Master's degree thesis

LOG950 Logistics

Assessing the possibilities of cost reduction of international transportation.

A case study of Norwegian Icons AS

Bezzaz Saad Eddine

Adarkwa Junior Bright

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Preface

This Case Study is submitted to the faculty at Molde University College-Specialized University in Logistics In partial fulfilment of the requirement for MSc. Degree in Logistics. As preparation for this thesis a proposal document has been written and approved in December 2018. This thesis has been written within the period of January to May 2019 under the academic and industrial supervision of **Hansson Lisa and Svenning Geir Arne**.

This case study has been conducted on the Possibilities of cost reduction of international transportation. A case study of Norwegian Icons. The paper consists of an introduction, literature review, case description, methodology, data analysis and discussions, conclusion, recommendations, and further research. From the discussion of this study, we believe that one can understand the transportation activities of Norwegian Icons and how to transport High-quality products from Norway to Japan efficiently.

Acknowledgements

First and foremost, we would like to thank the Almighty God for giving us the strength, knowledge, and courage to endure all the difficulties that we went through in the pursuit of courses studied and the accomplishment of the paper.

Our Special gratitude and thanks would be extended to our supervisors for their valuable supervision in the form academic and industrial knowledge, constructive feedbacks, and Guidance throughout the writing process of this master Thesis.

We would like to express our heartfelt gratitude and appreciation to Molde University College for giving us the academic admission to study in Norway.

We also appreciate the contribution from the firm and its network members used for this case Study (Norwegian Icons) for given as the opportunity to participate in solving an organizational challenge and also providing valuable information.

Finally, we would like to thank our friends and family for their unfailing support, prayers, encouragement, and understanding. Thank you all.

Abstract

The growing importance of internationalization and transportation of Product across borders has created the need for a strategy to guide firms in their international transportation processes. The volume of product, information and money flowing across international borders provides a challenge because it is ever expanding. To minimize total costs and maximize customer value, transportation integration plays an essential role within the supply chain. This Paper assesses the possibility of costs reduction in an international supply chain of the firm, Transportation efficiency can be measured in many ways, which leads to different conclusions. The literature states that costs, time and service level are fundamental variables in the choice of transportation modes, it can be established that cost and time variables turn to define the mode of transportation. On the other hand, distance, transport flows and freight volumes are more associated with infrastructure location and distribution focuses, while the loading unites characteristics such as maximum weight, size and damage are related to planning models for loading unit allocation. The discussion presents an efficient way of transporting a high-quality product from Norway as well as China to Japan.

From Norway to Japan, the results of the study show that there no significant difference in terms of TLC for the two-transportation mode. However, maritime is the efficient mode for exporting the product from China to Japan.

The results of the study are limited to Norwegian Icons and its transportations to Japan. However, the model is applicable to other organizations.

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Acronyms

CN	Corporate Network
FDI	Foreign direct investment
IANA	Intermodal Association of America
ITTC	Intermodal total transport cost
NI	Norwegian Icons
TC	Total cost
3PL	Third-Party Logistics Services provider
NOK	Norwegian Kroner
¥	Japanese yen
KG	Kilogram
TSA	Transportation Security Administration
TLC	Total Logistics Cost
EOQ	Economic Order Quantity
GSC	Global Supply Chain
LCL	Less than Container Load
TSA	Transportation Security Administration
ETQ	Economic transportation Quantity

1.0 INTRODUCTION

The growing importance of internationalization and transportation of Product and services from Norway to a different country(s) has created the need for a strategy to guide firms in their international transportation processes, since the initial involvement in international market is conceived to be a gradual and a sequential process which involves greater uncertainty, higher cost and lack of knowledge. The volume of product, information and money flowing across international borders provides a challenge because it is ever expanding. Johanson and Wiedersheim-Paul (1975) stressed that “the most important obstacles to internationalization of a firm are lack of knowledge and resources. These obstacles are reduced through incremental decision-making about foreign markets and operations”.

According to Johanson and Wiedersheim-Paul (1975) internationalization refers to either an attitude of the firm towards foreign activities or the actual carrying out of activity abroad, and Planning, arranging, and buying of the international transportation services needed to move a firm's freight is known as transportation management Wood, Barone et al. (2012). Transportation is the activity that is considered most costly in international logistics. Transportation plays a key role in achieving customers’ satisfaction, this applies to both services and products since the right product no matter how high the quality or superb the utility is, it is of no value toward customers unless it is where it is needed at the desired time. Transportation is an important domain of human activity, it supports and makes possible the flow of social, economic and exchange activities. As firm strategically competes on the basis of costs, services, or time, transportation can play a key integrative role in the supply chain structure, where the structure attempts to coordinate cross-functional activities into holistic business processes both within and across the company's supply chain. According to Crainic and Laporte (1997),” Transportation is a complex domain, with several players and levels of decision making, where investments are capital-intensive and usually requires long implementation delays”. For Coviello and McAuley (1999) with the number of interpretations being found in internationalization literature, a single universally accepted definition of the term “internationalization” remains elusion. They identified three individual schools of internationalization namely: the economic school of foreign direct investment (FDI) theory, which explains internationalization as firms choosing their optimal structure for each stage of production by evaluating the cost of economic transactions, transactions perceived to be high risk and acquiring significant management time or resources commitment are more likely to be internalized as part of hierarchical structured organization. Research into this area primary aims at explaining a pattern of investment in terms of its extent, form and location of international production and not a long-term process of internationalization. The next school of internationalization is the school of the established chain model, it suggests that internationalization activity occurs incrementally and are influenced by increased market knowledge and commitment, this school also suggests that internalization is a pattern of innovation and adoption of behaviour. The third school according to Coviello and McAuley (1999) is the relationship of the network perspective which draws on organizational growth, behaviour and learning theories to capture internationalization. Under this school, internationalization occurs incrementally and are influenced by increased market knowledge commitment that is enhanced market knowledge, leading to further commitment in a more distant market which includes offshore manufacturing and sales operations.

Since societies are auto satisfied with goods and service, transportation finds its necessity in our life. Logistics policies and transportation cost issues are currently at the heart of a number of reflections within the companies, in a context of sustainable development, for Hesse and Rodrigue (2006) transportation and logistics are fundamental to the emergence and operation of both early and more recent forms of development. However, the logistics organizations of firms which combine procurement, production, inventory, distribution and transport, involve a number of arbitrations, short or long term (Abdallah 2004). In many economies, companies engaged in international trade struggle with high trade costs arising from transport, logistics and regulation that impede their competitiveness and prevent them from taking full advantage of their productive capacity competitiveness Business (2018).

From 1950–2004, world trade grew at a rapid average rate of 5.9 per cent per annum. The annual growth rate of manufacturing trade was even faster, at 7.2 per cent Hummels (2007). For Leonidou, Katsikeas et al. (2002) Exporting has traditionally been the most popular mode of international market entry, favoured especially by small and mediumsized firms(SMEs). Trade costs have a huge role in developing international commerce between countries, nowadays, the importance of transportation costs in relative terms is considerably higher than in the past.

Transportation management is concerned with freight consolidation, carrier rate and charges, carrier section, certain documentation, tracing and expediting loss and damage claims. Freight consolidation according to Wood, Barone et al. (2012) means the assembling of many smaller shipments into a smaller number of large shipments which in turns reduces the charge per product since paperwork and individual handling are reduced.

According to Wood, Barone et al. (2012) international managers in the 21st century will have to make numerous adjustments to their strategies, tactics, activities, practices in order to accommodate the concerns of environment stakeholders such as activist groups, government, and the general public. The volume material, information and money flowing across international borders provides a challenge because it is ever expanding. For Tseng (2004), the operation of transportation determines the efficiency of moving products, the progress in techniques and management principles improves the moving load, delivery speed, service quality, operation costs, the usage of facility and energy saving. Tseng stressed that, "without the linking of transportation, a powerful logistics strategy cannot bring its capacity into full play".

According to Hummels (2007)"Understanding modern changes in transportation costs turns out to be unexpectedly complex. Shifts in the types of products traded, the intensity with which they use transportation services, and whether these goods are shipped by ocean or air freight all affect measured costs ". Efficient transportation minimizes total cost and creates value for customers which makes transportation integration an essential part in the supply chain since transportation cost determines the efficiency of moving product.

Previous studies on internationalization and transportation have focused on examining issues such as export behaviour of small and medium enterprises, looking at the forces that drives internationalization. The purpose of this study is to assess the possibilities of cost reduction of international transportation.

1.1 Problem Statement

According to Szymanski, Bharadwaj et al. (1993), companies that are planning to enter foreign markets should analyze how similar the local and foreign markets are in terms of marketing strategy variables and performance targets, and one of the marketing variables is Distribution. The main problem expressed by NI since they are already in the Japanese market is the need for logistics model adapted to the network characteristics, which can, in turn, be transferred directly to other international markets. Knowing that in most of the industries, transportation is considered to have the highest cost among the related elements in the logistics system. Therefore, an improvement in transport efficiency could change the overall performance of logistics and help the company to enhance its competitive advantage.

An interview was conducted with the manager of NI in order to have a clear view of the challenges that the company is facing in their logistics operations, thus our research questions will be built based on real business life problems.

The logistics challenges expressed by NI include; transport costs, order policy, warehouse costs, and cash flow or liquidity challenges.

1.2 Research Question

The main challenge expressed by Norwegian Icons is how to design a logistic model adapted to the nature of the "network". However, the principal research question of this study is "**How can Norwegian Icons organize the international transportation activity of exporting High-Quality products of different manufacturers to Japan in an efficient way**?"

A central part of a case study is the research question, according to Bell, Bryman, and Harley (2018) research questions are necessary to clarify what is being studied and guides the literature search, the design of the research, the data collection, the analysis and most importantly it narrows down the research topic.

Table 1: The Research Question process Adopted from Bell, Bryman and Harley (2018)

1. Research area	2. Narrow the reasearch area	3. Research questions	4. Select Research Questions
• Global supply chain	•Transporting High Quality Norwegian Designs products from Norway to Japan •Globla outsourcing and logistics managemt •Risk management in international logistics	•How can NI organize the transportation activity of exporting from Norway and China to Japan in an efficient way •How can Norwegian Icons Logistics planning contribute to a more efficient delivery of goods from the manufacturers to the customers •How can NI implement a common system of supply chain management with norwegian design exporters •How can NI minimize the cost of shipping goods from Norway to Japan ? •which mode of transport minimzes the international transportation costs ? •what would be the adequate ordering policy after transport minimzing ? •What is or the best shipping options in term of transport costs, time and service level. •Does transportation costs minimization increases or decreases customers satisfaction?	• How can NI organize the transportation activity of exporting from Norway to Japan in an efficient way • What is or are the best shipping options in term of transport costs, time and service level?

The Table above shows that research question can be derived using the four steps outlined by Bell, Bryman et al. (2018), as depicted above, the research area for this case study was chosen from Global Supply Chain, then narrowed to international transportation and Transporting High Quality Norwegian Products to Japan using Norwegian Icon as a case study. After the case study was specified, some potential research questions were developed as shown in the third column of the table, finally, two of the potential research was selected for the purpose of this study.

The objective for this research is to explore if there are ways to reduce the global supply chain management costs and more particularly transportation cost during the export process of the Corporate network without compromising the high service level, this is, this study seeks to investigate the existing method used by Norwegian Icons (NI) to transporting High quality Norwegian designs to Japan and propose an alternative if appropriate for management decision making. This objective is selected due to the fact that efficient transportation requires more and more attention from managers since it has the potential of saving money, times and resources and improved transportation could change the overall performance of the logistics system and thus the global performance of the network.

1.3 Scope of study

The study is aimed at assessing the international transportation of High-quality Norwegian designs of “Corporate network” to Japan, it is mainly focused on the transportation of high-quality products from Corporate Norway only, does not consider the whole activity of corporate Network. This research will also consider exploring additional efficient methods related to supply chain management cost like ordering policy and inventory management.

1.4 Structure of the thesis

This study is organized as follows. The first Chapter entails the Introduction of the study and background information’s related to the study, problem statement, research question and the scope of the study are treated in this first part of the study.

The second chapter examines literatures on the area of Transportation and internationalization to enable us to review existing theories which provide the knowledge for the framework of the study.

The next Chapter presents the description of the case “Norwegian Icons” which is a company that focuses on exports Norwegian design and also the presentation of corporate network, Japan which consists of high-end manufacturers, this chapter also examine the organization of marketing channel, and description of the export logistics.

Research methodology, sources of data and types of data including data collection mechanisms. Data analysis and methods for interpretation as well as the limitation on data are treated under the fourth chapter.

The first part of Chapter five uses the total landed cost to understand the global operating cost of exporting products and analyze the weight of international transportation cost, the second part of this chapter shows the calculations and mathematical formula used in the development of total logistics cost model.

Chapter Six uses the total logistics cost model to analyze the different transport options and modes and compare it with the current transportation strategy which is followed by the explanations to the findings of the data analysis, discussions and recommendations on alternatives ways to organize the international transport of Norwegian Icons products. Finally, a synopsis of the summary of the study is provided and suggests future research.

2.0 LITERATURE REVIEW

The primary objective of the literature review is to find out what kind of theory could be studied and applied to the case of Norwegian Icons, in order to get a scientific and objective answer of the research problem of this study concerning transportation as well as to obtain a satisfactory level of understanding of the relevant literature and also to find out what has been done by other scholars on this area of study.

