or domestic wholesale. The chain is then divided after the consumers, which either recycle the products or refuse them.

Now when the global furniture sector has been described the supply chains in emerging markets are explained below.

3.2 Supply chains in emerging markets

It is good to understand other emerging markets where more research has been done, before going deep into IKEA's glue board and plank supply chains in India. There are many global organizations that try to expand to new emerging markets (Accenture, 2014). Blanco (n.d)

define an emerging market as a country where people earn low to middle income per capita, which are less than in developed countries. In emerging markets there live more people compared to developed countries (*ibid.*). According to Accenture (2014) many of these emerging markets are located in Asia. One study made by (*ibid.*) mentions that only in China more companies experience greater growth than India.

Nevertheless, there are several obstacles that need to be overcome in order to succeed in emerging markets. For example, the logistical infrastructure like roads and railroads can be underdeveloped, making transportation of goods and people difficult, especially over different country borders (PWC, 2014). Government's sometimes try to attract businesses to especially weak and poor areas with incentives in order to overcome infrastructure limitations. IT infrastructure can also be limited since there often is a wide quality gap on the IT systems used. Important data can often be split between multiply systems, be manually collected or not collected at all.

The income differences within emerging markets are usually great and together with variations of these social situations and political interference this can create safety problems for companies being active in the region (PWC, 2014). Another obstacle can be lack of skilled labours which can make recruitment and management harder.

To succeed in emerging markets companies, need to have many different factors in mind. One of these factors is affordability (Blanco, n.d.). When people earn less income than in developed countries the products must become cheaper so the consumer can buy the product. To achieve this low price, the company need to adapt the supply chain to the market, (*ibid.*) mentions three major strategies that can be used. Of which the two first strategies was investigated in this report.

- Produce the entire product in another country and send it to the market.
- Send components to the market where they are assembled and then sold.
- Local produce and assembly in the market.

3.2.1 Supply Chains in India

Logistics cost is a larger proportion of the total cost in India compared to many other countries. In India on average logistics cost is 20% of total cost of a product, compared to 10% in China and 8% in the United States. When the logistic cost is split up, 40% of it is transportation, 26% is warehousing, packaging and losses, 24% is inventory and 10% order processing and administration (Sanyal 2006 see Deman & Tuyishime 2009., pp 15-17). See Figure 6, below.

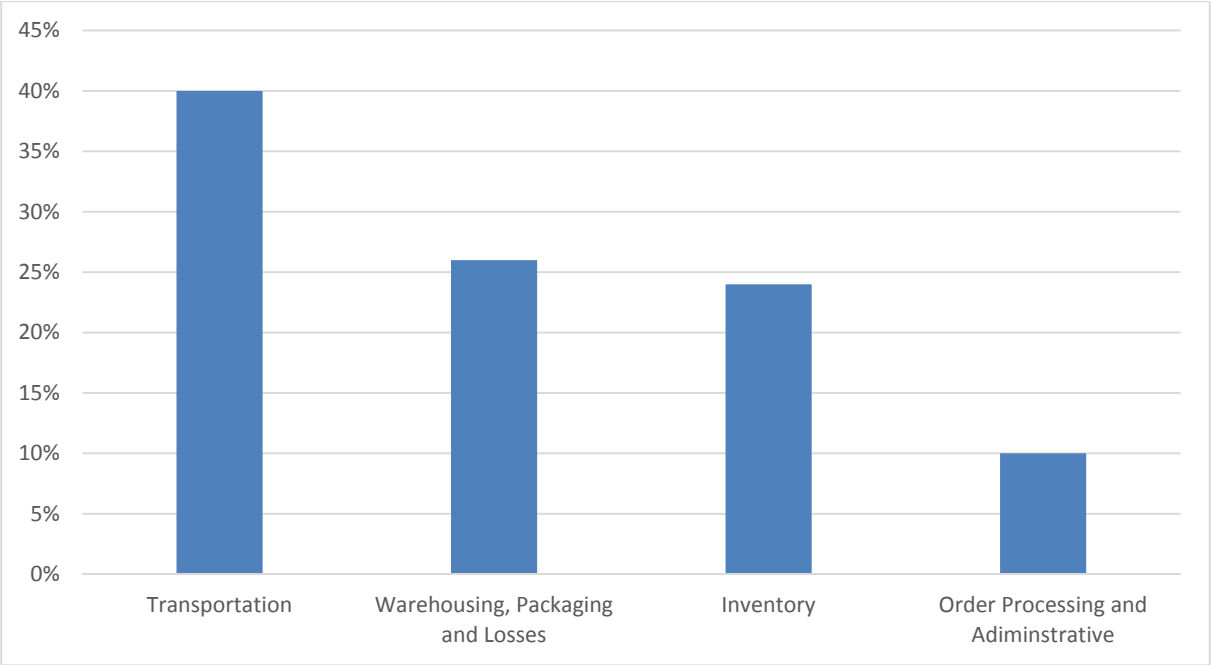

Figure 6. Percent contribution of logistics cost, a presentation of data from (Sanyal 2006 see Deman & Tuyishime, 2009, pp 17).

Transportation is the largest logistic cost in India followed by *warehousing, packaging and losses* that is nearly on the same level as *inventory*. The smallest cost is the *order processing and administration cost.*

The next chapter give an explanation why the logistical costs are higher in India and what kind of environment IKEA need to operate in in their future chains to India.

3.3 India´s infrastructure

As mentioned India is an emerging market. The country has lacking infrastructure and limitations of management technologies (Singh, n.d.). This section gives a description of India´s infrastructure to give a better understanding of the logistical environment in India. The section starts with a brief overview over the ports, marine transport and the road network in India. An overview of the railway network is also described.

3.3.1 Ports and marine transport

The ports in India are under a heavy burden, since 1991 trade barriers gradually have been lifted which have resulted in a boom of sea trade. There are 12 major ports and 180 minor (Kilgore *et al.*, 2007., p 17). The two biggest ports handle most of the trade by sea. This bad utilization of existing ports makes debarking very slowly, on average it takes 3.5 days to debark (*ibid.*, p.38). Many of the minor ports have infrastructure problems. Not even the major Indian ports are designed to take bigger containerships (6000 TEU) (*ibid.*, p.38). These bigger containerships take up 25% of the world trade (*ibid.*, p.38). (Ibid.) argue that it is hard for manufacturer's that want to export to India instead of producing in the country. The Indian ports are also poorly ranked compared to other countries port in the region due lacking equipment, storage places and long lead times (Deman & Tuyishime, 2009).

Even the communication infrastructure is also lacking in Indian ports. This lead to increased paperwork and customs clearance take six days on average in India compared to one/ two days for example in Belgium (Deman & Tuyishime, 2009).

3.3.2 Road network and transportation

India has experienced a growing trade on the global market. However, infrastructure like roads has not been able to expand in the same pace (Singh, n.d.). These flaws in the infrastructure have hurt India's competitiveness. 80% of India's roads are rural (*ibid.,* p. 53), while only around 6,4% of the roads are highways (*ibid,.* p. 53). Some of these highways have the average speed is only 30 km per hour due the low quality of the roads (*ibid.,* p. 54). This lack of roads has resulted in limited access to the interior mainland (Singh n.d.). Among all roads 50% are paved and the road network has reached max capacity (Deman & Tuyishime 2009., p. 18). The highways capacity is around 15 000 cars a day but on average the Indian highways records around 39 000 cars a day (*ibid.*, p. 18. This overcrowding has made some cities forbid transportation trucks on certain hours of the day, making it even harder for companies to transport their goods. The Indian freight industry is fragmented and divided between transporters, agents and small operations. The freight rates in India are low, but have low service quality, bad reliability and bad transit times. The road safety is large and the fatality rates are around 10 times as high compared to developed economies (*ibid.*, p. 20). Truck transports are responsible for a disproportional large share of these fatalities.

3.3.3 Railways network and transportation

The Indian railway network is the second largest railway network in the world and is over 110 000 km long and have nearly 7000 stations (Deman & Tuyishime, 2009., p. 21). Container Corporation of India (CONCOR) is a company which has monopoly on moving containers on the railway network (Mitra 2006). However, CONCOR is not able to handle the increasing volumes that need to be transported and do not have the funding to invest in needed infrastructure. The lack of infrastructure together with monopoly prices results in high transactions costs.

The Indian railroad efficiency is far below multiply developed countries. The speed is lower, capacity is less, loading capacity lower and the wagons carries more deadweight compared (Vaidyanathan 2007).

3.4 Wood and wood products in India

In this section the forest situation in India are described, together with the trade, wooden markets and regulations and taxes are described.

3.4.1 Forest situation India

India´s government made a goal in 1952 to have forest area cowering one third of the country. However, India has not been able to reach this goal due to human and animal pressure. There live 1.2 billion people in India and the country have a large goat and cattle population that graze and thereby consume forest resources. In 2011, 22% of India's landmass was covered by forest (Sood, 2014., p. 2). A large portion of these forest areas are in the mountain areas above 4000 meter above the sea, making it hard to access (*ibid.,* p.2).

During the last 30 years, there have been two policies that have had great effect on forestry and the wood industry. In 1988 a National Forest Policy stated that the forest primarily should meet the India´s tribal people, small industries and scheduled castes. The policy also stated that substitutes for wood were preferable. The timber production slowed down and investing incentives for large scale harvesting on woods was decreased. Instead India began importing wood for the country's needs. In 1997 a new major change occurred when the Supreme High Court stated that only the central government was allowed to approve use of forest land for

any non-forestry purposes. This stopped some states from reserving certain forest for harvesting and many sawmills were forced to close resulting in even lower timber production (Sood, 2014).

In 2011 the amount of wood harvested in India was 3,2 million cubic meters (Sood, 2014., p. 2). Most of the timber was produced outside forests, in plantations, farms or private lands. According to unofficial estimate around 44 million cubic meters of timber outside forests could be harvested in 2011 (*Ibid.,* p. 2).

3.4.2 Trade with forest products

For a long time, experts viewed India as a good potential market for wood, but for a long time the Indian industries used substitutes like steel and concrete. However, in 2003 the imports began to rise and increased from 630 million USD to 2.7 billion in 2011 (Sood, 2014., p. 3). Most of these have been logs but the percentage have dropped from 90% to 74% thanks to lower tariffs and increased modernization among the importers (*ibid.,* p. 1). The great part of logs can also be explained by an old ban to import value added wood products. The three main export countries for logs are Malaysia, Myanmar and New Zeeland (*ibid.*). (*Ibid.*) mean the growing need of wood can be explained by rising incomes and housebuilding.

3.4.3 Market and market access

Historically wood processing has been mostly made in small-scale workshops by a single craftsman. However larger firms are increasing both in terms of number and production. There are no quantitative restrictions for importing wood and wood products. However sawn products need to be dried in a certain temperature before export to India in order to protect the country against foreign species. Wood like glue board and particleboard are exempted from these restrictions (Sood, 2014).

3.4.4 Regulations and taxes

The tax system in India is really complex and hard to get a grip on (Singh, n.d.). Tax laws and fees vary from state to state since all levels of government in India have the authority to change taxes on products and services. There are federal taxes, state taxes and even city taxes.

3.5 IKEA

In this section IKEA and their supply chains are described.

3.5.1 IKEA as a company

This study is made in collaboration with IKEA therefore it is important when reading the report to understand what type of company IKEA is and how they operate. The company is a Swedish furniture retailer (IKEA, n.d.). IKEA was founded in the southern Sweden in the landscape Småland, by Ingvar Kamprad. Today the company have around 340 furniture stores IKEA (2016., p. 8) located in North America, Europe, Asia and Australia. The biggest market is Europe with 69% of the total sales, followed by America with 18%, Asia and Australia 9% and Russia 4% (*ibid.,* p. 41). IKEA´s vision is "To *create a better everyday life for the many people"* (*ibid.,* p. 3). To fulfil this vision IKEA strives to offer good products for an affordable price. The company´s goal is to be the world's leading home furnishing retailer. This research project has been carried out with the support and collaboration of IKEA group, IKEA Industry and Range Strategy Product Development Supply Chain (IKEA, n.d.).

To make IKEA able to reach out to more people IKEA have taken the decision to expand to India and open warehouses in the country. According to an IKEA employees at IKEA's headquarter a large portion of IKEA´s products have wooden components in them. Logistics costs are a significant part of the end cost for IKEA´s furnitures. Therefore, the employee argued of the importance to have good knowledge about different logistical solutions and the supply chains.

If IKEA in the future shall be able to offer low prices the company have to keep working on increasing efficiency and improve the logistical chains. The company also has a goal to keep growing and reach out to more people (IKEA, 2014). The goal for the expansion for India is to open the first warehouse in 2017 according to an IKEA employee at the headquarter.

3.5.2 Supply Chain management IKEA

In the old planning system, the IKEA regions and stores had a lot of power and freedom in planning replenishment orders. However, the system was not perfect and shortages sometimes occurred, which left some regions to overestimate their demand to secure their deliveries. This led to some regions having shortages of certain products while others had large inventories (Jonsson *et al.,* 2013).

In order to overcome these problems, IKEA implemented a new strategy for planning and replacement. The Company centralized the planning. The planners should work with long term purchasing, marketing and logistic strategies. It is beneficial for companies that sell low cost products to have a centralized planning function and vertical integration. Enterprises with rapid growth also usually get benefits of centralized planning. All these terms are fulfilled by IKEA, which have experienced a rapid growth and sell low costs products. Jonsson *et al.* (2013) identified four positive effects of the centralization for IKEA. The standardisation increased and coordination and integration between different functions within IKEA improved. The centralization also allowed specialized knowledge within the company (Jonsson *et al.,* 2013).

3.6 Shipments

In this section different shipping alternatives and conditions are described.

3.6.1 Shipment types

Wood defines three general types of transport ships, private fleets, tramps and liner carriers used in the shipping industry (Wood *et al.,* 2002). Private fleets are owned by the manufacturer and merchants to transport their own goods. Lumber and oil companies are types of companies that often own their ships. Tramps are ships that do not have a fixed schedule, these go between different ports and companies can charter these vessels or lease them.

However, most companies do not need to own ships themselves since they do not have full shiploads that need to be transported. These volumes are often more valuable per unit weight than cargo on tramps. The companies that have smaller loads can choose liner services. Liner services are ships that have fixed schedules between ports (Wood *et al.,* 2002). IKEA's goods will most likely be transported on liner services when the chain begins operating.

3.6.2 Cargo Types

There are two main types of cargo bulk and container cargo, this work mainly focused on container cargo. Bulk is cargo that is transported loose. An example of cargo that is often

transported in bulk is ores, petroleum, grain, logs and coal. Container cargo are often transported on liner vessels, but can also be transported on other types of vessel. The containers have standardized dimensions and are an important way to ship goods between Asia and Europe (Wood *et al.,* 2002). From my own experience as a charter I know that smaller cargo sizes and more valuable units often are shipped in containers.

3.6.3 Solas

In 2015 The International Maritime Organization changed the Safety of Life at Sea Convention (SOLAS). In order to be allowed to ship packed containers for exporting purpose, the shipper become responsible to verify the containers weight. There are two ways to get the verification, either the container needs to be weighted after it is packed, or all individual parts need to be weighted. Shippers are not allowed to estimate the weight, and the weight must be investigated by the party that load the vessel (World Shipping Council, 2015). In order to have the containers weighted the shipper may have to pay a certain fee which in this case affect IKEA.

3.6.4 Bunker (BAF)

The shipping industry is a very energy consuming industry. Sometimes the fuel cost for certain vessels can be high as 50% of the transportation cost. However, the fuel cost has seen serious fluctuations in price. These fluctuations made it hard for carriers to offer it is customers' stable freight rates. In order to solve these problem carriers use bunker (BAF) a cost separated from the basic freight cost. Depending on the fuel cost the bunker price can increase of decrease the transportation cost (Yuksekbas, 2012).

3.6.5 Shipping strategies and terms used in this work

This work investigated the costs of liner services and container cargo. The two costs (BAF) and SOLAS were also investigated. It's preferable to investigate container cargo since this is a common way to transport high value units like furniture, glue board and planks.

4 Method

This chapter give a description on the method the study was conducted with, the way data was collected and analysed. There is also an explanation of the two different chains compared, the finished product chain (baseline) and the plank and glue board chain. Ethical considerations are also explained. In the end, methods used in this work are explained together with the model used to calculate and analyse costs for the glue board and plank chan. There is an explanation how to analyse numerical data as well as assumptions and limitations of my data.

4.1 General method

The report follows Merriam (1994., pp.73-79) too early in the work a literature research of earlier literature about relevant articles. (*Ibid.*) argued that all research should proceed or make attention of earlier made research and then help to expand the knowledge in the field. Another benefit of making a literature review is that older investigations can help formulate study questions that need to answered, and fitting methods that can be used (*Ibid.*). I did follow the advice and did a literature review. There were several authors that argued more research needed to be done about logistics in emerging markets and logistics chains containing wooden products. Therefore, the decision to write about IKEA´s supply chains of wooden products to India was made.

When the subject of the thesis was decided the method of the research needed to be chosen. A case study described by Yin (2003., pp. 1-33) seemed to be a fitting research method when looking at a certain case, for this work the case was IKEA´s supply chains of wooden products to India. In the study there are several different kinds of chains that was reviewed, a glue board/ plank chain and a finished product chain.

The aim with case studies is to collect data, present it and then analyse it in a good way (Yin, 2003., pp. 1-33). Case studies can be used to investigate many different subjects, for example operational and managerial processer. (*Ibid.*) mentions five important components when creating a research case.

- Decide the questions that should be answered and studied and the method that should be used. It's also important to explain why the research needs to be done.
- When the questions above are answered a proposition of the scope of the study should be made.
- Third it's important to decide the "unit of analysis" when deciding this unit, it's important to keep in mind the research questions that should be answered.
- The fourth point is to linkage the data of the analysis to the proposition in a logic way.
- Finally, it should be defined how the findings in the study should be interpreted.

There are two main different ways of conducting research, deductive logic and inductive reasoning (Leedy, 2010). In deductive reasoning the researcher lists a number of premises how something works and then forms a conclusion from these premises (*ibid.*). With deductive reasoning the researcher do not need to observe the reality (Bibblansvarar n.d.). Deductive reasoning is a great tool to make research hypotheses and testing them. Inductive

reasoning does not begin with a statement of what's true and not, instead the research begins with an observation (Leedy, 2010).

Robson (2002., pp. 1-10) defines two different types of research design which decide how you gather the data, flexible and fixed research design. Fixed research design is often surveys or scientific experiments where the process of the experiment and research is strictly fixed and usually handle quantitative data. Flexible research design is often qualitative; these studies are not strictly planned. Usually the method evolves through the process. (*Ibid.*) mean that you can mix fixed and flexible design by using "mixed methods" which use both methods.

The report is a deductive case study with a flexible design. Data was not collected from observing the glue board/ plank chains or the baseline chain (finished product chain) because the glue board/ plank chain was under construction and the baseline chain IKEA already had good knowledge about therefore a deductive case study was fitting. The data was quantitative and qualitative, and therefore the flexible design described by Robson (2002) was a good strategy. Yin (2003., pp. 1-33) guide how to make a case study is followed and inspiration was found for the research questions from the literature review. After the research questions were defined a proposition was written and I received feedback from supervisors and other students.

The unit of analysis in the work is three different products in this work they are named X, Y and Z to see if the finished product chain or glue board/ plank chain was most cost efficient. For each of the products cost per unit, cost per full container and some other factors were measured. Containers with glue board and planks where also used as a unit of analysis, in order to compare the planks and glue board to gain deeper understanding of material chains in emerging markets.

Yin (2003) argues that it is hard to make big conclusions about the reality from case studies since they are so focused on just one case. In this study only three products was investigated and therefore it was hard to make statements that is true for all products that companies might sell in India.

Case studies can be affected by the researcher personal opinions (Riley, 1963, see Merriam, 1994., pp. 45-49). Yin (2003) mentions some internal problems with case studies of validity, incorrect assumptions can be made. Another problem is inferences; which occur when the researcher cannot study a subject directly and instead need to rely on documents and interviews. These kinds of sources might not give the correct picture. It is important to make many case studies in similar fields (Yin, 2003., pp. 33-39). I am an inexperienced researcher and as Merriam (1994) described it is possible that I have made wrong assumptions and analyses. The study also use a lot of documents and therefore it is important to do more research in the field as Yin (2003) argued.

4.2 Data and data collection

For the data collection both qualitative and quantitate data was used, the mix of these two can be explained by the flexible design of the study. Qualitative data from interviews was used to understand the first, third and last research question to better understand the glue board and plank supply chain. In order to understand how the chains was constructed and managed but also what kinds of risks that existed. The qualitative data allowed a deeper understanding how the supply chain operated, which was an aim for the study.

Quantitative data sent by mail was used to highlight the different types of costs that exist in the chains. I received qualitative data for the glue board/ plank chains as well as the finished product chain (baseline chain). For the glue board and plank chain I received cost from many actors in the chain and put it together. For the baseline chain I received a complete cost break down from supplier to warehouse. Quantitative data was a good way to get a better understanding of the costs in the chains. It allowed a good overview, which was one of the studies aims without getting in to small and unnecessary details.

The interviews were to collect qualitative data for mainly the glue board and plank chains Granot et al. (2012) and Leech (2002) interview guides was followed, described under the heading "Interview guide" below. I began the interviews with trying to understand the history of the participant and then trying to gather information about relevant questions. In the beginning broad questions and letting the participant answer, and then make follow-up questions about how the subject viewed the data or the situation.

I started to contact employees within IKEA asking them if they wanted to participate and if they or knew people that could contribute to the study. The persons I managed to get in contact with were.

- -Business developer for ocean.
- -Transport developer for transport.
- -Project leader India.
- -Project leader.
- -Operation manager India.
- -Solution Owner - Supply Chain Optimization & Simulation Platform.

There were also other people involved other than the persons mentioned above that provided data by email or attending meetings.

4.2.1 Interview guide

Granot et al. (2012) mentions an interview strategy he calls the three-stage interview. In the first stage the interviewer should understand the history of the interview participant. The second stage focus is the subject's experiences on the topic. The interviewer should not focus on the subject's opinions. A good way for the researcher to get a picture of the participant's experiences is to ask them to reconstruct a day of the context that is investigated.

In the last the interviewer should ask the participant what they described experiences means for the individual to gain deeper insight. It is also important to make participants feel more related to the topic of the study. Granot et al. (2012) argue it is important to set a certain date and time for the interview. Because people are often and need time to plan the interviews that usually took around 30-40 minutes.

The interviews started by welcoming and making the participants feel comfort by telling them the reasons behind the research and handled them as experts in their field. The interviews begun with easy questions about their history and later questions about the supply chain where asked. I did adjust the questions to the person asking questions in their field. I did for example ask how they worked and interacted with transport companies to better understand the chain. I also asked about potential risks and how they managed these risks. The interview subjects also received questions about how the chain was managed in order to understand if the chain was agile or lean.

It is important to make the participant feel ease and the interviewer should act like they have little knowledge about the subject (Leech, 2002). This is important so the subject do not leave out parts that he or she assumes the interviewer already knows. (Ibid.) also mentions that participants might be nervous of attending in the interview so it is important to act friendly and curious and use common. If the participant should feel ease its important that they know the research's cause and therefor it is a good idea to give a brief description of the study and why the interview is important.

4.3 Analysis

When making a case analysis there are three general strategies that are good to use (Yin 2003., pp. 109-138). The most usual strategy is to rely on theoretical propositions. The proposition should be built on earlier studies. Another good tool to use is rival theories and explanations. The third general tool is to build a case description which explains in what environment the study was made and other important factors.

In this work all three tools was used to compare the different chains, the work use theoretical works already done to be compared to see if the studies result showed any difference to earlier research done. The work also use supply chain mapping and other types of descriptions to try visualize the result.

4.3.1 Explanation of chains compared in the work

In the figure below the two chains compared in this work is explained. First of is the glue board and plank chain, in this chain glue board and planks are produced in Poland and then sent by truck and boat to India. In India the material was going to be assembled to finished products and then sent by truck to a distribution centre and finally to a warehouse.

The "Baseline" chain was not the focus in this study, but the costs of this chain was compared with the glue board and plank chain. This chain started with the finished product cost at the supplier, all three products had different suppliers, and these suppliers were located outside India. Then the finished products were sent by boat and truck to India where the products were distributed to a warehouse, see the two chains in Figure 7, below.

The two different chains were investigated to see on how they would affect the price for three different products, X, Y and Z. In this work the name of the products are not published do company confidentiality.