2.1 Transportation Costs

To minimize total costs and maximize customer value, transportation integration is essential within the supply chain. Modern multinational companies seek to minimize costs associated with transportation in their quest to improve logistics to achieve competitive power. Therefore, the accurate definition, measurement, and management of transportation costs for supply chain operations are essential for the successful operation of the business since Supply chain management, broadly defines the integration of key business processes from user through original suppliers that provides products, services, and information for customers and other stakeholders. Many authors such as (Hummels 1999, Krugman 1991, Venables and Limao 2002, Hummels 2007) studied economic approach of the international transportation costs determinants, mainly are distance, the weight of the product, volume, number of shipments and transit time, these variables are considered the main explanatory variables of transport costs. (Martínez-Zarzoso, Pérez-García, and Suárez-Burguet 2008) emphasized in their study the different impact of transport cost determinants has on transportation costs within different sectors.

According to Hummels (2007) The economic approach to examine transportation costs is in three perspectives, the first one transportation costs relative to the value of the goods being moved, which is equivalent to the percentage of change in delivered price resulting from paying of transportation (ad valorem terms), followed by transportation costs related to other known barriers to trade, like tariff in this case we should examine the tariffs imposed Japan on imported product, although Business (2018) stated that high transportation costs put even greater barriers to trade than import tariffs; and the last one is the extent to which transportation costs alter relative prices, that is the ad valorem percentage change in prices due by transportation is high for voluminous goods than tiny goods for the same product’s price (1000 NOK coal vs 1000 NOK microship).

In logistic perspective, the cost of transport is the line-haul rate for transporting goods and any accessorial between two points plus any additional charges, such as for pickup at the origin, delivery at the destination, insurance, or preparing the goods for shipment, makes the total cost of service Ballou (2007).

When trying to determine and figure out the transportation cost, one must consider some obstructions that are important to have a good understanding of, which are Incoterms. Incoterms is a standardized contract practice that was founded in Great Britain in the nineteenth century Ramberg (2010). Regarding NI, it does not really matter which incoterm category to be opted for since their products are sent to their stores in Japan and latter to Japanese clients. However, another cost could be taking into consideration here, the cost of owning their private carrier especially outbound shipment in Japan, this cost is can be classified by NI as a long-term investment to enhance customer service delivery, according to Ballou (2007) the major reason for leasing or owning transport equipment is to provide a high service level for clients that is not always obtainable from hire carriers. For (GRØNLAND, HOVI et al. 2014) the choice of a logistics system depends on what provides the enterprise with the highest competitiveness in terms of cost-effective supply chains, service performance that meets customer needs and securing optimal supply of Good.

2.2 Transportation Network and Transportation Mode Selection

Global transportation from suppliers to the markets in another country or around the world yields higher cost and longer transit time, which makes international growth and transportation mode selection an important challenge to logistics management. Transportation mode and carrier selection involves identifying relevant transportation performance variables, selection mode of transport and carrier, negotiating rates and service levels, and evaluating carrier performance.

According to Ballou (2007) there are three main levels of transportation networks ranging from physical to operational, and to strategic.

Physical Network is the lowest level and as the name suggests its main focus is on physical movement on the ground that the product takes from origin to destination including guideways, terminals and controls.

The operational level is a series of nodes and arcs, nodes represent decision point and arcs are those decisions that are made in term of costs, distance and so forth.

The third level is strategic network and this is more about the path from end to end, that is from the beginning of each plant to the very final destination, where each path represents a complete option and has end-to-end cost, distance, service characteristics and service level.

There are different transport modes that are available to companies to manage their transportation needs in supply chain such as maritime transport, air transport, rail transport, road transport, package carrier and pipelines, the use of these transport modes generally depends on the cost, the time, the supply chain strategy approach (responsive, efficient), the distance and level of service. Based on Sunil Chopra (2016) we discuss the main characteristics and performance of each transportation mode.

Maritime transport: Maritime transport has undergone several important technological developments, and the most important is containerization that helps to offer more capacity of cargoes to be transported which improved the efficiency of transportation in general, even though it is limited by its nature to certain areas. The most important shipping carriers include A.P. Moller–Maersk Group, Mediterranean Shipping Company (MSC), COSCO and CMA CGM Group Alphaliner (2018). Maritime transportation is a major mode for shipping all kinds of goods, it is generally much slower than its direct competitor air, customs issues and loading & unloading can cause additional delays. However, is less costly (even though the index rate volatility is high) and better carbon footprint (CO_2 and NO_x emissions depends on some factors as speed).

Air Transport: for Long (2003) The main characteristic of air transport is that it is quicker and smoother than land or sea, less transport-related stress, less packaging is needed and fewer insurance expenses. However, air Transport is more expensive than other modes, even though the price of air shipment fell by 71 – 88% relative to ocean transport from 1960 to 2000 (Choate 2009), air freight rate stays high, when compared to other transportation modes, it is two times high than trucking and 16 times compared to rail transport Ballou (2007). main challenges that air carrier face include identifying the location and number of hubs, assigning planes to route, and managing prices and availability at different prices.

Rail transport: Transportation time of rail transport mode could be long, but the price structure that offers and heavy load capabilities makes on rail a competitive transport mode for heavy and low-value shipments that are not time sensitive as coal, the major drawback of rail is on-time performance because of large amount of time taken at each transition.

Road transport: this is also referred to truck transportation, it is mainly used in last mile delivery and within intermodal freight transportation. Trucking is generally more expensive than rail but offers door to door delivery and shorter delivery time.

Pipeline: Primarily used in oil and Gas industry to transport both crude and refined petroleum, natural liquefied gas.

Packaging carriers: They are transportation companies like DHL, FedEx, UPS and National posts, package carriers use air, truck and train to transport packages. E-business industry as Amazon, eBay subcontract their transportation activity to packaging in order to pick up and deliver a small package to the final customer.

It is important to consider the ratio weight/value, this ratio is a useful statistical method for pre and posts transportation mode assessment, the higher the ratio the more the need of storage or space during transportation and after delivery. Hence, the maritime transportation mode seems suitable, the transportation of raw materials is a good example of this case. on the other hand, A fall in the weight/value ratio means the product transported is of high-value ratio leads to the need of air transport because the value of goods transported during the lead time “in-transit inventory cost” is high, by consequence, it will increase the cost of handling products. Therefore, the need for higher quality service, insurance and rapid delivery seems important.

Concerning transportation mode choice, the cost, time and the quality of service required during transportation are the main variables that affect the decision, these variables determine the performance of carrier. Strasser (1992) consider transport mode selection is based on carrier’s performance. Cullinane and Toy (2000) apply content analysis methodology to the freight route/mode choice and they conclude that five variables mostly used in transport mode selection which are freight rate, speed, transit time reliability, characteristics of the goods and service level.

Besides the cost, time and the service quality factors, as well as strategic and operational considerations of transport mode decision, there are other exogenous factors that might affect the company’s decisions such as:

● Geography: exporting products globally is usually done by air, or by the ocean. Therefore, geography limits the options in this case.

● The shipment size: high weight or high cube items are difficult to be transported by air, and large oversized shipments might be restricted to rail or barge.

● The required speed of transported goods, for instance transporting product 800 km in one day cannot be done just by air.

(Larson 1988) developed a model that determines the optimal transportation alternative and lot size or shipping quantity. Through the calculations of Economic transportation Quantity (ETQ). The same as Economic Order Quantity (EOQ), Economic transportation Quantity is derived from a total cost formula that includes the cost of buying the material and delivering it to the destination where it creates revenue, ordering costs (including origin and destination costs, plus shipment loading costs), Holding Costs for the origin and destination inventory, and holding for in-transit inventory. Larson stressed that the Economic transportation Quantity model is a step in the direction of coordinating the operations of the vendor, carrier, and the buyer.

The table below summarizes the performance and characteristics of each transport modes based on the ranking of the impact of using different modes of transportation on certain variables presented by Sunil Chopra (2016) combined with the ranking table of Ballou (2007) about transport modes performance. The scale is from 1 to 6, 1 indicates the best performance and 6 is the worst. For instance, the air cost scale level is 6 which means it is the worst because it is the most expensive transport mode among the others, while water transportation has 1 in cost which means is the cheapest and 6 on average time which means is slowest transport mode.

Table 2: Ranking of transportation modes in terms of supply chain performance

1 == Best
6 == Worst

Mode of transportation	*Cost*	*Average Time*	*Variability time*	*Cycle Inventory*	*Safety inventory*	*In-transit cost*	*Loss and damage*
Air	*6*	*1*	*2*	*2*	*2*	*2*	*3*
Water	*1*	*6*	*5*	*6*	*6*	*6*	*2*
Rail	*2*	*5*	*4*	*5*	*5*	*5*	*5*
Truck	*3*	*4*	*3*	*4*	*4*	*3*	*4*

Sources: (Ballou 2007, Sunil Chopra 2016)

The table above shows that there is no transport mode which can outperform the others in all criteria. For example, maritime is the best in term of transport cost but has the worst performance in terms transport time and time reliability. On the other hand, air transport is largely expensive than the other transport mode, but is the fastest in terms of transit time and reliability.

(Ballou 2007, Sunil Chopra 2016) presents this table from general perspective. However, it is important to point out some relativity regarding transport cost, which is related to variables such as distance and the weight of transported cargo. Hesse and Rodrigue (2004) mentioned that different transportation modes have different cost depending on the serviced distance. The authors argued that transportation by road is the cheapest for shorter distance between 500 and 750 km, followed by rail transport which becomes more advantageous to distance up to 1500 km, and maritime becomes more profitable to use for relatively longer distances.

In practice companies refers to more than one transport mode for their shipment delivery for efficiency seeking, this concept is known as intermodal transportation which is discussed in the following section.

2.3 Intermodal Freight Transportation

“Intermodal freight transportation consists of using at least two different transportation modes to move freight loads that are in the same transportation units from origin to destination without handling the goods themselves. Macharis and Bontekoning (2004), and for Dewitt and Clinger (2000), intermodal freight transportation is defined as the use of two or more modes to move a shipment from origin to destination, it involves the movement of physical infrastructure, goods movement and transfer and information drivers and capabilities under a single freight bill.

An integrated intermodal transport system has significant and critical factors in the successful execution of supply chains both domestically and internally, internationalization and globalization of an organization places demand on intermodal transportation system requiring organizations to rethink their transportation policies and investments. Environmental concern and traffic safety have increased the attention of intermodal transport problem in every economy. The importance of speed and agility in the supply chain is driving organizations towards an interest in intermodal freight transportation problem-solving.

According to Macharis and Bontekoning (2004), intermodal transportation freight transport has developed into a significant sector of the transport industry. “Intermodal freight transport is the term used to describe the movement of goods in one and the loading unit or vehicle which uses successive, various modes of transport (road, rail, water) without any handling of the goods themselves during transfers between mode” (European Conference of ministers of Transportation,1993) we consider that intermodal transportation has been used as a strategic tool for benefiting from the advantages of modes of transport, with road–rail, road–air, sea–rail and sea–road combinations being the most suitable and competitive for freight transport.

According Dewitt and Clinger (2000). The growth of intermodal freight transportation will be driven and challenged by four factors:

- Measuring, understanding, and responding to the role of intermodal in the changing customer requirements and hyper-competition of supply chains in a global marketplace

- The need to reliably and flexibly respond to changing customers' requirements with seamless and integrated coordination of freight and equipment flows through various modes

- Knowledge of current and future intermodal operational options and alternatives, as well as the potential for improved information and communications technology and the challenges associated with their application

- Constraints on and coordination of infrastructure capacity, including policy and regulatory issues, as well as better management of existing infrastructure and broader considerations on future investment in new infrastructure.

The main goal of intermodal activities for Seo, Chen et al. (2017) is to provide consignors with convenience, rapidity, safety, and economic efficiency in intermodal transport. For Min (1991) due to the lengthy distribution channel, international trade is often characterized by intermodal shipment which moves products across national boundaries via more than one mode transportation, the intermodal choice however has never been a simple matter for any manager because it can be affected by the multitude of conflicting factors such as cost, on-time service, and risk. Highly efficiency choices of intermodal transport combinations can lead to high consignor satisfaction. Authors have mainly focused on the following issues to provide optimum solutions to freight transportation

- Container time, type and capacity.
- Weight and size of freight.
- Delivery times, shipment priority and preference for a specific mode of transport.
- Regional geographic constraints.
- The freight's points of origin and destination.
- Available infrastructure

Kordnejad (2014) stressed that loading space utilization of the train or transshipment cost is critical factors for the success of the intermodal system, therefore, it is necessary to consolidate other freight flows in the train or container in order to achieve high loading space utilization. According to the Intermodal Association of America (IANA), freight containers are utilized in intermodal, which eliminates direct handling of shipments and potentially reduces damage as well.

2.4 Transportation Management and Transportation Risk

Transportation remains a significant factor for the success of Logistics, it is one of the determinants to organization integration and efficiency. Transportation plays a competitive strategic role for a business in consideration of the target customers' needs in the way to fulfil every customer in a responsive manner, whether the competitive strategy that a firm use is cost leadership or differentiation, transportation is a mean to achieve it.

"Firms usually use inventory and transportation to increase responsiveness or efficiency" Sunil Chopra (2016). Freight transportation is usually dependent upon the demand of a product in another location or across a border. The product demands relate to the costs of the transportation services provided, transportation services characteristics of freight include transit time, accessibility, capability and security Coyle, Novack et al. (2011).

Transportation management differs according to the product characteristics transported, Fisher (1997) distinguish two types of products characteristics innovative and functional, he proposed the alignment between the supply chain strategy and products characteristics, the functional products match with physically efficient supply chain, whereas market responsive supply chain is fitted to innovative products.