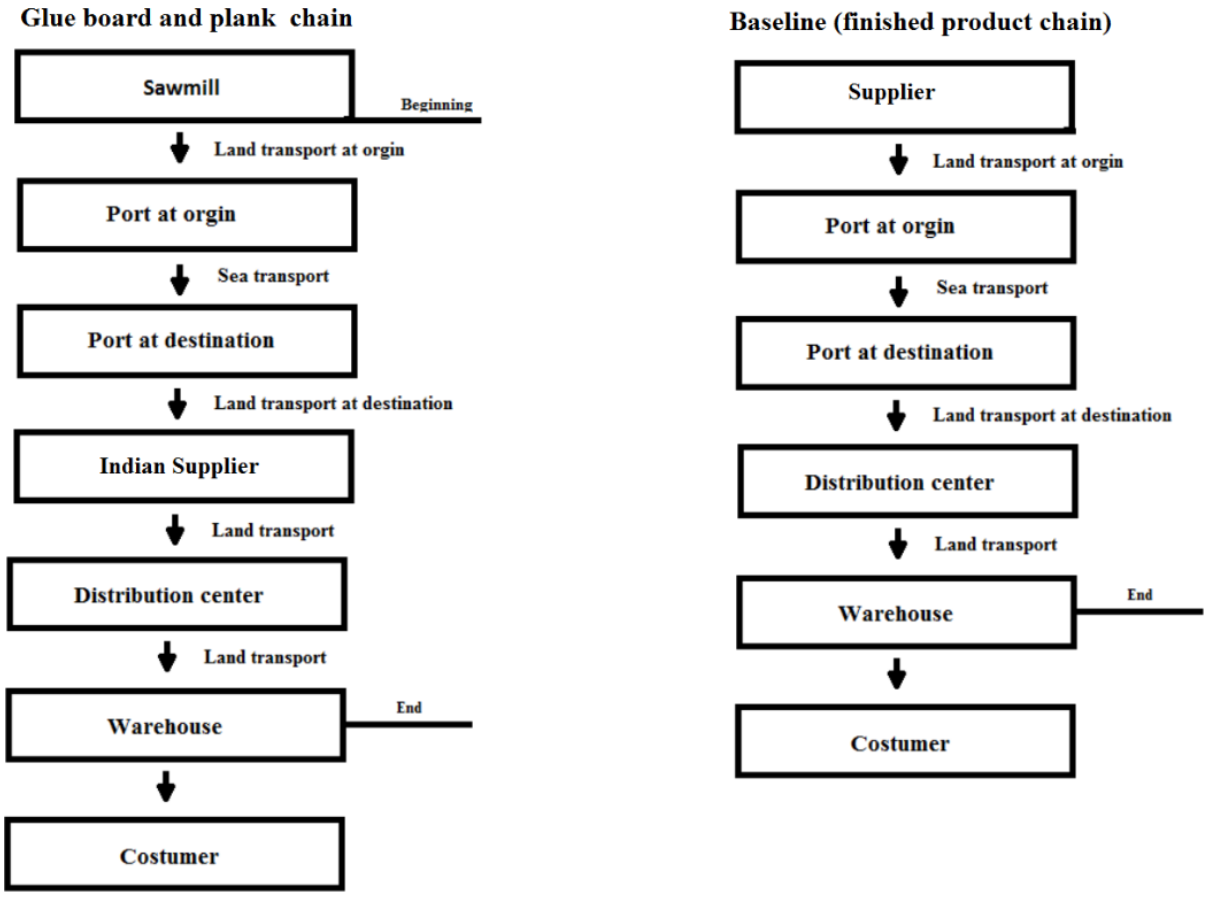

Figure 7. The two different chains investigated in this work.

There are comparisons between the glue board/ plank chain with the baseline chain as well as comparisons between the glue board and plank chain. Finally there are comparisons between the three different products investigated. To read how the different chains and products were compared please read the section "Tools used in figures and models in the result in the end of this chapter.

4.3.2 Sourcing

The figure below shows the most cost efficient countries that IKEA´s suppliers that produce the three products outside India and send the finished products to IKEA´s new warehouses operate in. These three producers and their countries were found by IKEA´s optimization program that find cost efficient ways to produce and send finished products. The cost of sending the three finished products was then compared to the second chain that starts at sawmill in Poland that produce glue board and planks. This sawmill is located in Poland in this study because that was a location where IKEA had several industries, see Figure 8, below. I would also like to argue Poland is a good country to investigate since it is a nation with a lot of forest.

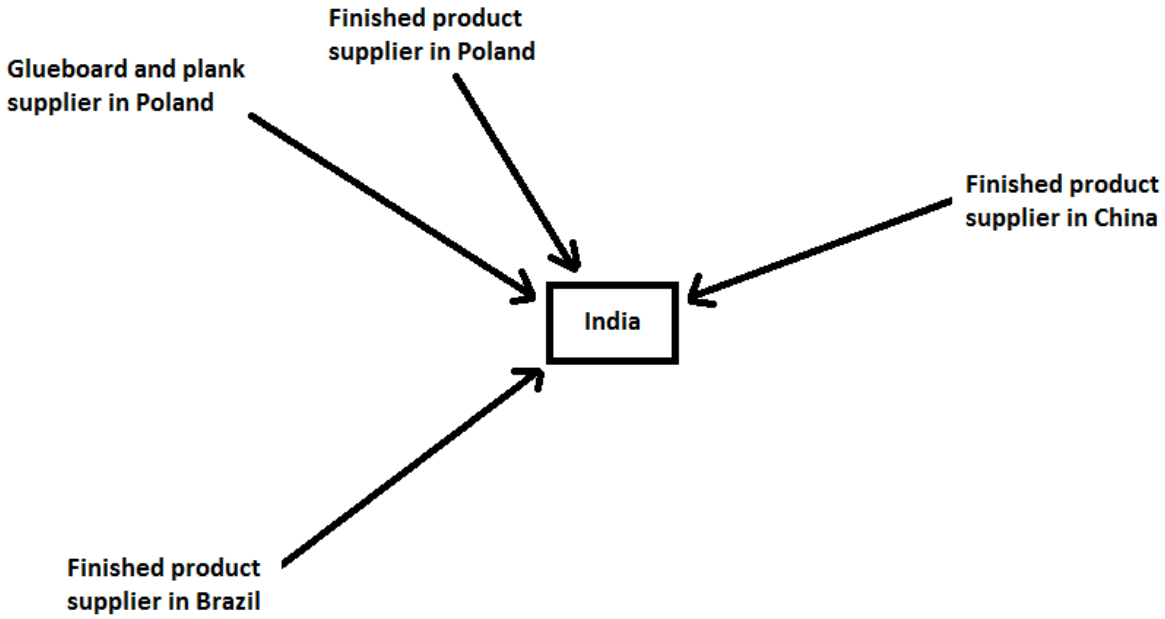

Figure 8. The origin of the glue board and plank supplier and the finished product suppliers.

In the following section the methods to analyse the two types of chains are presented.

4.3.3 Continuous data analysing

Merriam (2009., pp. 136-157) argues it is important to analyse data continuously to reduce the risk there is data in the end of the study that is unclear. The study followed (ibid.) advice and did analyse data about the two different chains continuously. It also use Bogdan *et al.* (1982, see Merriam, 2009., pp. 133-157) advices how to analyse data continuously.

Bogdan *et al.* (1982, see Merriam, 2009., pp. 133-157) gives nine advices how to analyse data continuously

- Define delimitations otherwise the researcher can receive information that is irrelevant and not usable.
- Decide method for the research.
- Analytic questions need to be developed to build a structure. When this is made, the researcher can make general questions and decide which questions that is important and irrelevant.
- Every interview should partly build upon what previous interviews have given.
- Make notes during the investigation, to stimulate critical thinking.
- It is a good idea to write PM: s and a list about important insights.
- Ideas and thoughts are good to be shared with interview subjects.
- Start the literature review outside in field, because experience in the subject gives more value from the review.
- The researcher should ask himself questions like “what does this reminds me of?” and try to think outside the box.

4.3.4Handling of the qualitative data

The majority of the data used to answer research question regarding the glue board and plank chains which was for research questions one, three and four was qualitative data. The report tried to follow Yin (2003., pp. 137-138) advice how to handle this kind of data. By using all

data available, comparing and comparing it to other research, leaving out unimportant information and using my own experience as a marine charterer.

4.3.5 Analyse and present cost categories in supply chains

Much data for especially research question two was quantitate data used to compare the glue board /plank chain with each other and the baseline chain (finished product chain), I followed Zeng & Rossetti (2003) advices presented below how to evaluate and present cost categories.

- Different alternatives should be defined. In this case the report evaluate the different solutions of sending finished products to India or sending planks/ glue board to be assembled in the country.
- Decide what criteria which should be used. The different cost categories chosen can be viewed in the results.
- Another tool is to reclassify costs, for example calculate them in unit types. I did this by calculating costs per container/ per m3 and per product I did also investigate how different numbers of containers affected the cost.
- According to Zeng & Rossetti, the final step is to create a cost matrix and calculate cost in a percentage of the total cost. It might also be interesting to do a sensitivity analysis. I did both these and the results can be viewed in later chapters.

4.4 Ethical considerations

It is important to think about ethical aspects of a study (Robson, 2002., pp. 65-76). (Ibid.) argues that participants should be informed it is voluntarily for them to take part, and they can choose to avoid answering questions they might feel unease about. Participants' should also be able to be anonymous.

This study has been carried out with the knowledge that the report will be published on the university network viable for everyone. IKEA is a company with competitors, for normal business reasons information about products and their costs have been left out. Instead the three products are called X, Y and Z in this work.

4.5 Tools used in figures and models in the result

Tools used to analyse data to be able answer research question two are described below.

4.5.1 Explanation of model used

Below is the model made for calculating the cost for sending planks and glue board to India explained. The cost of sending planks and glue board was compared to the Baseline cost. The baseline cost was a field IKEA had a great knowledge in due a lot of knowledge and experience of calculating costs for sending finished products. They distributed this information so I could use it. The baseline cost contained for example production, transportations, handling, and duty costs. The costs from the baseline chain were then compared to the costs investigated in the glue board and plank chain calculated with the formula below. The total costs for the three products was compared for the two types of chains but also more narrow costs like shipping, duty and land transports costs.

The report also has several comparisons between the glue board and plank chain using the model displayed below. Examples of comparisons made are total costs, transportations costs and duty costs.

There are also comparisons between the three different products investigated in this work. For example how many of each products could fit in one container and how big the final cost was for each one of them.

$$\boldsymbol{Cost\ to\ port} = \left(\frac{(\boldsymbol{m}+\boldsymbol{v})}{\boldsymbol{c}}\right) * \boldsymbol{L_1}$$

$$\boldsymbol{Number\ of\ containers\ needed}\ (\boldsymbol{n}) = \frac{\boldsymbol{v}}{\boldsymbol{c}}$$

$m = Material\ cost$
$v = Volume\ that\ need\ to\ be\ transported$
$c = Volume\ that\ fit\ in\ 1\ contianer$
$L_1 = Land\ transport\ from\ sawmill\ to\ port$
$n = Number\ of\ containers$

$$\boldsymbol{Sea\ transportation\ cost} = \boldsymbol{n}(\boldsymbol{s}+\boldsymbol{o}+\boldsymbol{f}+\boldsymbol{B}+\boldsymbol{d})+\boldsymbol{b}$$

$s = Controll\ cost\ for\ SOLAS$
$o = Cost\ for\ handling\ and\ loading\ at\ port\ of\ orgin\ per\ container$
$f = Frieght\ cost\ (exluded\ for\ BAF)\ per\ container$
$B = BAF\ cost\ per\ container$
$d = Cost\ for\ handling\ and\ unloading\ at\ port\ of\ destination$
$b = Booking\ fee\ for\ whole\ trip$

$$\boldsymbol{Duty\ and\ insurance\ cost} = \boldsymbol{TDL}+\boldsymbol{TBL}+\boldsymbol{TCL}$$

$Total\ landing\ charge\ (TDL) = (m * v) * DL$
$DL = Landing\ charge\ cost\ (0.01)\ in\ this\ case$
$Total\ basic\ costum\ duty\ (TBL) = ((m * v) + DL) * BL$
$BL = Basic\ costum\ duty\ cost\ (0.1)\ in\ this\ case$
$Total\ costum\ educational\ cess\ and\ basic\ duty\ (TCL) = (m * v) * CL$
$CL = Costum\ education\ cess\ and\ basic\ duty\ (0.03) in\ this\ case$

$$\boldsymbol{Cost\ to\ indian\ supplier} = \boldsymbol{n} * \boldsymbol{L_2}$$

$L_2 = Land\ transport\ cost\ from\ port\ of\ destination\ to\ indian\ supplier$

$$\boldsymbol{Production\ cost} = \boldsymbol{P}$$

$$\boldsymbol{Handling\ and\ transportation\ cost\ from\ supplier\ to\ warehouse} = \boldsymbol{W}$$

$$\boldsymbol{Number\ of\ products\ that\ fit\ in\ 1\ container\ with\ planks\ and\ glue\ board} = \boldsymbol{N}$$
$$\boldsymbol{Number\ of\ finished\ products\ that\ fit\ in\ 1\ container} = \boldsymbol{N_1}$$

$$\boldsymbol{Total\ cost\ for\ 1\ products} = \frac{\boldsymbol{Cost\ to\ port}+\boldsymbol{sea\ transport\ cost}+\boldsymbol{duty\ and\ insurance\ cost}}{\boldsymbol{N}} + \frac{\boldsymbol{Cost\ to\ indian\ supplier}+\boldsymbol{P}+\boldsymbol{W}}{\boldsymbol{N_1}}$$

The following chapter describe some the analyses that was made off with the formula above to compare the costs for transporting glue board and planks with the finished product chain and comparisons between the three different products.

Most costs was converted to EUR with EUR/ Polish Zloty 0.24, EUR/ Dollar 0.94, EUR/ Indian Rupee 0.014 and EUR/ Yuan 0.14. A small number of the costs had a slightly different rate since they was received at another date and was then converted with the daily currency rate to show the

cost the moment the costs was calculated. Dollar and Yuan fluctuated less than + 1% and the polish zloty fluctuated around -3,5% at the most compared with the rates above.

4.5.2 Sensitivity and break even analysis

The only certain about the outcome of investments and forecast is the past (Jovanovic, 1999). There are no economic models or experts that can predict exactly the outcome of certain decisions of the future. This uncertainty makes it essential to do sensitive analysis, break even analysis and calculate different scenarios that can occur.