The network`s manufacturers products are high end both classical and modern fashion designs, low volume, high variety, high profit margin and short life cycle, targeted Japanese market characterized by high purchasing power, demanded clients and fashion trends change quickly, to Serita, Pöntiskoski et al. (2009) asserts that all these features make their products innovative in the Fisher classification, and the transportation decisions should be the one which hedge against uncertainty, and ensure the speed and flexibility not about minimizing costs. The managers should invest aggressively in ways to reduce lead time, and for inventory strategy, a significant buffer stock of parts and finished goods should be significantly deployed Fisher (1997) with consideration of managing both shortage and excess stock where both generates high costs.

Logistics managers must balance transportation and inventory costs while deciding on which mode of transport to select since high responsiveness to customers leads to higher transportation cost. If responsiveness decreases and aggregate orders arranged in a longer time horizon before delivery dates end would lead to take advantage of economies of scale and incur lower transportation as a result of large shipment. According to Sunil Chopra (2016) organizations should consider the trade-off between responsiveness and transportation cost at the time of designing transportation network. Developing transportation strategies based on the mode of transport, packaging requirement, supervision, insurance, and determining how they inter-relates can be compared to the techniques used by commercial and industrial risk management firms Wood, Barone, et al. (2012). Thus, higher packaging costs may be balanced out by lower supervision expenses and using a courier may lower insurance premium and packing costs.

Transportation is one of the logistics activities with full of risk, many transportation risks are created by poor execution of day-to-day operations. Ineffective decision making, employee errors, and basic glitches cause temporary disruptions of freight flows. Such risks will lead to having supply interruptions that bring transportation operations to stop, the nature of the risk may vary but includes product pilferage, product contamination, and delivery delay. Other risks are out of the control of the organization and effects the operations of the organization, delivery schedule disruption such as congestion, poor weather, and equipment malfunction. Risks related to transportation that are also external to the organization includes Carrier bankruptcy, labour disruption and capacity shortages (during peak economic growth).

For most firms, transportation usually represents the most important, single element in logistics costs, since freight movement has been observed to account for between one-third and two-thirds of total logistics costs Ballou (2003). For GRØNLAND, HOVI et al. (2014) transportation patterns for freight transport is largely as a result of how the organizations

Logistics systems are designed. Transportation of goods, freights transport, have no other purpose than to support the corporate value creation.

2.5 Sustainable Transportation

Addressing the sustainability of transportation systems is an important activity as evidenced by a growing number of initiatives around the word to defined and measure sustainability in transportation planning and infrastructure provisions. Today's global economy has challenged transportation managers and societies to deploy a sustainable system in their planning. Sustainable transportation mainly focuses on reducing exhaust gasses, and these includes carbon dioxide dioxide (CO_2), Sulphur (SO_2), Nitrogen (NOX), Carbon Monoxide (CO). Practicing sustainable transportation means incorporating the three "Pillars" (Economic Viability, Social equity, and Environmental protection) of sustainability into the planning of the transportation.

Economic Viability; activities that fits under this pillar include proper governance, risk management, and compliance. This pillar provides measures that organizations adopt to and develop sustainable strategies. Social Protection; a sustainable strategy should have the support and approval of its stakeholders, employees, and the community it operates in. this pillar is about treating the employees fairly and been good to the community and it members. Environmental protection; Environmental pillar has received most attention, company tries to reduce their carbon footprint, packing waste, and the overall impact on the environment. By lessening the amount of materials use in packaging for instance reduces the overall spending on the product.

Generally, there is little motivation for most firms to invest in those things that will help move towards transportation system sustainability because the costs and benefits are so out of line with each other. To develop a sustainable intervention programs for sustainable transportation, governmental and industrial policies on transportation sustainability should be enforced, this has the potential of involving all players and stakeholders to contribute in addressing the issues collaboratively.

One way for Norwegian Icons to be sustainable in its transportation is to integrate "Synchromodal transport" in its transportation activities. Synchromodal transportation seeks to balance between goods flow, transport chains and infrastructure chain such that the volume of goods can largely be consolidated and the unused capacities of the transport modes and the infrastructure can be utilized at all times. In Synchromodal transportation the firms agrees on a delivery of the product at a specified costs, quality and sustainability but the service provider has the authority on which mode and how the product would reach the destination. Thus the 3PL investigates the possibilities of using an existing transport infrastructure and resource more efficiently by developing sophisticated synchromodal transit chain through an improved information availability and exchange and better planning and scheduling.

Most studies on sustainable freight transportation concentrate on the reduction of CO_2 as it is dominate and has the greatest effect, implementing Synchromodal transportation system offers better advantages of sustainability in all dimensions. However, Trust and collaboration are very necessary for this process because many companies and business entities fells reluctant in cooperation with each other for fear of market completion. To achieve a win-win game in the synchromodal Transport, coordination among the actors and players is very essential to enhance fair gain and risk sharing.

3.0 CASE DESCRIPTION

3.1 Norwegian Icons AS

Norwegian Icons AS is a company that focuses on exports of Norwegian design. Through the Norwegian Icons, business and communication channel (Direct Trade) between the international market and the producers in Norway have been created. Norwegian Icons now collaborates with the most important producers of Norwegian design both classic and contemporary designers in Norway, as well as with the best retailers for international design for the Japanese Design market.

Norwegian Icons acts as the network project coordinator and facilitator, it is employed as external consultants for the network and responsible for running the processes in the network in the future. Norwegian Icons is also largely responsible for implementing joint projects, especially in Japan. The corporate network has been heavily focused on implementing international and national projects in order to achieve increased reputation at home and abroad. Now, the network *is fully focus on the Japanese market as a test case for the development of trade and communications platform into a particular international market* **(NI Document 1).**

3.2 Core Participants of “Corporate Network Japan”

The project of the network consists of a group of companies that today are represented in Japan and wish to be part of "Corporate Network, Japan". Besides Norwegian Icon, the corporate network consists of five principal manufacturers with the Norwegian Icon. In addition, the presence of an external consultant for the development of the network. The core participants in the network are:

● Northern Lighting: Northern Lighting is the network leader and ensures the implementation of activities and measurement of the impact of the project. The project owner will set up operational tasks for an external project coordinator with experience from Japan. On behalf of the network, Northern Lighting will report progress on the project to Innovation Norway to its member companies quarterly.

Northern Lighting's products are made in collaboration with designers, craftsmen and innovators around the world based on Scandinavian simplicity and the ever-changing Nordic light. Northern Lighting's products are branded as high-quality and sustainability products.

● From Oslo is a new Scandinavian furniture and interior design Company founded to pay tribute to Norwegian design heritage. Fram Oslo offer modern and sustainable quality products, which the users will be able to enjoy for generations. The company builds on the Scandinavian design heritage, and especially what is characteristic of Norway and Norwegian design. Fram Oslo also creates furniture and interior products in other categories, where top quality raw materials such as wool, mohair, linen and cotton are used. Fram Oslo is a core component of the corporate network, with the desire to improve its market position internationally

● Tonning & Stryn: this company for a number of years has been considered as central representatives of the craft-based furniture company that bring the best of design, crafts, tailoring and quality. They have a long tradition of quality production, and sees the importance of participating in a collaboration that can lift their products into the international market.

● Heymat: is an Industrial cleaning company in northern Norway with 20 years of experience from the leasing of doormats to commercial and industrial companies throughout northern Norway. Their products are made from recycled materials that are easily and efficiently maintained. Their products has great potential in the Japanese market and has already received a lot of positive attention after the launch.

● Fjordfiesta: is a small Norwegian furniture manufacturer started in 2001. They are first and foremost known for the relaunch of Hans Brattrud's great Scandia chairs. The Scandiastole was designed in 1957 and today appears as classic and modern forms. Their chairs come in several designs: Junior for dining and Net for lounge use. Fjordfiesta has been involved in the process of the network, but has called for a clearer plan and more feedback on what the network should work with.

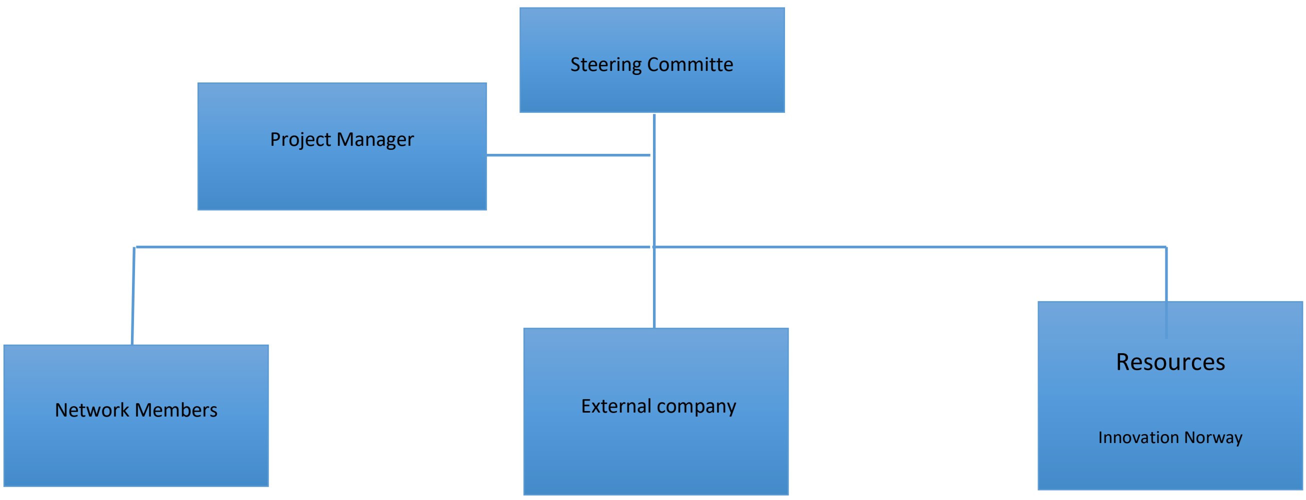
Other companies in the Corporate Network are: Skaugum Bestikk, Biri tapet, Slåke, Utopia Workshop, Magnor, Eikund, Tynes, and Figgjo

The roles in the network are clearly distributed among the participants. Manufacturers will contribute products, expertise and experience for the progress of the internationalization processes. Norwegian Icons as the network project coordinator will provide specific market expertise in Japan. Having a clear facilitator who runs the process of the network in the future is necessary for the development and the growth of the project. The aim for achieving cooperation lies in respect, shared understanding, joint decisions, equal opportunities for all participants, knowledge and competence sharing and personal responsibility (NI Document 1).

3.3 The Corporate Network management

The network is organized with a management team and project manager who has the purpose of mobilizing the partners. The reason for the network is unifying expertise and experience, and everyone should contribute products for the presence of the projects in Japan. Norwegian Icons (Project Manager) reports to the management team or steering committee, which consists of chief marketing manager from Northern Lighting, and general manager from Norwegian Icons. The figure below shows the organization of the network.

Figure 1: The Network Organization



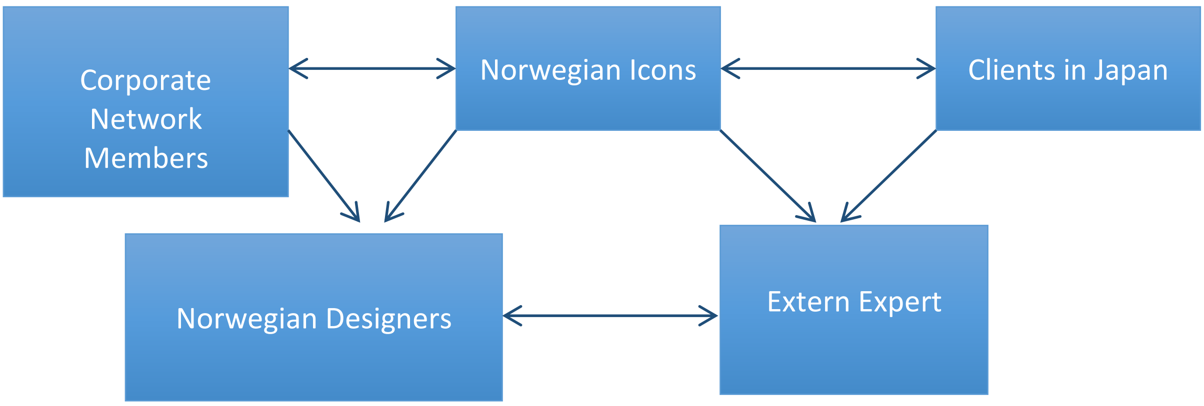
Source: Norwegian Icons Document 1

The vision of the network is intended to develop Norwegian design's recognition in Japan, to establish a direct trading value for the Japanese design market for a Norwegian design industry by developing a model for exporting Norwegian design to international high-quality design markets and promote international exports for network members. The network also aims to strength Norway brand reputation, and that this will strengthen the national position of the manufacturers.

Effective communication is important for the development of the network as it helps to Develop and maintain trust for the betterment of the network. To enhance this communication within the network is not only between members of the network but also with all distributors in Japan since it is important to set good and direct communication channels between Japan and Norway. That is, NI tries to establish good communication channels with all its distributors in Japan to enable reporting of sales figures, order portal which includes order confirmation, delivery date, as well as information about client visits and trends in the Japanese market to communicate back to the manufactures.

The figure below describes how the communication lines of corporate network and the separate entities on the experience domain of each part where NI ensure the communication and information flux that exists between the customers and the manufacturers.

Figure 2: Communication Lines



Source: Norwegian Icons Document 1

3.4 Marketing channel organization of Corporate Network

Currently, NI has 21 stores in Japan. 15 in Tokyo, 2 in Osaka, and one in each of the following cities Kanazawa, Kobe, Hiroshima, and Fukuoka.

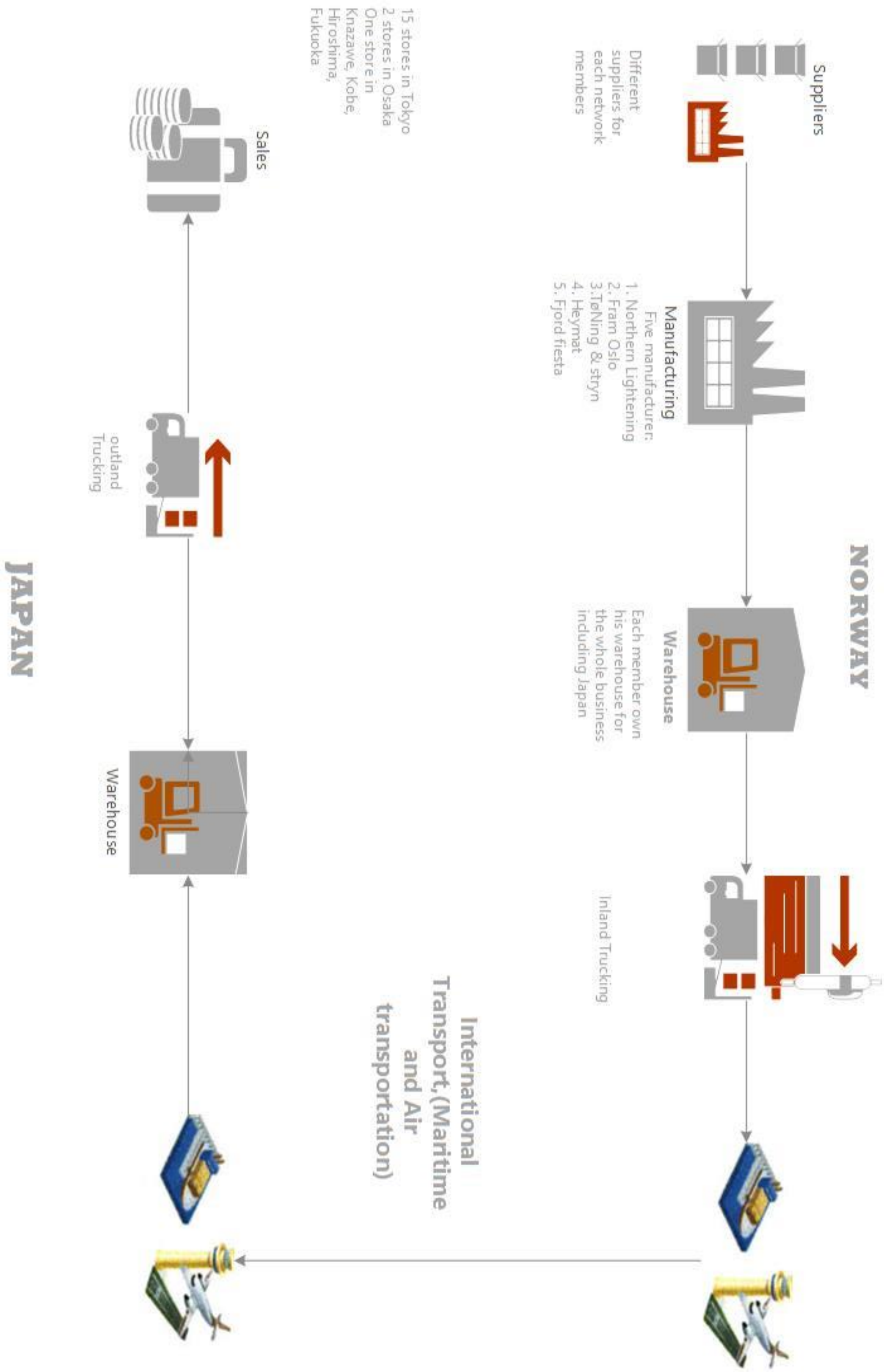
It is important that the different products of the manufacturers are treated individually. Therefore, it would not be appropriate to set up an equal percentage of growth for all manufacturers. It is more appropriate to look at potential growth for individual objects and individual plans for an individual producer. In the strategic analysis, NI looks into how the network can generate increased sales in the various channels.

- Showroom shop: Display the entire collection together,
- Online shop for the Japanese market Established warehouse with the possibility of expansion and full distribution in Japan,
- Permanent presence in stores and other online portals,
- Project deliveries on furnishings: for example, hotels, galleries and cafes/ restaurants.

3.5 The Global Supply Chain of "Corporate Network Japan"

The transportation cost is one part of the supply chain total costs. Therefore, before assessing the transportation mode and costs of the Network, we need first to understand the underlying supply chain and the product movement of all network members. The Figure below, shows a graphical representation of the networks supply chain as described by the CEO of the Norwegian Icons (Interview 1)

Figure 3: Global Supply Chain of the Network as described by the CEO Norwegian Icons



Source: Authors Construct (2019)

The figure demonstrates the supply chain from manufacturing through to where the products are needed (Japan). The first process is sourcing of each manufacturer, the manufacturers have their purchasing strategy and partners and works independently from the other members when buying raw materials since the Japanese market is one of many markets for manufacturers.

The next process is manufacturing, thus, the transformation process of transforming the raw materials into finished goods or semi-finished Goods, majority of these manufacturers produces their products in Norway except Northern lightening which has production plant in different countries in Scandinavia, Europe and China. The final products are transferred to a local warehouse where each member has their own warehouse which is used to stock the products of different markets.

The internationalization process and NI implication begin when orders are received from Japan to NI for different network members, these orders might concern one or many manufacturers, once the orders are received, NI proceed to fulfil it and transport to clients in Japan, each manufacturer is responsible for inland transportation from their location to Oslo, the transportation is either by truck or air. For manufacturers located far from Oslo, for instance, Heymat AS which is located up North of Norway in the region of Rana deliver directly from Rana to Tokyo, air transport is used as a transport mode for such case. More than 90% of orders in term of value belongs to five important manufacturers namely Northern (Lightening), Heymat, Tonning & stryn, Fram Oslo, and fjordfiesta

International transportation is mainly direct from Norway to Japan. However, there are some exceptions. Northern lightening delivers approximately 25 % of its products directly from their manufacturing located in China to Japan. NI takes in charge both line haul and mainly use air transport mode for the international transportation, maritime transport is just exception, one case of Less than full container load shipping transportation were used in 2018 from Norway to Japan.

For international transportation, NI works with a third-party logistics provider to perform the international transportation from Oslo to Tokyo, these 3PLs tasks are Freight shipping, payment of the exportation fee and export clearance to the Japanese government, X-ray fee, pick-up activity and container service (terminal handling) at the port. The choice for

3PL was made based on the cost (freight rate), service proposed (flexibility) and they become a partner for their business. In extreme cases, NI calls Packaging carriers such as FedEx or UPS for small shipping transportation.

After the products are released from Tokyo port, they are transported by another Japanese 3PL logistics partner to NI stores and showrooms, the company owns as well a warehouse in Japan where the products are stocked. The warehouse is not just used for product stocking but also for the final component assembly, standardization checking (products that needs standardization mostly are Lamps), product damages and product quality inspection and labelling. The main issue regarding quality of the product is not the final products damages, knowing that less than 1% of products are damaged after international shipping, but related to packaging which should to be in perfect condition and conformed to regulation and marketing reasons. The costs of the warehouse are more connected to the quality control than product handling, the transportation is mainly done by truck from the warehouse to individual stores and showrooms.

Generally, we identify five activities or processes in this global supply chain thus, manufacturing, inland transportation, international transportation, outland transportation and stocking where each activity embeds related cost, the manufacturing costs of exported product to Japan export for each network member, the inventory costs of warehouses in Norway, the inland transportation costs within Norway. The activity also includes International transportation costs from Norway to Japan, China to Japan, outland transportation costs within Japan and finally, the warehousing costs in Japan as well as in the different stores.

4.0 METHODOLOGY

This chapter provides the knowledge on the methodology applied in the execution of this study. First we take a look at the case presented to Molde University by Norwegian Icons. Norwegian Icons is an initiative dedicated to telling the world about the best of Norwegian interior design from 1940 to 1975. The aim is to increase global awareness of Norway's contribution to the Mid-Century Scandinavian design movement, as well as promote the work of contemporary Norwegian manufacturers. With this aim, the company has chosen Japan design market to test its globalization activity, the aim of this study is to assess the Possibilities of cost reduction of international transportation for corporate network Japan.

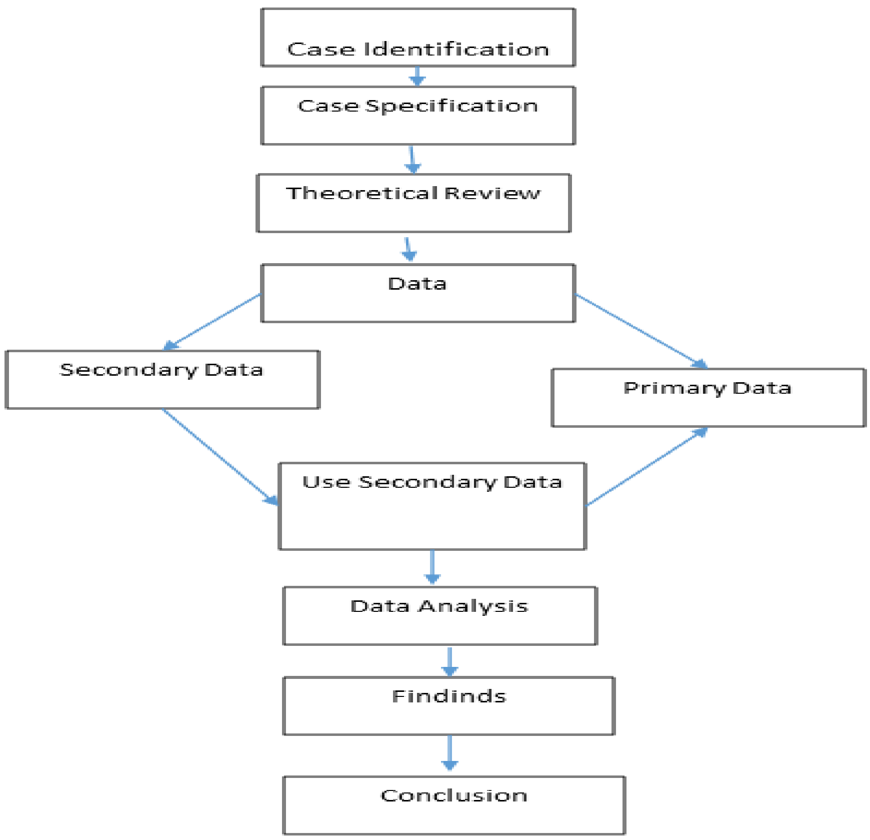
4.1 Research Design

This research is based on an exploratory case study aiming at determining the nature of the problem to provide a better understanding of the problem, which will form as a basis for more conclusive research. According to Yin (2011), there are two main paths to follow when applying case study research: exploratory case study or explanatory case study. The purpose of a research design is to present a plan on how to collect and analyze data. For Yin (1998) "research design is the logic that links the data to be collected (and the conclusion to be drawn) to the initial questions of the study." In the literature, one can find several kinds of research designs for different research approaches which include experimental design, cross-section or social survey design, longitudinal design, case study design and comparative design where each of them applies to a particular problem. Some research design fit more for qualitative research while others are for quantitative research. According to Bell, Bryman et al. (2018) case study is the most often used and most popular research design in social science. For Yin (1998) the design of a case study contains two dimensions, where the researcher analyzes a single case or several cases (multiple-case design) based on a holistic or embedded case study design.

The design of a research can be based on qualitative, quantitate or combination of quantitative and qualitative. This study was designed to assess the global transportation of high-quality Norwegian product to Japan, to achieve this goal the research was designed as an exploratory case study. This was to enable us to explore different calculations on different transportation modes using data that already exists in the record and files of its Network. This case study is an organizational case “real case” presented to Molde University College by Norwegian Icons, the company seeks to have an efficient way of exporting its products (High-quality Norwegian Designs) to Japan. An embedded case study approach was used to assess the transportation of the company by focusing on the data obtained from NI, network members, 3PL partners with NI in Norway and Japan, and other logistics provider freight forwarders. The Quantitative methods was used to analyze the data from Norwegian Icon that sets the stage as the case study in this research work. While the qualitative method was suitable to gather insight managers point of view.

The framework of the study is as illustrated in the figure below adopted from (Bell, Bryman et al. 2018).

Figure 4: Framework of the study



4.2 Data Collection and Method

According to Bell, Bryman et al. (2018), the technique used to collect the data is called method. The study consists of two phases, the first phase involves qualitative designed to probe and explore issues related to the study's central objective, which serves to augment existing literature of the research. The second phase of this study embodied interviews and quantitative design, data collection at this stage was mainly by consulting various documents, emails contacts, and telephone calls. The mail was sent to potential third-party Logistics (3PL) and the selected network members for secondary data and other relevant documents for the analysis.

Interviews are commonly used for data gathering, according to Dunne, Pryor, and Yates (2005) interview is a very adaptable and powerful method in a broad range of research project and the interview is very malleable research tool appropriate to a very wide range of research

The data used for a research can consist of both primary and secondary data, and the source of data can be both internal and external. Internal sources are sources within a firm or organization, i.e. employees, accounting, and contracts. External sources, on the other hand, are sourced from suppliers, customers', reports internet-based information and so on.