Break even analysis is a method that calculate when a certain investment or strategy neither make profit or loss. Break even analysis can help decision makers to calculate the breakeven point for an investment or way to act. This method is only needed if there is uncertainty involved in different outcomes.

Break even analyses made in this work are.

- How much can the price for material increase for the polish sawmill in the glue board and plank chain until the baseline cost becomes more cost efficient?
- How much could the material and transport costs increase for the glue board and plank chain increase until the baseline cost becomes more cost efficient?

Sensitivity analysis is used when the outcome is uncertain and can be used to see how changes in input data affect the final result. Many of these changes might never occur, but there is a possibility that they can and therefore it is important to see how they would affect the final result. The idea with sensitive analysis is to get insight how new input data changes would affect a project or business. When performing a sensitive analysis, the first step is to define some different quantitative data and then decide what range these data can vary within. Finally, you calculate with the different variables within the range and analyse the result (Jovanovic, 1999).

Sensitivity analyses that made in this work are.

- How does 1 EUR in increased logistics cost increase the total cost for the three different products X, Y and Z?
- How does 1 EUR in increased production cost increase the total cost for the three different products X, Y and Z?
- How do different material costs affect the price for the three different products X, Y and Z?

4.6 Assumptions in the analysis

There are some important assumptions that need to be considered in the report. There is no existing production in India therefore there are no known production costs. In order to fill this gap three existing IKEA suppliers that produce these products have been chosen and the assumption that the Indian manufacturer has the same production costs was made. This is probably not the case in reality, but IKEA´s goal is to make the Indian supplier just as good as the existing.

It was also assumed that every container could be filled with 50m^3 of planks and glue board. In reality there can be a slightly different number. Costs between the Indian supplier and Indian distribution centre were assumed to be the same as for the existing supplier, expect the transportation cost between distribution centre and warehouse that was assumed to be 20 EUR /m^3. This is a conservative assumption, which probably is lower in reality.

5 The empirical study, results and analysis

The chapter present data about the glue board/ plank chain and the baseline chain. To see how the two chains are constructed please read the analysis section in the method chapter.

This chapter begins with an explanation of the glue board and plank chain. The section wants to answer the first research question which is to explain how a wooden supply chain to India can be constructed.

The second part of the chapter is divided in three "sections" that can be viewed below. Each section compare different things, the sections wants to answer the second research question which is what costs that occur in the glue board and plank chain. The section also wants to investigate if it is cheaper to send glue board and planks to be assembled in India instead of finished products to the country.

The chapter begins with an explanation of the different costs that occur in the glue board and plank chain. There are also cost and number of containers comparisons between the two different material chains

When the two material chains have been compared, comparisons between the baseline and glue board/ plank chains are made. There are cost comparisons on how the three different products are affected if they are sent in the baseline chain or the glue board/ plank chains. Break even analyses are made to see how much the glue board and plank chain cost can increase before baseline solution is cheaper. Duties and insurances between the baseline and glue board/ plank chains are compared as well as filling rate of containers between the two different types of chains.

The last part of the second section of the chapter compares how the three different products in the glue board and plank chain get affected by cost changes.

In the third section of the chapter the third research question which is what risks that exist in the glue board and plank chains to India are presented. Risks that are investigated are supply, demand, process, control, environment, infrastructure and contentious risks.

The last section of the chapter explains the final research question how the chain is managed. Is the glue board and plank chain lean or agile? How is inventories handled and are there any bottlenecks or bullwhip effects.

Explanation how the chapter is structured and how the research questions are answered see Table 2 below.

Table 2. Description how the chapters are structured. The chapter is divided in four sections one for each research question that can be read in aim and delimitations. Section two is divided in three parts, one comparing glue board and plank chain, then a comparison between baseline and glue board/ plank chains and finally a comparison between the three different products

Subjects reviewed in the chapter
Research question 1 Supply chain structure in glue board and plank chain
Research question 2 Supply chain costs in glue board and plank chain Cost and number of containers comparisons between glue board and plank chain
Cost comparisons and break even analyses between baseline and glue board/ plank chains. Duties and insurance comparisons between baseline and glue board/ plank chains. Fill rate comparisons between baseline and glue board/ plank chains.
Comparisons between the three different products get affected by changed costs in the glue board and plank chains.
Research question 3 Review of different types of risks in the glue board and plank chains as well as how they are managed.
Research question 4 Explanation how the chain is managed, is it lean or agile? How inventories are handled and what are the lead times? Explanation of potential bottlenecks and bullwhip effects in the chain.

5.1 Supply chain structure and costs in glue board and plank chain

In the illustration below you can see a brief overview of IKEA´s glue board and plank supply chain to India from sawmill to port. As mentioned earlier did this study focus on the supply chain of planks and glue board between sawmill and warehouse. The chain start with a *land transport* from a Polish *sawmill* to a port in the same country. In the picture below this port is named as *port of origin*. At the *port of origin*, the material are handled and then sent by container ship to a port in India, this port is named *port of destination* in the figure. Here is the material unloaded and then sent by truck to an *Indian supplier*. The Indian supplier assembles the material to finished products that are sent to a *distribution centre*. The distribution centre works like a hub where goods are stored and distributed to *warehouses* in the area. When the warehouses need the products, they are transported to the stores. Where the products are handled and made ready for sale, when the products are available to the *customers* this study ends, see Figure 9, below for an overview of the chain.

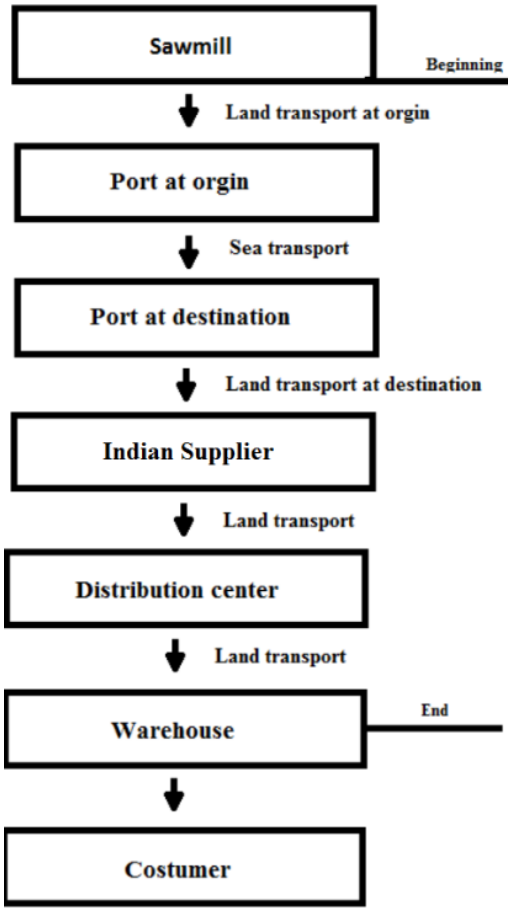

Figure 9.Visual explanation of the range of the studies result and analysis's.

In the following section the costs that occur in the figure above are presented.

5.2 Supply chain costs in glue board and plank chain

The costs that occur in the supply chain is investigated and presented in Table 3 below.. The first cost is material cost at the sawmill. This is not a direct logistical cost but it affects the taxation which is a major part of the transportation cost, and thereby I decided to include the cost. Then there is a land transport costs that will occur when containers are transported between sawmills, ports, distribution centres and warehouses. These costs include all the fees that IKEA need to pay for the truck transports. The third cost is administration costs, the only fee investigated was booking fee, and no other costs like internal administration or operating management are included. Operational handling cost (shipping) is divided into loading and unloading at ports. This cost includes a certain number of days of storage, and transports within the port as well as loading and unloading. The control cost investigated in this model is SOLAS, this fee is paid at the loading port for weighting the containers. This control is mandatory for all containers that shall be shipped. This report did not investigate control costs that occur when IKEA make follow-ups on delivery times or contracts. The fuel cost (BAF) is used by most ships and are affected by fuel prices and occurs during the shipment. The customs and insurances are integrated in each other and both these are directly affected by material prices. The rates are the same for planks and glue board but the more valuable the material are, the more IKEA will need to pay per m3. In this cost fees for entering the port is included. Additional fees might occur if materials are transported between certain states, but these fees have not been considered. The costs for risks are already included in the insurance and duty cost. The distribution centre handling costs include storage and handling cost that

occur at the distribution centre. Retail handling includes the costs needed for making the products available for the customers at the warehouse. To view a summary of the different costs view Table 3 below.

Table 3. Explanation of the costs received from the investigation

Logistics category	Brief definition
Material cost	Cost for acquiring planks and glue board.
Land transportation	Cost for loading and unloading trucks and land transports.
Administration	In this model only booking fee is investigated, leaving other costs l like administration, planning, bookkeeping and management costs out.
Operational and	Cost for loading and unloading ship and using port handling cost (ship) infrastructure, for example, machines and storage place for a set time.
Sea transport	Cost for transporting the cargo by sea.
Control cost	SOLAS is a fee for weighting the container at port and need to be paid by the shipper.
Fuel adjusted cost (BAF)	Fuel adjusted bunker price, increases with rising fuel prices and decreases with falling fuel prices.
Custom and insurances	There are different fees for importing different products, for example, there is a 10% fee for importing planks and glue board while the fee for finished products is around 29%. These rates are the base duty. There are also landing charges and custom educational duty that need to be paid. In these taxes insurances are accounted for.
Risks and damage	This category is represented in the insurance that shipper need to pay to transport their goods, (already accounted for in Customs).
DC handling cost	Cost for distribution centre to handle and forward goods to warehouses.
Interest cost	Capital cost that occurs during the whole chain.
Retail handling cost	Cost for warehouse to handle goods and make them available for customers.

5.3 Comparisons between planks and glue board

In this section the glue board and plank chain are compared with each other.

5.3.1 Cost of material and transport between sawmill and supplier for four containers glue board and plank chains

Table 4 and Table 5 below show the cost of sending four containers between the sawmill and the Indian supplier. The cost is the same for *sea and land transport* and *handling charges*. Important to notice is that in reality it can be a slight difference, since it might be possible to load different volumes per container of planks or glue board. The difference in cost per m3 is caused by the higher *material cost* for glue board cost per m3. *Duty and insurance cost* is based on this value and a higher material price results in a higher duty cost.

Table 4. Description of costs for sending four containers of planks as well as proportion of different cost posts

Costs	Cost (in EUR)	% of total cost (per category)	Cost per m3 (in EUR)
Sea transport and handling	3263	0.07	16.32
Land transport and handling	7508	0.15	37.54
Material	35200	0.70	176.00
Duty/ Insurance	4014	0.08	20.07
Total cost	49985		
Cost per container	12496		
Cost per m^3			250

Table 5. Description of costs for sending four containers of planks as well as proportion of different cost posts

Costs	Cost (in EUR)	% of total cost (per category)	Cost per m3 (in EUR)
Sea transport and handling	3263	0.02	16.32
Land transport and handling	7508	0.05	37.54
Material	120000	0.84	600.00
Duty/ Insurance	12120	0.08	84.60
Total cost	142891		
Cost per container	35722		
Cost per m^3			738

5.3.2 Proportions of costs for glue board and planks

The different cost shares between sawmill and Indian supplier are visualized in Figure 10 and Figure 11, below. Material and logistic costs after supplier are not included. In both cases is the material cost the largest part of the total cost. For glue board material cost is a larger share, because the material cost is higher. The land transport is the second largest cost for planks but third largest for glue board, the cost is the same for one container but the higher share of material costs for glue board decrease the land transportation share. The duty and insurance share is similar since the taxation rate is the same for glue board and planks. Sea transport is the same for both materials but the higher material cost for glue board decrease the total share for this material.

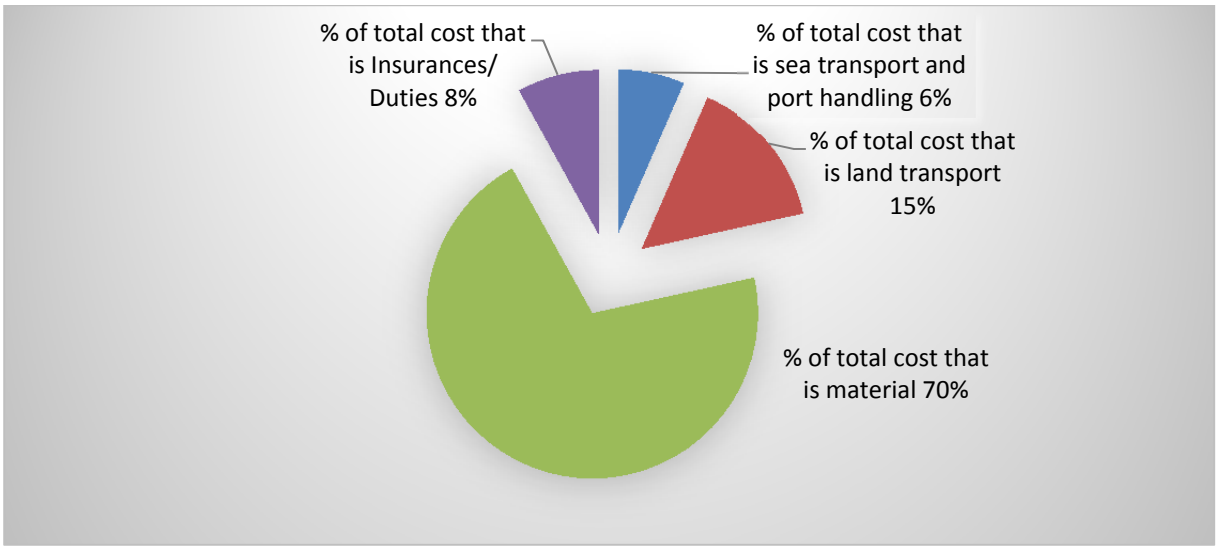

Figure 10. The costs proportions for transporting planks.

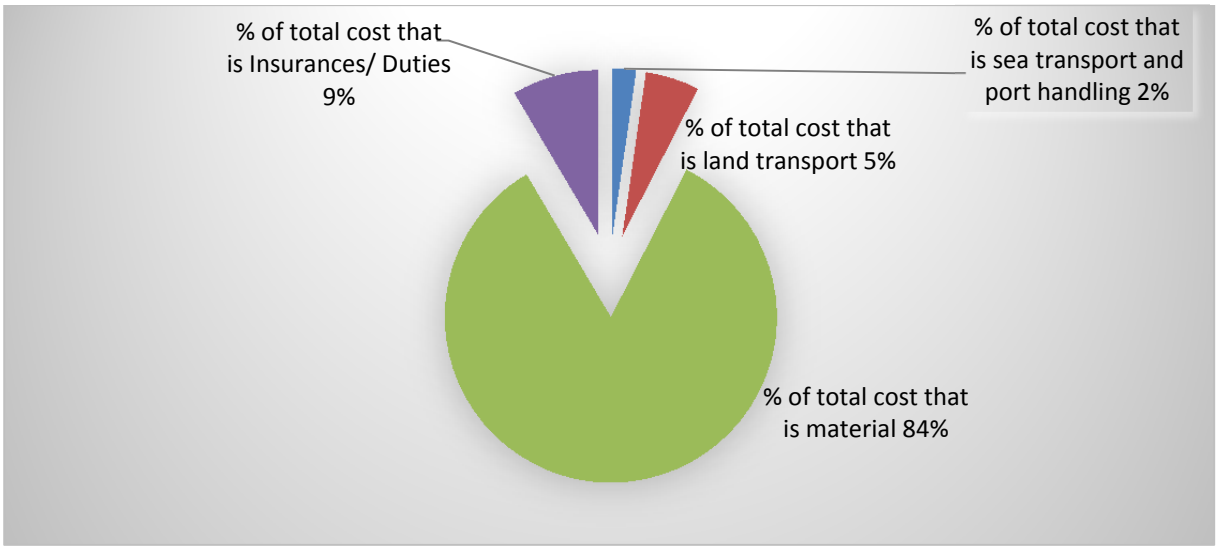

Figure 11. The cost proportions for transporting glue board.

The following section describes how cost for transporting glue board and planks are affected by number of containers and filling rates.

5.3.3 Effect of number of containers

There was little difference in price per m3 cost for importing different numbers of containers. The figures shows how numbers of containers affect the price per container, one containers price is 100% and if the price decrease the % go below 100% if the price increase the cost go above 100%, see Figure 12 and Figure 13 below.

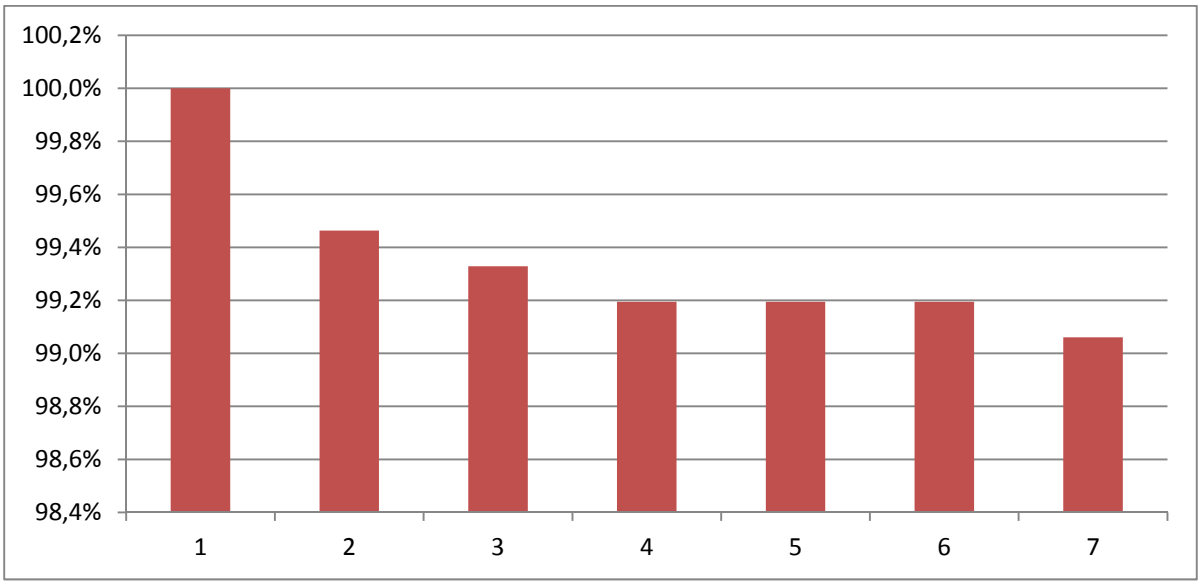

Figure 12. Describing how transport cost decrease for planks with increasing number of containers.

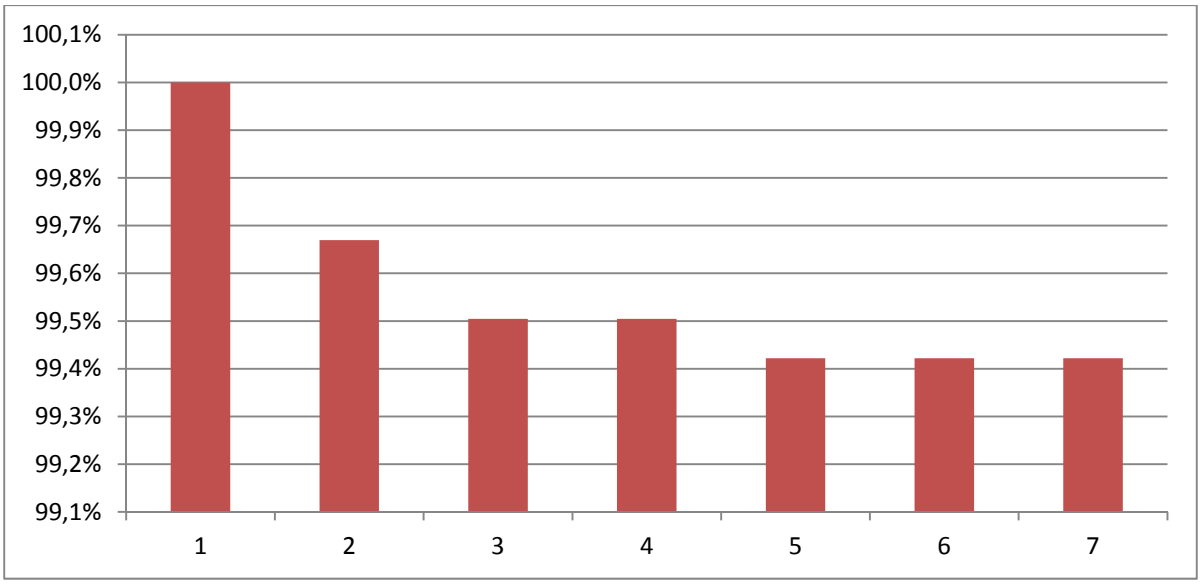

Figure 13. Describing how transport cost decrease for glue board with increasing number of containers.

It is barely 1% cost difference per m3 between one and seven containers as can be viewed above. This is the case since all the costs except booking fee are dependent on the number of containers. The booking fee itself is a really small portion of the transportation, especially for glue board. In both cases the fee is below 1% of the total cost of material and transport even for one container. In this case the statement made by the IKEA business employee that argued transportation is not about quantity but about networks seems to be right.

Worth mentioning is the large increase of price per m3 if the containers are not fully filled, that can be viewed below. Transport and handling cost are the same for containers even if they are not full. The only costs that are not affected by the fill rate are material and duties. See Figure 14 and Figure 15 below.

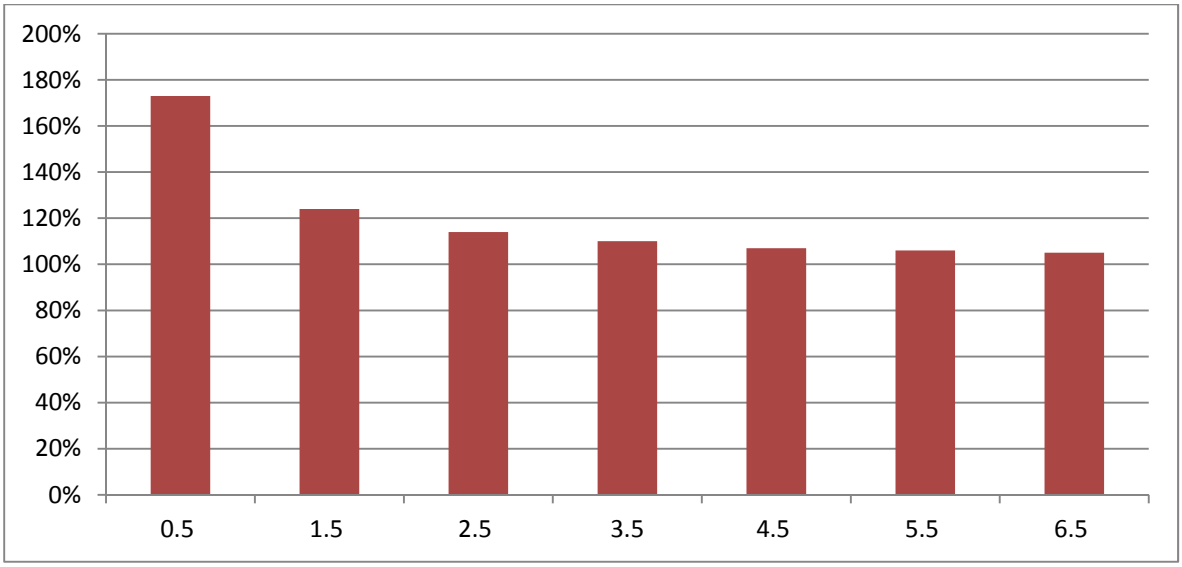

Figure 14. Describing price increase per m3 increase for planks if containers are half full, (0.5 means a half container, 1.5 means one and a half container and so on).

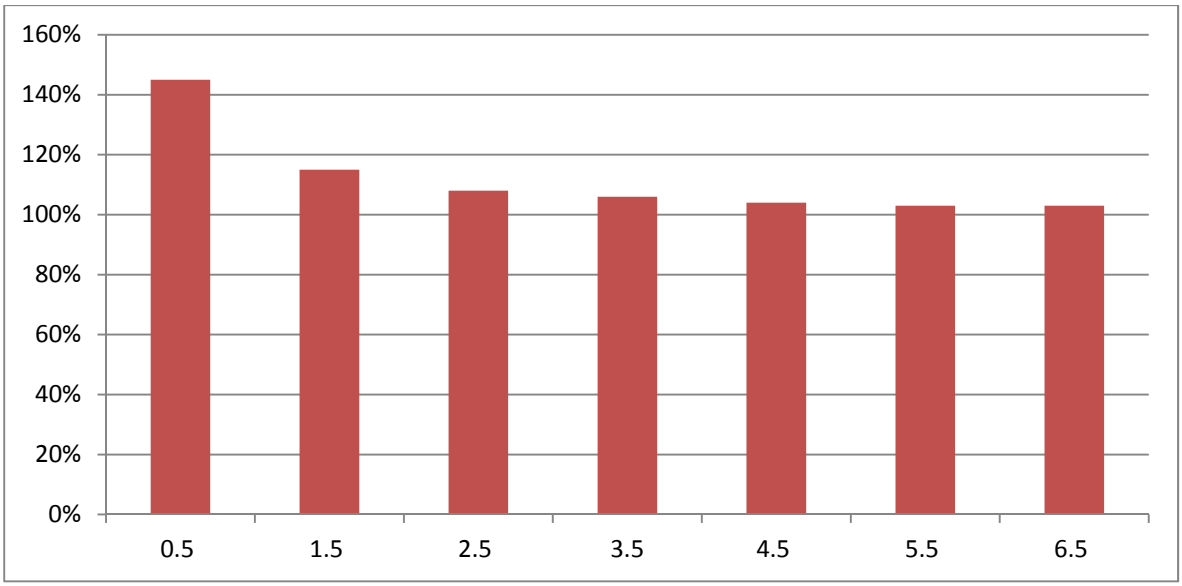

Figure 15. Describing price increase per m^3 for glue board if containers are half full, (0.5 means a half container, 1.5 means one and a half container and so on).