Primary data can be defined as the type of data collected by the researcher through interviews, survey and observations, which provides firsthand information and considered to be authoritative and quite expensive to collect.

Secondary data, on the other hand, is second-hand information which is already collected and recorded by any other person rather than the user for the purpose not relating to the current research problem, it is the readily available form of data collected from various sources such as reports, books, Journal and so on. In both cases, this data can be either qualitative or quantitative in nature.

The data used in this study were collected from Norwegian Icons Head office in Oslo and Some selected network members, a semi-structured interview with both closed and openended questions was used to gather data from the Network and its members, the data collect includes; invoices, reports, and so on.

Table 3: Overview of Data types and Sources

Types of data		Data Sources	
		Internal	External
Primary	Qualitative	-Interviews of some managers from the network and the manager of Norwegian Icons. -The transportation mode used in sending the products to customers in Japan -Invoices from the network members.	-Telephone and E-mail to Third party Logistics service providers both domestic and international companies.
	Quantitative	- Historical data on how many products have been sent to Japan -Total Landed Cost - Total Logistics cost -Freight rate	-Data collected from online freight rate (internet based in formation), reports and books -3PL freight cost, Pro-forma invoices from both domestic and international
Secondary	Qualitative	Existing mode of transportation	-Different modes and ranking for 3PLs
	Quantitative	Manufacturing cost, Inland and international transportation cost, invoices.	-Freight rate from Oslo to other Ports in Japan -Validity checks

Source: Field Study (2019)

Secondary data and interviewing of some sales managers of 3PLs as well as the manager of NI were used to analyze the data for managerial use. Interviews are commonly used for data gathering, according to Dunne, Pryor, and Yates (2005) interview is a very adaptable and powerful method in a broad range of research project and the interview is very malleable research tool appropriate to a very wide range of research.

Collection of secondary data was to help us answer the research questions in an appropriate manner, According to Sachdeva (2009) secondary sources of data are edited primary sources or second-hand versions that the researcher collects and utilizes in research. Thus, secondary data takes the role of explaining and combining the information from the primary source with additional information; it serves as a reference base against which to compare the validity and accuracy of primary data. In this research, secondary data were collected from the following sources

- Norwegian Icons
- Network members,
- Logistics Services providers and freight forwarders,
- Stores in Japan

To gain an in-depth understanding of the transportation activity from Norway to Japan, these data were gathered through the study of internal documents, various reports of the network members, such as sales reports, inland transportation costs. This served as a reference point against which data to compare the validity and accuracy of the status quo and the alternative option for decision-making purposes.

Interviews with different third-party logistics provider (3PLs) and carriers on transportation mode was aimed at examining the offers in terms of price, time and service, and make a comparative study of the impact of each offer on the transportation cost and the total logistics cost as well. It also enables us to analyze the existing transportation system and proposed alternative transportation based on different variables. This research was conducted as a case study for Norwegian Icons, Ellram (1996) stressed that case study methodology would be desirable to provide an insight into a little phenomenon.

An overview of the Document used in this case study is represented in the table below

Table 4: An overview of the Document used in this case study

Organization	Documents
Norwegian Icons	Internationalization of Norwegian Design producers 2017
	Commercial Invoices 2018
	Price list 2018
Network Members	Manufacturing Cost 2018
	Sales Reports 2018
Japanese 3PL	Outland Transportation cost 2018
	Air freight Quotation invoices 2018
	Warehousing cost 2018
Norwegian 3PL	Sea and Air freight Quotation invoices 2018
	Samples of pro-forma freight quotation by air and sea
External Freight Forwarders	Samples of pro-forma freight quotation

4.3 Data Analysis

Analyzing data for scientific purpose can be done in many ways depending on how the data was acquired, the type of data, which can be either quantitative, qualitative or both, and the objective of the study. In this research work, descriptive statistical data analysis would be employed to analyze both secondary and primary data obtained from obtained from the network and 3PLs. Trochim and Donnelly (2006) point out that descriptive data analysis is used to uncover the patterns in data. It helps to present a basic feature of the research topic and the data set. Descriptive statistics can be used to compare across units of data. It forms the basis of most quantitative analysis of data Trochim and Donnelly (2006).

The total landed costs were included in the analysis to have a clear understanding of the weight of international transport costs

Total Logistics equation is used to find out which mode of transporting is more efficient than the other with respect to Norwegian Icon .

The study used Microsoft Excel data system analysis tool for the input and representation of data in a graphical from for analysis and interpretation of the data gathered from the field of study. This helped represent a pictorial and tabulated form of the various contributing variables to the case study.

4.4 Limitations of the data

Due to the multiple sources of data and the time constraint, there were a limited number of interviews conducted for this study. A higher number of interviews would have enabled the study to cover more members of the network and therefore, allow the possibility to generalize the findings of this study.

Data on volume of products was one of the main limitations of this study, Norwegian Icons do not have information on the volume of the products shipped to the customers in Japan and therefore failed to provide such information when demanded. The data used in this study was gathered in its natural stated, it represents what Norwegian Icons has been practicing as well as the network members and the data was acquired for the aim of testing the status quo.

Another limitation is about the maritime ordering cost from China to Japan received from freight forwarder, the invoice should contain the freight cost and the ordering cost separated, but instead, it contains the whole amount of transport cos. Therefore, this cost was based on assumption.

5.0 TOTAL LANDED COST ANALYSIS & TLC MODEL DEVELOPMENT

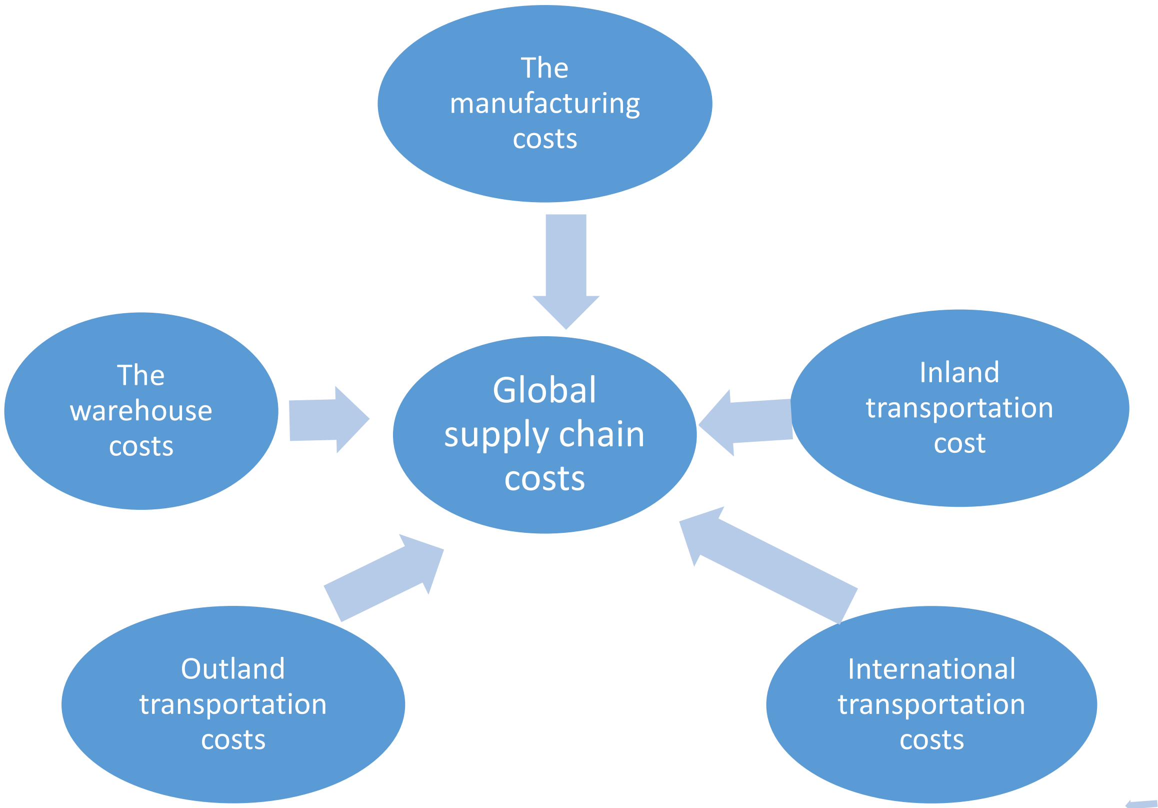
This chapter is divided into two different parts, the first part related to total landed cost analysis which is more about cost calculation of different activities of global supply chain and understand each cost associated with every aspect of supply chain with high focus on international transportation. The second part focuses on developing total logistics cost model of NI.

5.1 Analysis of total landed cost of global supply chain of “Network Japan”

This section is dedicated to assess the different activities of global supply chain costs. The warehousing costs in Norway for each manufacturer is not taken into consideration for the analysis of the global supply chain costs (GSC) because this cost is not related to the “network” as a whole, instead, it relates to each company as an individual for a different market and different products, also some small members do not have an active warehouse operation, and they produce based on customers order (make to order).

Practically to identify global supply chain costs is to map the supply chain and develop process models that describe what is taking place in the company's supply chain, the diagram below shows the global supply chain of corporate network Japan base on the description of the global supply chain cost of the network by the manager of Norwegian Icons.

Figure 5: Global Supply Chain Cost of the Network



Source: Authors Construct (2019)

The figure summarizes the main components of global supply chain of Corporate Network Japan. Each of these components are developed in the subsequent section which is in relation to the network members selected for this study.

5.1.1 The Manufacturing Cost

Manufacturing cost consists of equipment operation costs, labour cost, and the general overhead for the facility cost, we consider in our study the price proposed by the manufacturer to NI as manufacturing cost, each manufacturer has various range of products destined to the Japanese market in term of measurement, length, colour, quality and so on.

The appendix 1 covers the product cost of main product categories exported to Japan for the four manufacturers, Northern Lighting expand their business to cover not just lighting but also furniture and accessories. However, for the Japanese market, the products are mainly lamps, the average manufacturing cost was estimated at 1135 NOK per unit.

Heymats products are mainly mats which are made from recycled materials that are easily and efficiently maintained. The manufacturing costs differ according to the models (Blaane, Hagle, Lov) and the size, on average it costs 1916 NOK per unit.

Fjord Fiesta produces classical furniture, their product cost differs according to the range (chair, stackable chair, lounge, table, bench, and accessories) with an average of 1876 NOK per unit.

The product produced by Tonning & stryn ranges from Sofa, table, stolar, cabinet furniture and racking. However, the main export products are chairs including stolar and tables where manufacturing cost was 2100 NOK per unit.

The total product value exported in 2018 was estimated at 2 078 568,18 NOK [1]

5.1.2 Inland Transportation Cost

Each manufacturer takes charge of the inland transportation cost, the inland transportation is by air or truck, which mostly depends on the location of the manufacturer. All the information provided by the network members are based on approximation either by referencing it to the average amount by each export delivery or to the percentage of total transportation cost.

- Heymat is located in Rana and mostly uses air transport from the manufacturing site to Oslo. According to Heymat, the transportation cost is on average 7% of the total transportation cost. The total transportation cost by Heymat was 95101 NOK for all

[1] Appendices from 3 to 7

product. Therefore, inland transport cost is 6 657 NOK in 2018 for all transported products (Heymat Inland transportion 2018)

- Fjord Fiesta uses trucking transport from Dokka to Oslo, inland transportation was estimated at 2 800 NOK in 2018 for four deliveries, which in total was 11200 NOK. However, 35% of the cargo designed for the Japan market the remainder was for other customers not related to Norwegian Icons. Hence, the inland cost was 3 920 NOK for all transported products (Fjord fiesta Inland transportion 2018)

- Tonning & stryn inland transport use trucks and it costs from stryn to Oslo 5 200 NOK in 2018 (Tonning & stryn Inland transportion 2018).

- Northern Lighting is located in Oslo has an average total inland cost of 2 100 NOK in 2018, this is for the products exported from Norway (Northern Lighting Inland transportion 2018)

The approximated total inland transportation cost of the network was estimated at **17 777,00 NOK** in 2018.

5.1.3 The International Transportation Cost

The international transportation cost is the cost related to the transportation of products from the manufacturing country (Norway, China) to the customers in Japan. In practice, NI uses Third Party Logistics providers (3PL) to manage international transportation.

A. The Air Transport Cost

Air transportation serves as the main transport mode used by NI for moving products to the customers in Japan. In 2018 13 export operations were made by the firm. This transport cost has fixed part and variable part. The variable part depends on the weight and the volume of goods shipped and fixed in each shipping transaction whatever the weight or the quantity of product transported, In this work we refer to variable cost as **freight cost** and fixed cost to **Ordering cost.**

- **Air freight cost**

Air freight cost was determined by examining all invoices paid by NI to 3PLs, appendix 2 shows the freight cost and the freight rate of each transport. Air freight rate is calculated as the cost freight divided by the weight of shipped goods.

We observe that the airfreight rate is not same for all freight transport during the year under review; it heavily depends on the order size and the weight. The table below provides a statistical summary of the air freight, the weight and the rate of air freight of exporting products from Oslo to Tokyo.