The reason why planks get more affected than glue board is because per m3 are that a larger proportion of the total cost is logistical cost. The logistical costs are the same if the containers are half full which means the price per m3 increase. Glue board on the other hand have a larger proportion of material cost, meaning the logistical price increase per m3 from half full containers have less effect even if it still is significant.

5.4 Comparisons between baseline and glue board and plank chain

In this section the baseline supply chain is compared with the glue board and plank chain.

It was more cost efficient to transport glue boards and planks instead of finished products

in all three cases, the result can be seen in the table below. However the same costs in the two chains did sometimes occur in different parts of the chain, to see where the costs in the table occur please view the figure below the table.

The *"finished product cost at supplier"* is much lower in baseline because import taxes and logistics have not yet been paid. For the glue boards and planks the *"finished product cost"* is higher since a large portion of the logistics costs and the duties have already been paid. The reason why the *"logistics cost"* is higher in Baseline is that less products can fit in the containers and the transportation between supplier and store are much longer. *"Duty costs"* differences are explained by the lower base value for planks and glue boards compared to the finished products and the higher fees for finished products. In the end the "*Landed cost*" for transporting glue boards and planks to India is lower when compared to the baseline. For an explanation of the costs see Table 6 below and Figure 16 for an explanation of where the costs occur.

Table 6. Showing the cost in EUR per finished products with the two-different transportation and productions decisions for the products x, y and z

X	Baseline chain (cost in EUR)	Glue board/ plank chain (cost in EUR)
Finished product cost	62.45	82.81
Logistics and handling cost from supplier to store	36.60	11.61
Landed cost	99.05	94.41
Duty Cost	21.82	4.94

Y	Baseline chain (cost in EUR)	Glue board/ plank chain (cost in EUR)
Finished product cost	3.83	4.34
Logistics and handling cost from supplier to store	3.50	1.38
Landed cost	7.33	5.72
Duty Cost	1.76	0.17

Z	Baseline chain (cost in EUR)	Glue board/ plank chain (cost in EUR)
Finished product cost	16.96	20.67
Logistics and handling cost from supplier to store	9.91	3.17
Landed cost	26.86	23.83
Duty Cost	6.03	0.58

The costs are similar for all three products, finished products cost is the largest cost and duty cost is the smallest cost. This was the case both for the baseline chain and the glue board and plank chain. The costs for product X is the largest because it is the most expensive product and Y has the smallest costs since it is the cheapest product. In all the investigated cases the glue board and plank chains is cheaper compared to the baseline chains.

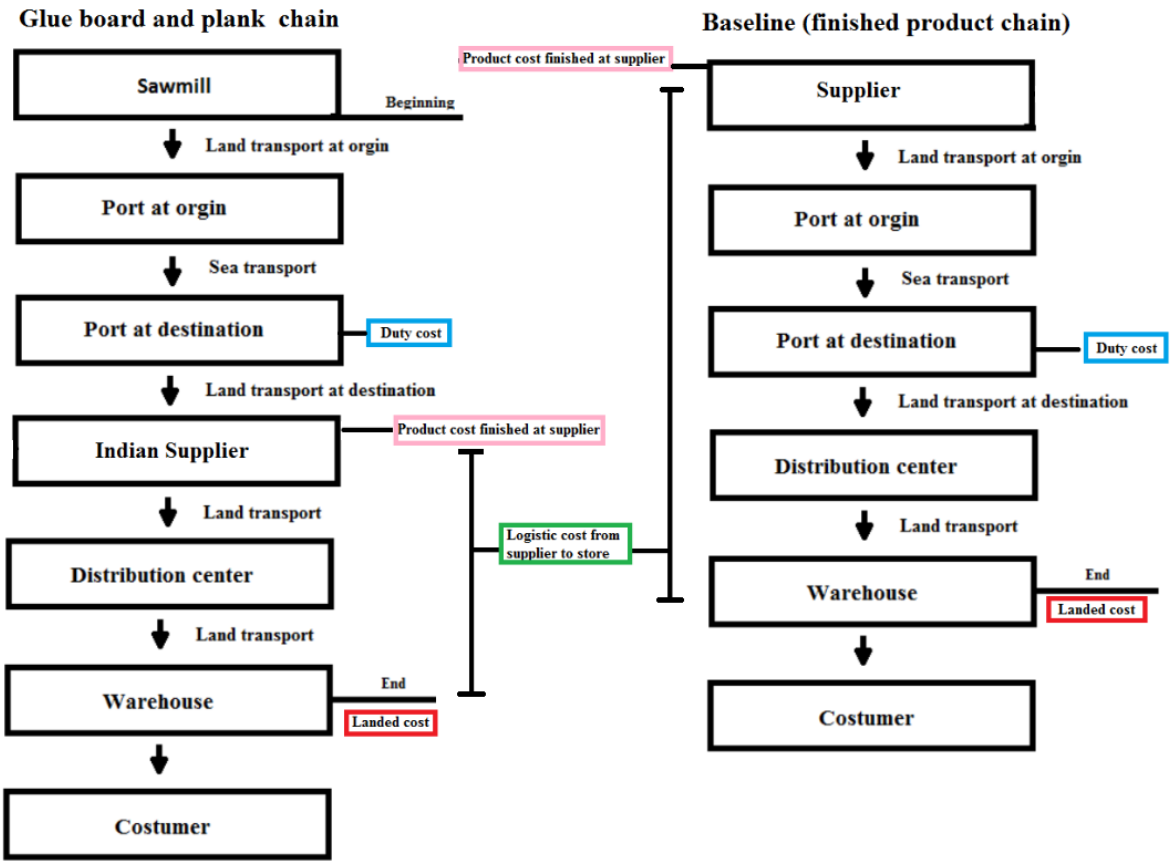

Figure 16. Visualization where the costs occurs in the different chains.

As it can be seen in the figure, the production cost occur in India for the planks and glue board chain, while in the finished product chain it occur outside India, to see where please read the sourcing section in the method chapter. The duty costs in both chains occur at the Indian port. The logistic cost from supplier to store is shorter in the glue board and plank chains comparted to the baseline chain. However, the landed costs occur for both chains at the warehouse.

5.4.1 The chain type effect on the different products

In this section the breakeven point for sending planks and glue board compared to finished products (baseline) to India is explained for the three products investigated.

Below is the breakeven analysis on the material cost. For the glue board product X, the material cost can increase 15% before it becomes more profitable to send finished products instead of material. For the two-plank products Y and Z are the corresponding number 96% and 53% see Table 7 below.

Table 7. Description how much material cost can increase before it is more profitable to send finished products

For product….	Material cost (in EUR)	Material cost increase (in % of base value)
X	687	15%
Y	345	96%
Z	270	53%

A possible explanation to why the material cost can increase more or less for certain products before reaching the breakeven point can be found in the figure below. Table 8 below shows

how much the total cost the products can increase before they cost as much as the baseline solution. For Y and Z the total costs can increase between 12.7%-28.2% before the breaking point is reached. X and Y were also the products that material costs could increase the most (see the figure above). The percentages in Table 7 are higher compared to Table 8 since in Table 7 only material cost is increased while Table 8 all costs are increased.

Table 8. Description how much the total transportation and material cost can increase before sending finished products is more profitable

For product….	Possible price increase (in EUR)	Price increase (in % of total cost)
X	4.64	4.9%
Y	1.61	28.2%
Z	3.03	12.7%

5.4.2 Duties and insurances comparisons between baseline and glue board and plank chain

There was a significant difference on the duty and insurances cost when sending finished products compared to planks or glue board. The tax effect of the total cost including material was between 22 - 24% of the total cost for the baseline. The tax part of the total costs for planks and glue boards was 2-4%. See Figure 17 below.

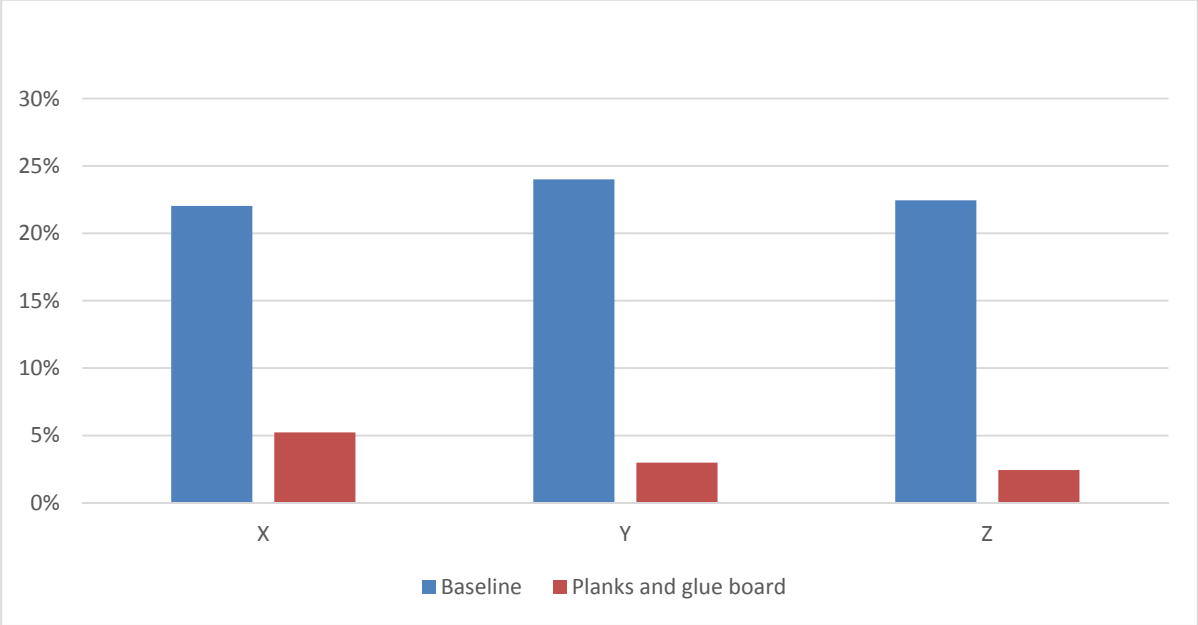

Figure 17. Illustrating the percentage of total costs that are duties and insurances for product X, Y and Z.

There were several reasons for this different taxation, like that the overall fee was lower for planks and glue board (around 10%) compared to baseline (around 30%). But the taxation itself became higher in Baseline since the finished products had a higher base value than the unrefined planks and glue boards. The glue board product X had the highest percentage, because the material cost was a higher proportion of the total cost compared to the planks since the taxation itself was based on the material value. All taxes occurred at the Indian port, and not at the Indian land transport or at the Polish port. In other cases it can occur taxes at the Indian land transport since some states have taxes for products from other states.

Deloitte (2013) mentioned in the literature review some risks in emerging markets, like difficult regulations and lacking infrastructure. When investigating the Indian supply chain, I

quickly realized the tax systems complexity. There were a lot of different rules that needed to be answered by a specific tax expert in the company and I received several different data about the taxation. However, the taxation knowledge will probably increase by time. There were also some questions about the level of refinement and taxes which the custom expert could not answer. One question was how much you can refine glue board or planks before you received higher duty rates. One question no one was able to answer was if IKEA could cut planks and glue board in right length before they are considered as spare parts rather than planks or glue board. The tax effect on spare parts is considerable higher, close to 30% compared to 10% for glue board and planks. The classification was done by sending a review product so the tax officers could decide the classification. A business developer in India said it would not be likely that different ports or officers could classify the product different. It seems like Deloitte (2013) in this case was correct, that emerging markets can have difficult regulations and taxes.

5.4.3 Fill rate effect of sending planks and glue board

It is possible to load material for more products in a container than if they are sent as the baseline solution which is finished products in containers. In these three cases, it is possible to send between 30% - 98% more products as planks or glue board than as finished products, see Table 9 below. So, if viewed from a fill-rate perspective there are great benefits for sending planks or glue board.

Table 9. Describing number of products that fit in one container if you send finished products (Baseline) and send planks/ glue board (Sawmill)

Product	Baseline (number of finished products that fit in one container)	Glue board/ plank chain (number of products that fit in one container as planks and glue board)	Ratio (glue board/ plank chain /baseline)
X	432	856	1.98
Y	3618	5877	1.62
Z	1288	1722	1.34

5.5 Comparisons between different products

In this section comparisons between the three different products in the glue board and plank chain are made.

5.5.1Changing production or logistics costs in glue board and plank chain

You can see the percentage effect on price if the transportation cost increase by 1 EUR for the different products in Table 10 below. X is affected the least since the total landed cost at store is the highest and Y get affected the most since the landed cost at store is the lowest.