Table 5: Statistical Description of Air freight Rate

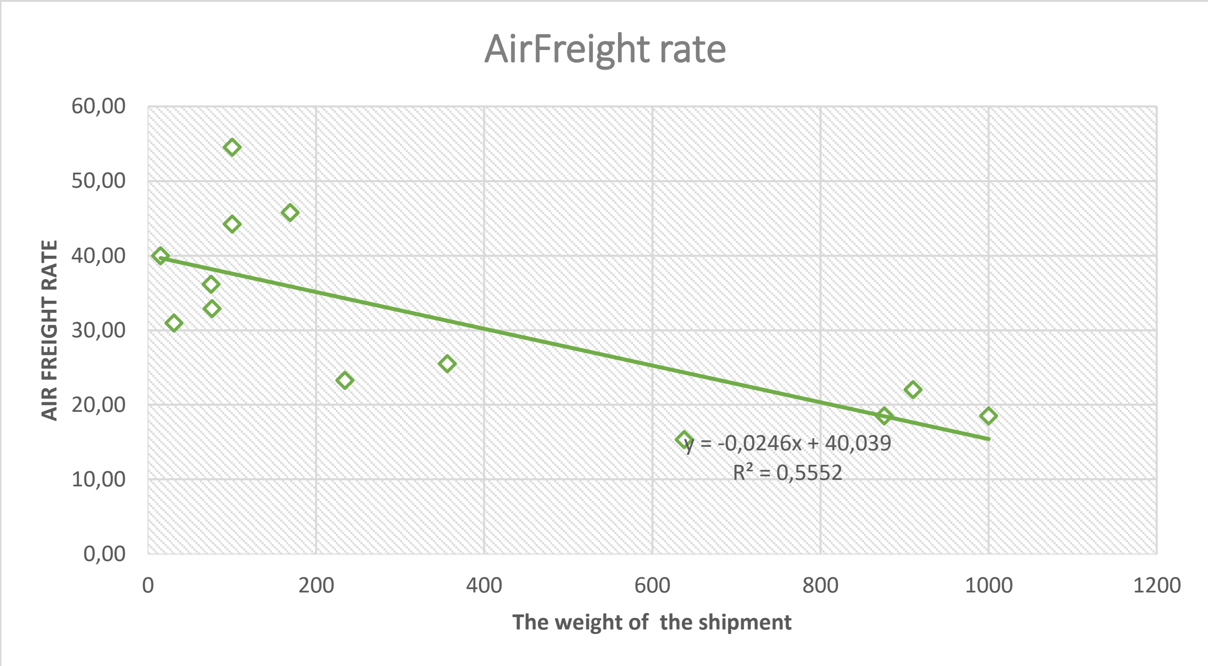
Statistics elements	Air Freight	Weight	freight rate
Min	600	15	15,35
1st quertile	2712	76	22,02
median	5452	169	30,97
Mean	7985	352	31.36
3rd quertile	9719	638	40
Max	20036	1000	54,52

The table 5 above shows that in 2018, the minimum quantity shipped by air was 15 KG, while the maximum was 1000 KG with an average of 352 KG. The table also shows that, the minimum freight rate paid in KG during the same period was 15.35 NOK and the maximum was 54,52 NOK with an average freight rate of 31,36 NOK in KG.

In order to have a an overview of the freight rate evolution when the quantity of goods shipped changes, the figure below shows a plot of the independent variable the weight of freight and the dependent variable which is the air freight rate.

Linear regression was shown in order to better understand and predict how much freight rate might be if NI transport cargo by air, we are going to develop one-variable linear regression that dependent variable to predict the independent variable. The results is as shown in figure 7 below.

Figure 6: Plot of Air Freight Rate Evolution with the Evolution of Shipment's Weight



The above figure shows that, the more the weight of goods shipped by air, the lesser the freight rate charged, the line drawn represents the linear regression line, the goal of linear regression is to create a predictive line through the data.

The summary of linear regression is as follows;

```
lm(formula = AirFreight.rate ~ Weight, data = freightrate)

Residuals:
     Min       1Q   Median       3Q      Max 
-10.9761  -5.7514   0.0358   4.3932  16.9436 

Coefficients:
             Estimate Std. Error t value Pr(>|t|)    
(Intercept) 40.039350   3.321108  12.056 1.11e-07 ***
Weight      -0.024629   0.006647  -3.705  0.00347 ** 

Residual standard error: 8.491 on 11 degrees of freedom
Multiple R-squared:  0.5552,	Adjusted R-squared:  0.5147 
F-statistic: 13.73 on 1 and 11 DF,  p-value: 0.00347
```

From the summary above the adjusted R-squared of the linear regression is 51,47%, meaning that the model is relatively good. R-squared is a statistical measure of how close the data are to the fitted regression line, in another term, R-squared shows the percentage of improvement of a linear regression model to the baseline model. The baseline model predicts the average value of the dependent variable regardless of the value of the independent variable. Our model predicts 51.47% which is better than the baseline model (The average freight rate).

The P value od the other hand, is below than the cut-off point of 0.05 significance level, which means that both predictors (the intercept, and the weight) are statistically significant. However, this model would have been more powerful if the data of freight rate of the previous year were included. That notwithstanding, it stays useful and provides an overview of how much a freight rate could be affected by the weight of shipped products, the equation of the linear regression is presented below;

$$\boldsymbol{Air\ Freight\ Rate = 40,04 - 0,025 * Weight}$$

From the above equation of the linear regression, airfreight rate for NI will decrease by 0.025 NOK for each KG added to the shipping, which stresses the importance of grouping order for a cheaper freight rate.

The freight rate is a variable part of transport cost, air transportation cost has the fixed part for each transaction no matter the weight of freight.

- ***Air ordering cost***

In addition to freight rate, NI has a fixed odering cost of air transportation for each freight transport, the table below shows the average costs for each element that constitute the average ordering cost of the thirteen (13) air transportation in 2018.

Table 6: Air Order Cost from Norway to Japan

Air Ordering cost composition	**Cost**
Export Fee	350 NOK
Export Clearance	380 NOK
Xray Fee	330 NOK
Terminal fee export (THC)	310 NOK
Documents and lebelling	450 NOK
Pick up	570 NOK
Total	**2390 NOK**

Source: Average cost of 13 Air shipping invoices (2018)

The above table shows that NI pays a fixed cost evaluated at 2390 NOK for each exporting transaction by air regardless of the weight or the volume of the products. These costs are of different nature:

- Export fee is a tax on exports paid to Japan,
- Export clearance is costs related formalities and procedures that should followed for the product to be exported
- X-ray Cost are related to use x-ray security system to scan all products before air cargo transport
- Terminal fee is the charge paid for handling the cargo at the terminal,
- Documents and labelling is costs related to preparing the required documentation for shipment.

Therefore, the importance of reducing the number of orders per year seems important, as shown in the table below.

Table 7 : Air Transport Cost by Product Weight

Weight (KG)	Air total cost/kg
15	199,3
31	108,1
356	32,2
76	64,3
169	59,9
100	68,1
75	68,0
876	21,2
234	33,5
910	24,6
100	78,4
1000	20,9
63	19,1

Source: Based on 3PL Shipping invoices (2018)

The table shows the total air cost in KG for each order. This cost is the sum of freight cost and fixed order costs of each order, the table also shows that, there is a huge difference between air total cost per KG of orders that contain 15kg and 1000kg. It can be seen from the table above that air transport cost per KG for an order of 15 kg is 10 times expensive compared to 1000kg order despite the fact that it's of the same distance. At this stage of the analysis, the importance of order grouping seems significant.

The total air transport of 2018 was **134 519 NOK**. According to the 3PL, the average transport time by Air is was days, with a minimum of 5 days and a maximum of 8 days (interview 3).

B. The Ocean transport cost from Norway to Japan

We now take a look at maritime transportation, unlike air transportation, it is charged per container.

Maritime transportation also have variable and fixed costs. However, the variable cost does not depend only on the weight of the product. According to Stopford (2009) the ocean freight rate mechanism is adjusted by linking supply (shipowners) and demand (shippers), when supply is tight freight rates raises, stimulating shipowners to provide more transport. When it falls, it has the opposite effect.

The ocean transport cost and freight rate are more complicated to determine, since it does not related to distance in most cases. for instance, goods shipped from Europe to China has much more to do with capacity, that is, if the products are shipped in the direction with lots of loads, the freight rate would be high and the transport become expensive, the same distance going the inverse direction with less load, the cost is much lower.

In 2018 NI shipped one freight from Oslo to Japan, the ocean freight of 400 kg was evaluated at 2150 NOK, this freight rate was not calculated using KG in maritime transport, but to have the same unit of measure and make comparison with the air transport mode, the freight rate was converted in KG which is equivalent to 5.37 NOK for less than container load (LCL). Three pallets of 1,344 CM goods of volume was transported to Japan, the freight rate was two and a half times lesser than Air transport freight rate for a similar quantity. However, the average transport time was 55 days with variability of 70 days maximum and 50 days minimum.

A single freight operation is not enough to determine the freight rate for decision making purposes. Therefore, we asked the 3PL to provide us with pro forma of sea quotation sample invoice of ocean cost and transport time from Oslo to Tokyo of different quantities, weight and volume (interview 3).

- The freight rate of 1000 kg is 7,981 NOK/KG
- The freight rate of 400 KG is 8,99 NOK/KG

We notice here that for the same quantity and distance the freight rate of 400 KG paid last year was much lower than the **proposed one** which explains that sea freight rate is subjected to space and equipment availability, which implies that for the same weight, volume and itinerary/route, the freight rate could be higher or lower.

In this analysis, we consider 8.5 NOK/KG as maritime freight rate and 60 days as transport time. Concerning the ordering cost, the table below shows the ordering cost structure for maritime.

Table 8: Maritime transport cost

Maritime Cost composition	Cost/NOK
Environment fee	80
Administration fee	80
Expedition	400
Export declaration	380
Inland operations Norge	45
Extra tariff lines	26
TOTAL COST	**1416**

Source : Quotation SEA Export LCL (2018)

The ordering cost of maritime transport amounted to 1416 NOK in 2018, which is 41% lesser than the air ordering costs, all fees and charges are minor compared to air ordering cost. We can also observe that unlike air transportation, there is a fee for environment because the International Maritime Organization (IMO) uses such financial instruments to protect the ocean environment from negative impacts of shipping activities. However, we consider 80 NOK is a insignificant contribution to green transport mode from sea transportation

The total maritime transport from Norway to Japan in 2018 was **3566 NOK**. The average transport time by sea was 55 days, with a minimum of 50 days and a maximum 70 days.

C. The Air transport cost from China to Japan

For this line haul, NI works with the Japanese 3PL to export Northern Lightings products from Guangzhou airport to Narita airport in Tokyo. In 2018, four delivery were made.

According to the documents provided by the Japanese 3PL, the total airfreight cost charged was 390 592 ¥[2] which is equivalent to 29 685 NOK, the total weight was 886 KG, with an average freight rate of 33,5 NOK/ kg. This cost is high as compared to the freight rate charged from Norway to Japan, even though the distance from China to Japan is much shorter. The 3PL attributes this high freight rate to the fact that they are providing door-to-door logistics service, covers the ultimate transportation from NI manufacturing facility in China to the warehouse in Japan.

The fixed air related cost was 3 202 NOK, the details is as shown in the table below

Table 9: Air Order Cost from China to Japan

Air Ordering cost composition	cost / ¥	cost /Nok
Tariff	5 300	402,8
Terminal charge	3 364	255,664
Custom handling cost	20 000	1520
Fee	10 000	760
Insurance	3 475	264,1
Total	**42 139**	**3202,564**

Source: Japanese 3PL Invoices (2018)

The table above shows the ordering cost for Air transport from China to Japan was valuated at 3202 NOK. Total air cost from China to Japan in 2018 was 42 493 NOK with an average transport time of 3 days, the minimum days was 2 and a maximum of 4 days.

5.1.4 The Warehouse Cost

The costs associated with warehouse in Japan are handling and storing of imported goods from either Norway or Japan, Norwegian Icons' warehousing cost in Japan is mainly composed of handling which consist of cost related to Labour, administrative and facility

[2] 1¥ = 0,076 NOK

Table 10: The Warehouse Cost Structure

Nature of cost	cost/units	units	total cost
receipt fee	2000	16,89 M^3	¥33 780,00
delivery fee	2000	18,12 M^3	¥36 252,00
sending work	250	154 CT	¥38 500,00
Labelling	150	530 pcs	¥79 500,00
Inspection	200	125 pcs	¥25 000,00
Storage	7500	25 spaces	¥187 500,00
			¥400 532,00

Source: Japanese 3PL (2018)

From the table above, we observe that the total warehousing cost in Japan is ¥ 400 532,00 equivalent to 30 440,43 NOK, which indicates that **47%** of warehouse cost come from renting spaces. The table also shows the storage costs is the highest of all the cost components of warehousing in Japan, followed by the receipt fee as well as Delivery fee, sending works and inspection are also higher than labelling.

5.1.5 The Outland Transportation Costs (In Japan)

After all freights reaches its destination (Tokyo) by sea or air, the products are transported to the warehouse or directly to the stores of different region in Japan. NI subcontracts these activities to a Japanese third-party logistics services provider.

According to the 3PL, in 2018 the total cost for the domestic transportation in Japan was 431 123¥ which is equivalents to 32 765 NOK (Japanese 3PL 2018).

The table below summarizes the different cost of total landed cost;

Table 11: The Global Supply Chain Cost of "Corporate Network Japan"

The cost nature	Amount Nok	proportion
Manufacturing cost	2 078 568,18	89%
Inland transportation	17 777,00	1%
International transport	180 578,00	8%
Warehouse	30 440,43	1%
Outland transport	32 765,00	1%
Total logistics cost	2 340 128,61	

The total landed cost of the global supply chain in 2018 was 2 340 128,61, which is the sum of all activities of the global supply chain cost. Manufacturing cost is the highest, according to the table, 89 per cent of the costs comes from the value of the product which indicates that the products are of a very high-quality. International transportation is the second largest which covers 8 percent of the global supply chain costs, a reduction in this cost will have a greater impact on the final cost of the product. Warehousing, outland transport, and inland transportation had 1% each.

The analyzes of this part of the study was focused on total landed cost in order to have an understanding of the weight of international transport costs. NI is not concerned about the manufacturing cost and inland transportation, NI is responsible for international transportation, the warehouse and the outland transportation in Japan. The figure below presents the cost structure the activities handled by NI for the Network.

Figure 7: NI Activities Cost Structure in Percentage

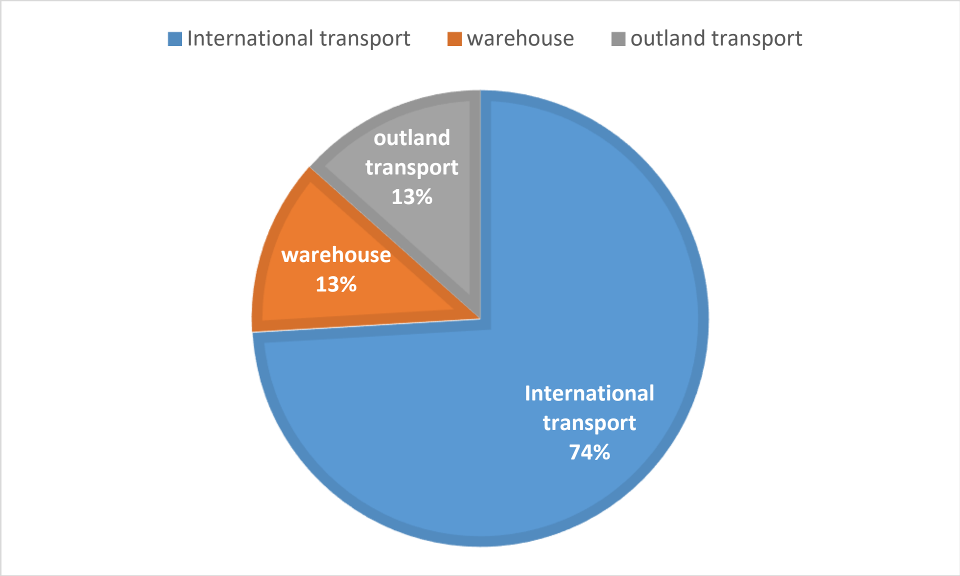


Figure 9 above shows that international transportation represents the major cost of NI with 74% of total costs, which means that if NI performs this activity efficiently, it would have a positive repercussion on the total logistics cost. Therefore, re-designing the international transport activity seem critical in order to preserve the place in the Japanese Design market and enhance the competitiveness of the Network in a highly competitive market and demanding clients.

This analysis served as a way to collect and comprehend all needed information about the international transport costs such as freight rate, ordering cost, lead time for each transport mode and for each Route. All this information combined with product cost, product weight and sales in Japan are going to be used as the input data in the following chapter for the analysis of total logistics costs and transport mode decision by analyzing the impact of the current international transport policy on the total cost equation and compare the use of ocean and air transport mode to determine the most efficient for NI.

5.2 Total Cost Model Development

The aim of this study is to find out the transportation mode that minimizes the total cost of the supply chain by taking into consideration the marketing strategy of the network that seeks to create a high service level for their customers and the nature of the products that are of high-quality.

(Slack, Chambers et al. 2010, Sunil Chopra 2016) “the Total cost equation consists of three main parts: the purchasing costs, the ordering costs, and the holding costs”. The equation is presented below;

$$TC = C^*D + Ct * \left(\frac{D}{Q}\right) + Ch^*(\frac{Q}{2} + (z^*\sigma_{DL}) + L * D)$$

Where:

C^*D represent the purchasing cost, for our case is the manufacturing costs,

$Ct^*(D/Q)$ represent the ordering cost or transaction fixed costs,

$Ch^*(\frac{Q}{2} + (z^*\sigma_{DL}) + L * D)$ is the cost of holding inventories which is composed of three parts:

- cycle stock= **Q/2**: It is the quantity of products to serve the demand during the review period, this quantity depends on the annual demand and the length of the review period.
- safety stock = **$z^*\sigma_{DL}$** : is the level of stock of products kept at a warehouse to buffer against unexpected demand during replenishment period. By having the safety stock, the company could satisfy unforecasted demand which increase the service level without altering the transportation plan
- pipeline inventory **= L*D**: also called In-transit inventory, which is simply the inventory stock during transportation time

Before we describe the rest of the equation, we explain the three concepts that total cost equation is composed of:

- ❖ **The manufacturing cost:** comprises of all costs of producing the products for each manufacturer member of the network. This cost determines the value of the product transported which is important for transport mode selection.
- ❖ **The ordering costs:** also known as setup costs, For (Slack, Chambers et al. 2010) Order costs are calculated by taking into account the cost of placing the order and price discount costs, it includes also the cost of receiving the order, the processing activities, loading and loading costs, the invoicing, auditing and the labour it takes to do that. Therefore, it's the cost it takes to actually place an order, its fixed cost does not change with the volume, whether the company orders 10 or 1000 items this is that fixed cost per that order.
- ❖ **The holding costs:** also known as the carrying cost, generally it is the cost of holding inventory. Holding costs are taken into account by including working capital costs (the dominant cost), storage costs (NOK/m^2), obsolescence risk costs (Slack, Chambers et al. 2010).

The remaining of the total cos equation are:

C = cost for each item produced

D = Demand of the products

Ct **=** Ordering cost or the cost for each shipping transaction is fixed regardless the shipment size

Ch = Holding costs for each item, which is the cost of capital, insurance and depreciation of items, it represented in form of percentage of product cost

Q = the size of shipping quantity,

Z = depend on the level of service opted by the network (could be cycle service level, item fill rate or other indicators). Hence it has different meanings it could be the cycle service level, the item fill rate. Concerning this work we are going to describe it in function of lead time

σD **=** **S**tandard deviation of demand, or the variability of demand.

L **=** lead time or transit time is defined as the elapsed period from receipt of customer order to delivery (Christopher 2016)

DL = Demand over lead time (Pipeline inventory)

σDL **=** **V**ariability of demand during transportation time,

The main question is how transportation could affect the total cost equation and therefore the transport mode decision, this decision is based on two main dimensions:

1. The cost of transportation and this one might be fixed or variable and affect the cost of individual item (**C**) if it is based on cost per item, it might affect the cost of ordering, like the cost of full truckload, or full ship.
2. Time of the average transportation (**L**) and also the variability of transportation time (**σL**). Therefore, it affects primarily the pipeline inventory, the longer it takes the longer the capital cost of quantity on the ship or the plane. It affects as well as the safety stock because longer and more variable transit time has an impact on the safety stock level.

There is another dimension which is less to affect the TC of the supply chain is the capacity, the latter could affect the ordering quantity (Q) if it is subject of capacity constraint. (the capacity of the container for instance)

When we make a decision about transportation mode, we are going to refer to the total cost equation to make the tradeoff between the different transport options.

For our analysis, we need to adapt the total logistics cost equation to the specificities of the study case. Therefore:

The Annual Demand

The products sold in Japan comes from two origin countries Norway and China. Therefore, we set:

Dn The annual demand of products shipped from Norway.

Dc The annual demand of products shipped from China.

Demand variability

The same as annual demand and since the demand is not stable and deterministic, we set

σDn The annual demand's standard deviation of products shipped from Norway

σDc The annual demand's standard deviation of products shipped from China

The cost per item

There two different product costs, we set

Cn The weighted average cost of products shipped from Norway

Cc The weighted average cost of products shipped from China

The ordering cost

We have two different line haul and two different transport mode. Therefore, there are four different values of ordering cost, we set:

CTaN as Fixed order cost for air transport from Norway

CTmN as Fixed order cost for ocean transport from Norway

CTaC as Fixed order cost for air transport China

CTmC as Fixed order cost for ocean transport China

The lead time (transport time)

We have two different itineraries and two different transport mode. Therefore, there are four different transport time, we set:

LDaN Air Transport time in days from Norway to Japan

LDmN Maritime transport time in days from Norway to Japan

LDaC Air Transport time in days from China to Japan

LDmC Maritime transport time in days from China to Japan

The Quantity

The quantity to be shipped could be determined by using Economic Order Quantity (EOQ), EOQ is the order quantity that minimizes the total cost equation and provides the optimal trade-off between the ordering and holding cost, the equation is presented below for each mode and itinerary. Since we have two shipping country and two transport mode. Therefore, four different shipment size exists:

The shipping quantity from Norway by air

$$QaN = \sqrt{\frac{2*CTaN*Dn}{Ch*Cn}}$$

The shipping quantity from China by air

$$QaC = \sqrt{\frac{2*CTaC*Dc}{Ch*Cc}}$$

The shipping quantity from Norway by ocean

$$QmN = \sqrt{\frac{2*CTmN*Dn}{Ch*Cn}}$$

The shipping quantity from China by ocean

$$QmC = \sqrt{\frac{2*CTmC*Dc}{Ch*Cc}}$$

The product weight

The products shipped from Norway has a different weight than those shipped from China

wN as the average weight of each item exported

wC as the average weight of each item exported

The yearly number of shipping operations

Since we have four different Q, the number of shipping orders is four different value, we set

The number of shipping delivery per year from Norway by Air

$$NnorA = \frac{Dn}{QaN}$$

The number of shipping delivery per year from China by Air

$$NchA = \frac{Dc}{QaC}$$

The yearly number of shipping delivery per year from Norway by Ocean

$$NnorM = \frac{Dn}{QmN}$$

The number of shipping operation per year from China by Ocean

$$NchM = \frac{Dc}{QmC}$$

The freight rates

The freight rate differs from destination and transport mode, we set

FRaN freight rate of air transport cost in NOK by KG from Norway

FRmN freight rate of maritime transport cost in NOK by KG from Norway

FRaC freight rate of air transport cost in NOK by KG from China

FRmC freight rate of maritime transport cost in NOK by KG from China

After gathering all this information, we can proceed to the analysis, for this purpose, we have three main costs to calculate: the transport cost, the safety stock cost, the cycle stock cost. The sum up of all these costs adding to it the manufacturing cost gives to us the total supply chain cost.

5.2.1 The transport cost

The transport cost is composed of three costs: freight cost, ordering cost, transport inventory cost

- **Freight cost:** which is the variable part of transport cost, it depends on the weight of the product, the equation formula is developed in the table below

Table 12: Freight Cost Equation

From Norway to Japan	Air transport	Freight cost = Dn*wN*FraN
	Maritime transport	Freight cost = Dn*wN*FrmN
From China to Japan	Air transport	Freight cost = Dc*wC*FraN
	Maritime transport	Freight cost = Dc*wC*FrmC

- **Ordering cost:** is the fixed part of transport costs, after analyzing various shipping invoices and interview with 3PL logistics, we figure out that the ordering cost is as well different from transport mode to another, shipping points and destination. The formula is demonstrated below:

Table 13: Ordering Cost Equation

From Norway to Japan	Air transport	Ordering cost = CTaN * NnorA
	Maritime transport	Ordering cost = CTmN * NnorM
From China to Japan	Air transport	Ordering cost = CTaC * NchA
	Maritime transport	Ordering cost = CTmC * NchM

- **Transport inventory cost**: • Transport inventory cost known also as pipeline inventory is in-transit inventory carrying cost, this cost depends on the value of shipped product and transport time. We consider 365 days per year. The equation to calculate in-transit inventory is detailed below

Table 14: Transport Inventory Cost Equation

From Norway to Japan	Air transport	inventory cost = (LDaN/365)*(Ch*Dn*Cn)
	Maritime transport	Inventory cost = (LDmN/365)*(Ch*Dn*Cn)
From China to Japan	Air transport	inventory cost = (LDaC/365)*(Ch*Dc*Cc)
	Maritime transport	inventory cost = (LDmC/365)*(Ch*Dc*Cc)

The transport cost for each mode of transportation is the sum of the freight cost, the ordering cost and inventory transport cost as shown below;

Transport cost = freight cost+ the ordering cost+ transport handling cost

5.2.2 The Safety Stock Cost

The safety stock is the number of products that should be kept at the Japanese warehouse to buffer against demand variability during the replenishment period, it depends on transport mode and transport time. The equation to calculate the safety stock cost is demonstrated in the below table.

Table 15: The Safety Stock Cost Equation

From Norway to Japan	Air transport	Safety cost = (LDaN/365)* (Ch*Cn* σDn* z)
	Maritime transport	Safety cost = (LDmN/365)*(Ch* Cn*σDn*z)
From China to Japan	Air transport	Safety cost = (LDaC/365)*(Ch*Cc* σDc*z)
	Maritime transport	Safety cost = (LDmC/365)*(Ch*Cc*σDn*z)

5.2.3 The Cycle Stock Cost

As we have four different shipping quantity and there are four different cycle stock cost, the table below shows the formula equation for each cycle stock cost.

Table 16: The Cycle Stock Cost Equation

From Norway to Japan	Air transport	Cycle stock cost = (QaN /2)* (Ch*Cn)
	Maritime transport	Cycle stock cost = (QmN /2)*(Ch* Cn)
From China to Japan	Air transport	Cycle stock cost = (QaC /2)*(Ch*Cc)
	Maritime transport	Cycle stock cost = (QmC /2)*(Ch*Cc)

5.2.4 The Manufacturing Cost

Concerning the production costs, we are going to consider two manufacturing costs, from Norway and from China. This is to enable Us to aggregate the cost of different products of manufacturers located in Norway, the aggregation process will be developed in the next chapter. The manufacturing cost in China is just the production cost of Northern lightening products destined for the Japanese market.