Table 10. Describing the effect on landed cost if logistics increase 1 EUR for the three different products

1 EUR change in logistic cost	New landed cost (in EUR)	Change (in % of total cost)
X	95.41	1.1%
Y	6.72	17.5%
Z	24.83	4.2%

Table 11 below show the effect on the landed cost if the production cost increase by 1 EUR in India. The change has the same effect as if transportation cost increase by 1 EUR where X increase the least and Y the most. The reason for this is that production or transportation costs do not affect any other costs. Material cost for example does increase the taxation.

Table 11. Describing the effect if production cost increase by 1 EUR for the three different products

1 EUR change in logistic cost	New landed cost (in EUR)	Change (in % if total cost)
X	95.41	1.1%
Y	6.72	17.5%
Z	24.83	4.2%

5.5.2 Material sensitivity analysis in glue board and plank chain

Table 12 and table 13 below shows the result of the sensitivity analysis for products X, Y and Z when material cost go down 100 EUR and up 100 EUR. Product X shows least effect on the landed cost at store while the decrease or increase in price affect less since the original price is higher. Y and Z are made of planks which make the 100 EUR affect the material price more due higher percentage change.

Table 12. Describing the effect of negative changed material prices on the landed cost

Product	-100 EUR (material price change)	-50 EUR (material price change)	-25 EUR (material price change)	-1 EUR (material price change)
X	93.06%	96.53%	93.06%	99.94%
Y	83.39%	91.61%	95.80%	99.83%
Z	86.45%	93.24%	96.64%	99.87%

Table 13. Describing the effect of increased material prices on the landed cost

Product	1 EUR (material price change)	25 EUR (material price change)	50 EUR (material price change)	100 EUR (material price change)
X	100.07	101.74	103.48	106.95
Y	100.17	104.02	108.22	116.43
Z	100.17	103.52	106.80	113.60

Conclusions that can be made from the tables in this section if that if the production or logistic cost increase with X euro then the total cost increase in % is proportional to the X price increase of the total cost. This is the case because production and logistic cost do not affect other costs. The material cost however does affect the duty cost, therefore the X price increase or decrease in material have a greater affect.

5.6 Risk result and analysis

Christopher (1998) defined a number of risks presented in the literature review. These were supply, demand, process, control and environmental risk, which are presented below. IKEA seemed to have good knowledge and be actively working with all these risks in their supply chain. As mentioned earlier, IKEA employees responsible for exports revaluate every supplier after a contract has expired. For example, they review if the partnership and transportations have worked well for good price. By doing this they can identify and remove contractors that have performed poorly and therefore reduce the supply risk. IKEA also have several suppliers that can produce furnitures, glue board and planks, giving them several options.

However, the employee responsible for land transport within India had another way of interacting with transport companies after contracts ended. Valuing longer cooperation's he tries to talk to the transporter that have performed poorly to solve the problems together continue the partnership.

5.6.1 Supply and demand risks

Demand risks are handled by the centralized forecast department which provides forecasts, so logistical operators know what volumes that needs to be transported. The forecast process is not the most agile since the forecasts need to be provided 2 months ahead. This forecasting is a risk since the future is unknown and therefore the forecasted volumes and demand can be incorrect, what this results in is explained in the section about process risks. Respondents in the interviews argued that there were good information flow in the chain between themselves and transport contractors and they believed it would be the case in India as well.

IKEA employees at both Sweden and India were not able to answer if the demand for IKEA products in India will be volatile or not. However they all mentioned the shops not yet had opened and they did therefore not have any data. But when they were asked to tell what they believed about the volatility of demand on their furniture they all thought it would be stable. I would also like to argue that IKEA have a good chance to make correct forecast thanks to large demands and the experience the interview subjects' appeared to have.

5.6.2 Process risks

I would argue the largest economic process risk is that the forecasted demand shows the wrong value. The danger does not lay in IKEA getting trouble to send or store the goods, since the people I interviewed all told me that IKEA is a well-known and respected customers that many want to sell their service to. The danger with wrong forecasts is that they force IKEA to break contract points with transporters by changing volumes needed to be transported to late, which leads to extra fees. Lead times are also long, so eventual miss calculations might take time to correct. When I asked two IKEA employees, one working with transport to India and one working with transportation within the country they told me there were a risk of goods that could get damaged, lost or delayed, but these problems were very rare.

The greatest process risk the IKEA employees that worked with exports could figure out was if the stores would not get the products in time and therefore not have the furnitures available for the customers, leading to lost sales. The greatest risk that the IKEA employee that worked with transports within India could think about was road accidents during transports with trucks. This employee worked with supply chains in Bangladesh, Pakistan and India and said these accidents could occur because of poor roads. He told it usually happened one or two times per year. Road accidents were an important issue for him and he worked active with transport companies to minimize these risks, how he worked are explained more in detail in the section "*risk management"*.

5.6.3 Control risk

IKEA want to make sure the suppliers meet IKEAs standards when they make the contracts according to IKEA employees working with contracting. However, the transports are made by external actors and therefore it is possible that IKEA might miss some bad behaviour. When making contracts a college always double-checks the deal to minimize risk wrongs in the contract.

IKEA have extended control of their supply chains and can monitor some transport on the minute. For the transport to India they have digital control systems and in India they do it by hand, but according to the Indian manager they will get a digital control system next year. The Indian manager talked about the great trust he had towards the trucking companies and their trust on IKEA. The employees' colleagues working with exports did not express the same level of trust about the shipping and transport companies.

5.6.4 Environmental risk

The IKEA employees say they try to both minimize costs but also environmental footprint when they made contracts with transport companies. Environmental problems should not be a problem for IKEAs transport to India. I did ask one business developer what they do if the weather is bad and a transport is delayed. It was the transport companies hired by IKEA problem to ensure that transports make it time. If goods are delayed IKEA receive compensation. In India, they have gone one step further when thinking on the environmental risk of their business. Together with trucking companies they are developing trucks with more biological and renewable parts and aiming on only driving with biofuel. This is something the transport companies like to be a part of according to the manager in India.

5.6.5 Continuous risks

Continuous risks affect IKEAs supply chain to India. IKEA business developer working with exports to India mentioned that fuel prices affect the transports cost on daily basis. Fuel prices can fluctuate greatly leading in fluctuating costs and therefore they update their contract each month to the new fuel price. However, the manager in India said the transport costs do not wary so much since they have standardized fuel prices. They only change the transport costs if the fuel price changes more than 5%, which according to him had not happened for the last 3 months.

IKEA pays transports to India in various currencies. For example, when I investigated prices I received them in Euro, Dollar, Polish zloty and Indian rupee. Since IKEA will sell their products in India the transport and material and transport costs can rise compared to revenue if other currencies mentioned increase in value compared to the local currency leading less revenue.

5.6.6 Infrastructure risks

IKEA new business people and management all says that port capacity and storage not are a problem since the good brand reputation. If other less known companies might have problems with infrastructure this work cannot tell. IKEA employees said the infrastructure was strong all the way to India, as well as the Indian railways, but the roads in India were not the best. However, there are investments on the way, so the infrastructure to the new warehouses is going to improve in the future.

5.6.7 Risk management

IKEA seems to leave a lot of responsibility on their contractors in the investigated chain. They are for example responsible that transportations are done within the timeframe.

Juttner *et al.* (2003, see Rao *et al.,* 2009) earlier in this work gave a four steps strategy how companies should handle risks. These steps were asses' risks, asses' effects, identify reasons behind these risks and the last step was to remove these risks. IKEA seems to do all these steps in their supply chain. However, they do it in different ways within the chain. The transport to India focus much on control and extra fees to mitigate risks, while transport within India focus more on collaboration and problem solving together. Although they use two widely different strategies, both parts seem to have good knowledge about risks and their effects. They also know why the risks exists like for example the employee working with exports and contracts knows fuel prices are global and go up and down and that big machines that can hurt cargo. The transport manager in India knows that the roads are lacking and therefore one or two crashes usually occur each year. Both tries to have handling plans how to handle the risks. The contractor takes help by fees trying to make transporters more exited to

reach deadlines. The supply chain manager in India is on the other hand working to develop better trucks with the transporters to reduce the risks of car accidents.

An IKEA employee also knew a way to reduce the chance of damaged goods in the container transports. By sending planks or glue board that is 2.4-meter-long you could load the breadth of the container. This allowed more efficient and easy loading which itself reduced the risk of damaged goods. If this is possible and profitable in these cases cannot be answered in this report.

5.7 Supply chain management

In this section there is an explanation how the supply chains to India will be managed when the chain beings operating.

5.7.1 The supply chain strategy

IKEA employees working with exports say that they want excellent service, which are deliveries at the right place and right time. They also want a cheap chain and that these factors are equally important. There seemed to be large steady demands and the volumes was forecasted months before shipping. IKEA was allowed to change volumes two months ahead, if they changed transport volumes later than that they received extra fees. When asking the IKEA supply chain manager in India I was told he valued fairness, respect, cost and to get the products at the right place at the right time for the customers. Since the land transport from Indian port to supplier will be made in containers just as the transport to India, I would say the chain continue to be lean. The flows in India will be built on the same forecasts when it begins operating as the shipping to India as the whole chain is considered in the system.

5.7.2 Lead time and inventory

It was hard to use Krajewski & Ritzman (2013., pp. 66-71) formula how to calculate expected lead time of orders. Because the IKEA bushiness developers working with exports argued it was impossible to give an upper limit on the transportation time. One reason was that certain ships take certain routes and the more ports the ship visit the longer time it will take, approximately one day per extra port. The transport time and thereby lead time was long, between one to three days for each land transport and 38-40 days' sea transport. This made the supply chain was heavily dependent on good forecasting due the long lead times.

Chopra & Meindl (2010) formula presented in the inventory section in the literature review for calculating frequency and order size presented in the inventory section of the literature review are also be hard to use in this specific. Since the transportation not yet had begun yet had begun IKEA employees had difficulties to tell how large the demand would be.

It is interesting to see how a strong and well-known brand can be important in questions about inventory capacity from external factors. The IKEA business developers, and Indian logistics manager told how IKEA was an attractive customer for external actors and that they never had problems to find storage in their existing supply chains. They did not believe it would be a problem in the Indian chain either. In the ports there were usually agreements that allowed free storage for 5-10 days, depending on country and contract. If goods needed to be storage longer than that, a daily fee needs to be paid. The costs could differ depending on what carriers IKEA was using. In India there should be no problem or large costs to store goods for a longer period of time. IKEA paid yearly fees per cubic meter.

The IKEA employees told that they needed stock to ensure that warehouses got their deliveries, which was of great importance. There did not seem to be high ordering costs, since ordering cost only was a small amount per trip to India. Important to note is however, that the ordering cost only include external fees and internal factors like, employees and other costs that IKEA need to pay to be able to transport containers. This study cannot answer if high setup costs are a reason why IKEA hold inventories.

There were no quantity discounts for shipping larger volumes argued an IKEA business developer, the shipping industry was not a market of quantities but a market of networks. It is the choice of network that decides the cost, not quantity. However, the Indian transport manager had another view and argued that the larger volumes the cheaper transport they get. My own data shows that quantity do affect the transport costs, but not in a great extent if the container are full. However, the difference between one or two containers is noticeable since the booking fee becomes a larger portion of the transport. The larger amount of containers, the less the effect. As long as the containers were full the only factor that was affected by volume was booking fee, in my model.

5.7.3 Bottlenecks and bullwhip

This report has not investigated bottlenecks that might occur in production of planks, glue board or finished material. It did not seem to be a bottleneck in transport capacity since IKEA due to a strong brand, is a highly acted customer for transportation companies according to all IKEA employees I talked with. No IKEA employee pointed out a process that they thought would need to work on full capacity for the supply chain to India. Neither did I manage to find a process that was going to run on full capacity, it seemed like IKEA would have an excess capacity for transport and inventory. However, the longest process was going to be sea transport

I was not able to find any clear evidence of bullwhip effects in the chain. However as mentioned before the chain had not start operating. Although I believe the centralized forecasting will help to reduce the risk of bullwhip effects, since the whole chain is accounted for in the process.

6 Discussion

In this chapter the method and results are discussed. A brief presentation of the most important results is made.

6.1 Reflections of study method

The reports search for answer to the research questions was a deductive case study with a flexible design described by Leedy (2010), Robson (2002) and Yin (2003). Since the chain had not begun operating it was not possible to observe the reality, therefore the deductive approach was selected instead of an inductive design, and it was a good choice. Data was collected from qualitative interviews and meetings, as well as secondary sources like data files showing the costs in the chains investigated. Information was also gathered from a literature review which gave inspiration that was important for this work, the flexible design was a good choice and allowed several types of data to be used. The use of supply chain mapping described by Gardner & Cooper (2003) proved to be a good strategy since it gave a good overview. However, the large scope made it hard to investigate the processes deeper.

The interviews were recorded with the permission of the participants and notes were taken to assure I did not miss data during the interviews. When needed, the interview subjects was contacted to clarify or make sure I had understood them right it was an important tool to assure that the data received was correct. In the end of the study one of my supervisors at IKEA also read through the work to ensure correct data was presented, which made me do some changes. I would argue it was a good and important way to validate the data.

The method activity based costing described by Andersson (2008) was a great tool for calculating how the number of containers affected the total cost of the different chains. The mathematical model used for the work was reviewed by IKEA employees to make sure the right costs were displayed and the calculations were correct and thereby validating the data. I would like to argue that the model can be used by other actors as well, even if some changes might be needed to specific cases.

6.1.1 Delimitations

It is important to keep in mind that the study was a case study of three products, therefore it is hard to draw great conclusions from the results and the results should be viewed critically. Similar studies would need to be conducted before conclusions can be made. Another weakness in the study is that it was conducted on a chain that not yet had begun operating, this made data regarding costs be based on predicted costs.

There were more delimitations in the study, like the fact that the study focused on the supply chain of glue board and planks from the Polish sawmill to the Indian supplier. The chain from the supplier to the warehouse was only briefly investigated. Behind this decision lay limitations in time and the need of focus to be able to receive enough relevant information.

6.2 Reflections of findings

The following section discuss how the results are similar or different to earlier made research presented in the report. Each heading discuss one of the research questions in this study, beginning with the first and ending with the last.

6.2.1 Supply chain structure

The findings about how IKEA´s supply chains are constructed are similar to the supply chains described by Kaplinsky *et al.* (2003). The description of the glue board and plank chain is however a little more in depth when compared to Kaplinski, *et al.* (2003) and therefore expanding the knowledge. Earlier in the work Accenture (2014) described the rapid growth in India, during my study I was informed that IKEA planned to open several new warehouses, which are in line with (*ibid.*) description of rapid growth.

In the report from PWC (2014) infrastructure limitations and IT infrastructure were described. The Indian manager described limitations in both roads and IT, but mentioned that it was easy to find storage places and that they was going to receive new IT systems, so the situation that (*ibid.*) described might be changing for the better? Or it might be so that the areas IKEA will work in have better roads and IT than the rest of India.

6.2.2 Supply chain costs comparisons between glue board/ plank chain and finished product chain (baseline)

Earlier I described how (Blanco, n.d) argued there were three existing strategies to supply emerging markets, send finished products, send components/ material or produce within the country. The results in the study show there are costs savings to be made when sending planks and glue board instead of finished products and this knowledge expand (*ibid.*) findings. However, more similar studies need to be conducted before it is possible to tell which strategy that is the best, since it only was a case study. There might also be impossible to draw great conclusions since different cases have various environments that might affect the profitability of certain strategies different.

The costs described by Mattson (2002) did also exist in the investigated chain and fitted well in his description. There were transports, handling, storage, delay and shortages costs. This report did however, not deeply investigate the transaction costs in real numbers described by Schmalensee & Willig (1989). However the way IKEA controlled their suppliers to make sure they meet IKEA standards and delivered in time proves these costs indeed exists. Earlier in this work I wrote about Sanyal (2006, see Deman & Tuyishime, 2009) who mentioned that the logistics costs was a great part of the total cost within India. This report investigated logistic costs both inside and outside India which was 7% for glue board and 22% of planks, a difference explained by the higher material cost proportion for glue board. I would argue that the logistic cost for glue boards is smaller, but for the planks the logistical cost is significant just as (*ibid.*) argued.

6.2.3 Risks in the supply chain to India

Christopher (1998) did define a number of risks, supply, demand, process, control and environmental risk. These risks existed in IKEA´s plank and glue board chain to India. Problems in processes could occur in the chain making the supply more problematic, like example damaged and delayed goods. The forecasts could show wrong values of the demand resulting in higher costs and IKEA controlled their suppliers to make sure they meet IKEA standards and delivered the goods in time. Therefore my results make (*ibid.*) claims more valid.

In the literature review Lambert & Cooper (2000) argued it is important to have a joint planning system and good communication between actors to be able to handle the demand. IKEA had a centralized forecasting department that will optimize the part of IKEA´s chain that was investigated in this report when it starts to operate in the future. This is a positive

result since IKEA is using the strategy promoted by Lambert & Cooper (2000). Earlier in the report Trkamn (2009) mentions there are continuous risks in supply chains. IKEA had several of these continuous risks, for example currency fluctuations and fuel prices that affected their chains. On the question of lacking infrastructure described be Deloitte (2013) IKEA employees argued there were no problems in port capacity, (*ibid.*) on the other hand, meant there were. The explanation of this difference might be that IKEA have a strong brand which could make it easier for them compared to other companies. Regarding the roads in India the supply chain manager argued that the Indian roads was bad, just as (*ibid.*) described, so in this point my results are in line with (*ibid.*)

As mentioned earlier IKEA leaves a lot of responsibility on their contractors, the chain investigated. It might be just as (Christopher and Lee, 2004) argued that management of risks has become harder with more global chains making it is easier for IKEA to outsource the risk management. In the literature review (Juttner *et al.,* 2003) referred to (Rao *et al.,* 2009) who described how risks should be handled. Risks should be assessed together with the effects of these risks, the reasons behind these risks should be investigated and then removed. As mentioned in the result IKEA worked with all these steps, but different parts of the chain had different strategies. Some worked more with collaboration and others worked on control and contracts. This report cannot tell which of these strategies that is the best, but it might be cultural differences that create this different strategies?

6.2.4 Supply chain management

IKEA employees argued that cost and service was equally important. However, in Christopher (2011) explanation in the literature review about lean chains he mentions that these chains often are built on forecasts and large volumes. An agile chain on the other hand often handles smaller and more unpredictable volumes. IKEA´s chain seems more like the lean chain described by (*ibid.*), while the transported volumes will be forecasted months before shipping. At the same time there are large quantities and steady demands. Contracts are formed with extra fees for changed volumes less than 2 months ahead, therefore I would argue that the main focus is lean cheap chains. However, as (*ibid.*) argued chains can be both lean and agile. The agile part in IKEA´s future chains to India is that two months before transports they are allowed to change volumes in their contracts, without any extra fees or other limitations

Both the formula described by Krajewski & Ritzman (2013., pp. 66-71) and (Chopra & Meindl, 2010) for calculating expected lead time and optimal inventory management was not possible to use in this work. It was hard to use formulas since IKEA´s chain had not begun operating, but I believe it would be useful tools to analyse the chain when the transports begins and there are more data available.

Krajewski & Ritzman (2013) theory that customers expect fast deliveries and companies thereby need to hold inventory fit well in this case, since the IKEA employees said they needed stocks to ensure that there are products available to customers. The high ordering costs as (*ibid.*) mentioned did seem to not be the case for holding inventories when viewing the result from the glue board and plank calculation model. However, few ordering costs were investigated, making this statement very uncertain. (*Ibid.*) argued that quantity discounts could be a reason for companies to hold inventories. It is uncertain if IKEA held inventories because of discount costs. I was as mentioned told that shipping industry not was a market of quantities, since the choice of network decided the cost. But in India the manager argued he could receive a cheaper price for larger quantities.

Krajewski & Ritzman (2013) argued that the longest process time or highest utilization process should be the bottleneck. In my investigating did I as mentioned not find process that someone believed would work on full capacity. The sea transport was the longest process. However, making the sea transport more quick would not increase the profitably so much since the sea transport only is a small part of the total cost and faster shipping would probably not increase the sales in warehouses. Faster shipping would probably not decrease the cost of transport, since from my own experience as a marine charterer costs increase if the vessels go above the normal speed. However, the impression received from the interviews was that the forecasts were the most essential part of the chain. It might not be a bottleneck by (*ibid.*) definition, but in my eyes it is the most important part of the chain. The volume that needs to be shipped is built on the forecasts and as mentioned there are long lead times. The long lead time also increase the importance of good forecasts because it takes so long time to send more material if a forecast fall short. It might not be important to make the forecasting process faster, but it is really important that the forecasting section in IKEA have resources and tools to make as accurate forecasts as possible. If the forecasts are accurate, it will help decrease unnecessary storage and extra fees for ordering late. (*Ibid.*) argued that improvements of the bottleneck would benefit the whole chain, and in this regard the forecasting process fit well in the definition of a bottleneck.

6.3 Key results

A point of great importance is the fact that in all three investigated cases there were cost savings to be done by sending planks and glue board from Poland to be assembled in India. To send finished products from IKEA´s cheapest suppliers were more expensive. The main reasons behind the costs savings was the lower tax rate and higher filling rate for the planks and glue board compared to the finished goods. Cost per container of planks and glue board did not get much affected by number of containers. The highest cost for the end product was material cost, both for plank and glue board products.

I would argue the most important process that had the greatest impact on IKEA´s future supply chain was forecasting. It was important to get the forecast right because long lead times for transports from Poland to India. Wrong forecasts could result in extra fees for IKEA if they were forced to break agreed volumes with contracted transport companies.

It is also interesting to see how different actors within the same supply chain of a company can have so different strategies to handle transport companies. The people that were going to work with the chain to India focused on control. IKEA and contracted transporters charged each other fees if the other did not meet agreed requirements. IKEA charged contractors if they became delayed and the contractors charged IKEA if they changed volumes too late. For future transports in India the Indian manager seemed to have another strategy. The manager wanted to focus on collaboration and long term partnerships. If one contractor had problems to meet deadlines the manager wanted to sit down and discussing the problem instead of charging extra fees.

IKEA has a strong and respected brand which makes them an attractive customer, which according to the IKEA employees interviewed helped them find storage place and transportation agreements.

7 Conclusions

In this chapter the conclusions of the study are presented and the research questions are reviewed. Practical recommendations to IKEA and similar companies are made and ideas of future research are presented.

There are possibilities to do cost savings and therefore receive higher profits by evaluating supply chains. Even if the transport takes a long time the biggest cost seems to be material for finished wooden products. Material cost also affect duties.

- In all three investigated cases it was cheaper to transport glue boards and planks. Because it allowed sending more products per container and the duty rates was lower.
- The logistical costs seem to be affected by routes and quantity and different parts of the chain are affected more than others. Transporting several containers by sea had only a small effect on the price little, but during transports by land in India quantity did matter for the price.
- Material cost in was the largest cost for supplying Indian manufacturers with planks and glue boards.
- Forecasting is a very important factor, at least in IKEA´s future supply chain to India. Long lead times, extra fees and transportation time makes it really important to plan and send the right volumes. Safety is also important to keep in mind when transporting containers on the Indian roads.
- It is interesting that a supply chain of a large and global company can have such different strategies to work with transport companies. In this case, it was between controlling and charging fees on transporters for delays (transport to India) compared to work together long-term trying to overcome problems (transport within India).
- Even if it was not a target at the beginning of the study, the received data points out that there are great benefits of being a large, well known company. It makes the company an attractive customer, which makes it easy to find storage or transportation.

7.1 Answers to research questions

- *”How could a supply chain for wooden product to emerging markets be constructed?*

To supply emerging markets with wood at least to India, it is preferable to send material, like planks and glue board instead of finished products.

- *“Evaluate the costs of producing planks and glue board and send it to emerging countries to be assembled and investigate what factors that influence the cost. Is it cheaper finished wooden products instead?”*

Planks and glue board have lower taxes and higher fill rates for containers which results in lower costs compared to finished products. Material cost also has a great effect on the final costs in the plank and glue board chain because duties in India are based on this cost.

- *Are there any supply chain risks that affect chains in India? For example, supply, process, control or demand risk?*

There is a risk goods can be damaged during transport and truck accidents can occur in India, but these risks should be unusual. Incorrect forecasts of the demand of products could result

in extra transport fees for sending more or less than planned. It is important that stores receive products from the supply chain to make sure the products are available for customers. Supply chains to emerging markets are also affected by continuous risks such as fluctuating fuel prices and currency rates which affect the transportation cost.

- *How are inventories handled in the investigated chain? Are there lead-times? Is the chain lean or agile?*

IKEA need inventories to keep the products available for their customers. The company has no problem to find storage places and transport agreements due to a strong and respected brand. There are long lead times because of long distances and the chain is lean focused.

7.2 Practical recommendations

My study of the three products shows there is a possibility to make cost savings by importing planks and glue board and then further refine them in an emerging market like India. This applies even if the transport way is long in this case (all the way from Poland). I do not believe it is possible to draw a conclusion and say this are the case in all similar cases. The result shows there is a possibility of cost savings for transporting glue board and planks instead of finished furnitures. Therefore I would recommend companies that want to expand to new markets to at least investigate the option to send glue board and planks instead of wooden furniture.

Another advice is that companies should evaluate if big volumes results in cost savings this was not the case in my study. I would also argue that it is important to investigate tax rates early, since at least in India the taxes can be quite complex. It is also important to investigate tax rates for different kinds of refinement levels for wooden products, since the tax difference can be really large.

7.3 Ideas of future research in the field.

- I only made an investigation on three products, and it would therefore be interesting to investigate similar cases to see if the same conclusions can be made.
- The focus on this study was from a sawmill in Poland to an Indian supplier. It would be interesting to more deeply investigate the chain between supplier and warehouse.
- This study did very briefly investigate control and management costs, which makes it interesting to investigate these subjects more in depth.
- It would be interesting to investigate how the environmental footprint is affected when sending planks and glue board instead of finished goods. Another important subject to investigate could be how different production locations affect the total environmental footprint.

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