Table 17: Manufacturing Cost Equation

From Norway to Japan	Manufacturing cost = Dn * Cn
From China to Japan	Manufacturing cost = Dc * Cc

Finally, we consider the total logistics cost, which is the sum of the transport cost, the safety stock cost, the cycle stock cost and manufacturing cost. The equation is shown below;

TC = transport cost + safety stock cost + cycle stock cost + manufacturing cost

6.0 ANALYSIS AND DISCUSSION

In this chapter, the total Cost Equation generated by the current transport practiced by NI will be analyzed and compared to an alternative transport mode in order to figure out whether there are any potential improvements in term of efficiency in exporting products to Japan.

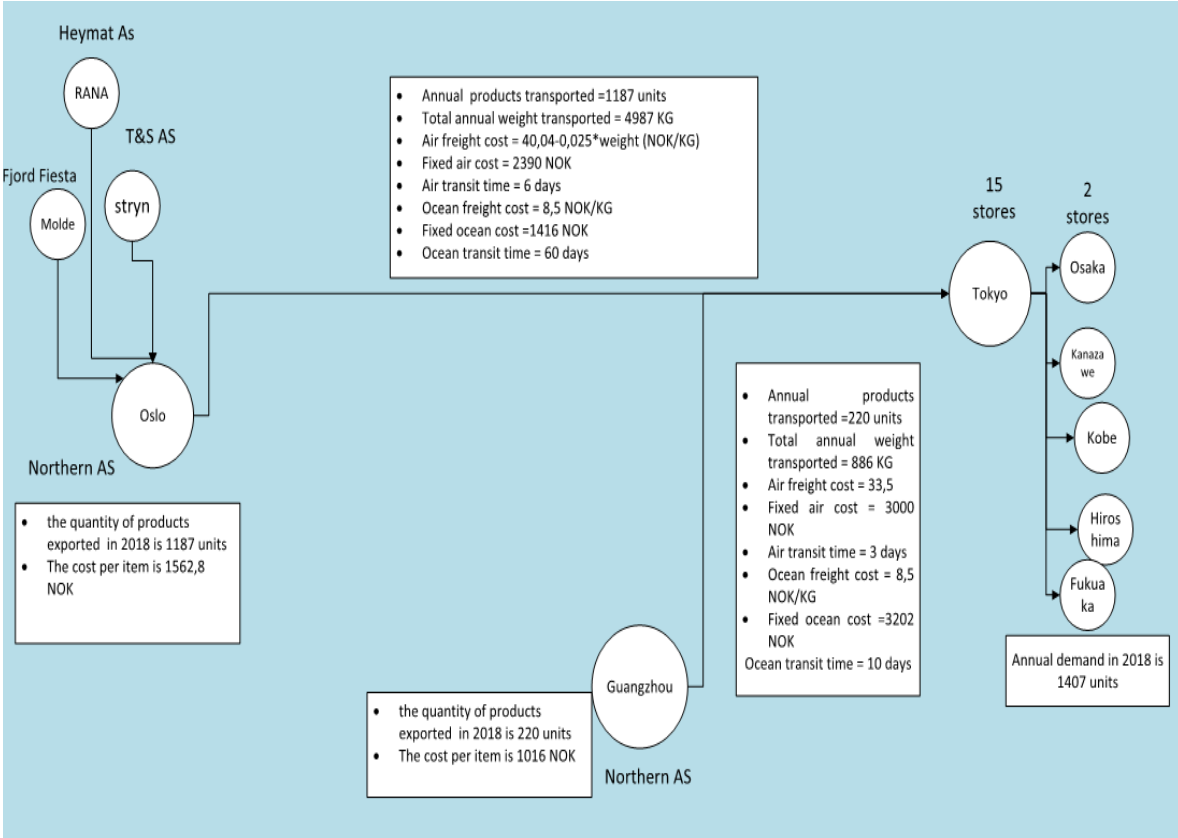
We will study in this chapter the four main network members namely “Northern lighting”, “Heymat”, “Fjord Fiesta”, “Tonning og Stryn”. These members of the Network have different characteristics in term of demand, demand variability, demand growth, weight and manufacturing price. Therefore, before we start the analysis we aggregate the various product characteristics in terms of (weight), cost, and sales in order to consider it as one single product

6.1 Data Aggregation

We need to calculate the annual demand and the weighted average cost of all members of the network products. The weighted cost by definition is statistically more accurate than using the average because it is influenced by the quantity sold of each manufacturer. Hence, the cost will be close to the cost of the most sold category.

Before we go into the detailed description of characteristics of products exported to Japan, we present an overview of the international operational of the “Corporate Network Japan” and all data and information related to each path together with the transport mode decision.

Figure 8: International Operation of the Network



Source: Authors construct (2019)

The figure shows four network members and the annual product transported and it characteristics such as weight, air freight cost, transit time, ocean cost and transit time from Oslo to customers in Japan, it reveals as well the quantity and weights of products transported annually from China to Japan, and it mode of transport. Air and ocean freight cost, transit time are also shown in this figure. It also shows the stores in Japan where customer's orders are received and products are sold to customers.

The information on this figure concerning the quantity sold and the product cost are the output of aggregation detailed in appendix 3 to appendix 7. The table 18 below summarizes the characteristics of products exported from Norway, and table 18 of products exported from China

Table 18: Furniture Characteristics from Norway to Japan

Furniture characteristics	
Demand	1187 units
Manufacturing costs	1562,8 NOK
Weight per item	4,2 KG
Annual demand coefficient variation	0.1

The quantity of product sold from Norway are 1187 units, the individual quantity of the network members are discussed below;

- **Fjord Fiesta**: the annual demand of fjord fiesta was 19 units with the weighted manufacturing cost of 2104 NOK, the total value exported by products are sold was 39980 NOK in 2018 (appendix 3).
- **Northern Lighting:** the annual demand of Northern lighting was 726 units with the weighted manufacturing cost of 1016,1 NOK. It must be noticed here that Northern lighting exports its products from two different countries(Norway and China) the sales of products were estimated at 506 units, the total value exported by Northern was 514 146,18 NOK (appendix 4).
- **Heymat**: currently, Heymat is the biggest manufacturer of the Network in terms quantity sold and value, the annual value in 2018 was 1 277 770,00 NOK corresponding to 651 units of door mat (appendix 5).
- **T&S:** is the smallest manufacturer both in quantities and value, total demand was 11 units and the manufacturing weighted cost was 2 109,09 NOK (appendix 6).

In practice, the demand often fluctuates, since we do not have sales data of previous years, we use annual demand coefficient of variation to assume variability in demand. The coefficient of variation represents the ration of the standard deviation to the mean. The mathematic formula is

Coefficient of variation = Standard deviation / Mean

We consider 0,1 demand coefficient variation for both itinerary.

Table 19: Products Characteristics from China to Japan

Northern Product Characteristics	
Demand	220 units
Manufacturing costs	1016,1 NOK
Average weight per item	4, 027 KG
Annual demand coefficient variation	0.1

The annual value of products exported to Japan was 2 078 568,00 NOK, this corresponds to 353 NOK per kg.

According to NI, 70% of sales of Northern lighting products are manufactured in Norway, Denmark and Slovenia and exported from Oslo to Japan. The remainder is produced and exported from China to Japan. Therefore, we consider 506 units of demand from Norway and 220 units from China.

6.2 Analysis of the impact of NI 2018 transportation strategy in total logistics cost

As we discussed earlier in the last chapter, NI used air transportation to move freight in the year under review. The records of 2018 of the Network shows that, 1407 units of products were exported to Japan, with 1187 from Norway and 220 from China, the total number of orders delivered was eighteen (18), fourteen from Norway (13 by air and one by ocean), and four from China, the figure below presents the input data.

Figure 9: Input Data of International Transport Strategy 2018

Norway to Japan	
inventory carrying cost	20%
Days per year	365
Ocean order cost	1416
Air order cost	2390

products	weight/kg	Cost/ nok	Demand Air	Value	Quantity by air	Quantity ocean	number of orde
NI furnitures	4,20	1562,8	1091	1704998,791	84	96	13
Northern	4,027	1016,1	220	223541,8182	55	0	4

China to Japan	
inventory carrying cost	20%
Days per year	365
Ocean order cost	1400
Air order cost	3202

Freight rate & transit time		Air rate	Ocean rate	Air time	Ocean Time
		nok/kg	nok/kg	days	days
OSL	TKY	22,57 NOK	5,38 NOK	6	55

Table 20 Below, summarizes the result of the total logistics cost of international transport strategy in 2018.

Table 20: Total Logistics Cost of Transport Strategy in 2018

Itinerary	Transport mode	The cost structure	Total cost
Norawy to Japan	Air transport	Air freight cost	103 449,00 NOK
		Air inventory cost	7 006,84 NOK
		Air ordering cost	31 070,00 NOK
		Air total transport cost	141 525,84 NOK
		Safety stock cost	0,00 NOK
		Cycle stock	16 394,22 NOK
		manufacturing costs	1 704 998,79 NOK
		Air total logistics cost	1 862 918,85 NOK
	Maritime transport	Ocean freight cost	2 150,00 NOK
		Ocean inventory cost	5 651,72 NOK
		Ocean ordering cost	1 400,00 NOK
		Ocean total transport cost	9 201,72 NOK
		Safety stock cost	0,00 NOK
		Cycle stock	18 753,42 NOK
		manufacturing costs	150 027,39 NOK
		Ocean total logistics cost	177 982,53 NOK
China to Japan	Air transport	Air freight cost	29 685,00 NOK
		Air inventory cost	459,33 NOK
		Air ordering cost	12 808,00 NOK
		Air total transport cost	42 952,33 NOK
		Safety stock cost	0,00 NOK
		Cycle stock	6 985,69 NOK
		manufacturing costs	223 542,00 NOK
		Air total logistics cost	273 480,02 NOK
		Total logistics cost 2018	**2 314 381,41 NOK**

The total logistics cost of "Corporate network Japan" in 2018 was evaluated at 2 314 381,41 NOK, which is a combination of total logistics cost from Norway to Japan by air and by sea, as well as the total logistics cost by air from China to Japan.

Air fright cost is the highest cost of the total transport cost, for instance, the air freight cost was 73% of the total transport cost by air. Therefore, NI needs to focus on freight rate from different 3PLs in order to get the cheapest one.

NI has no safety stock policy, all orders are shipped based on information received from the stores and showrooms in Japan. This policy of "ship to order" help NI to save inventory and safety costs. However, it makes transportation cost very high due to high freight rate of small shipments and the order cost because of the repetitive number of replenishment and the absence of grouping orders.

We constate that cost of ocean transport is 177 982,53 NOK and the major cost part comes from in-transit inventory cost instead of freight cost and that's because of the long transport time that takes products from Norway to Japan. However, the total transport cost of one order of the same size still very low compared to transportation by air.

The total costs of the use of air transportation as the only transport mode accentuate the transport cost particularly of orders from China to Japan where the freight cost charged by the Japanese logistics provider is relatively high for shorter for shorter distance.

Overall, NI transport costs in 2018 was extremely high, waiting client's orders and shipping by air make the export logistics costly. However, the inventory costs (safety cost, in-transit cost and cycle cost) were low. The necessity to balance the two main costs is the key for an efficient supply chain of NI.

6.3 Analysis of the impact of Air transport mode on TC

In this section, we will analyze the impact of selection air transport mode for exporting product to from Norway to Japan, since air transportation is used for both itinerary from Norway and from China.

The figure shows the input data of analysis, all data about the transport costs, time and the product characteristics are same. However, we include the demand variability in this analysis.

Figure 10: Input Data of International Transport by Air

Norway to Japan	
inventory carrying cost	25%
Days per year	365
Ocean order cost	1416
Air order cost	2390

products	weight/kg	Cost/ nok	Demand: units	Value/nok	Quantity by air / units	σD	Z value	N° of orders by air
NI furnitures	4,20	1562,8	1187	1855026,18	267	118,7	98%	4,45
Northern	4,027	1016	220	223541,82	74,00	22,00	98%	3,00

China to Japan	
inventory carrying cost	25%
Days per year	365
Ocean order cost	3000
Air order cost	3202

Freight rate & transit time		Air rate	Air time
		nok/kg	days
OSL	TKY	18,5	6
CHN	TKY	33,50	3

We applied the EOQ formula to figure out the optimal shipping quantity. However, in this case where we have a freight rate that decreases when the quantity increase, EOQ would not become the optimal quantity. Therefore, by taking into consideration certain volume constraints of the products, the 3PL recommends 1000 KG as suitable average weight for air transport of the network manufacturers, according to the 3PL, the freight rate will increase if the quantity to ship reaches a certain threshold, thereby excessive weight make the freight more costly. Therefore, we consider 1000 KG which represents the average of 267 units of quantity, the number of orders is 4,5 orders per year corresponding to one order every 82 days. It is notice that the shipping quantity has not be the same and fixed but it has to follow some indicators such as seasonality, new contracts takeoff, the sales that come from wholesales and individual clients.

Additionally, we also set the customer service level to ninety-eight per cent related to potential broken products or no convenient package to Japanese standards during transportation, this level means that NI needs to hold safety stock to buffer against two per cent of the potential package or product deficiency. The result is demonstrated in the table below;

Table 21:Total Logistics Cost of Air Transport

Itenerary	The cost structure	Total cost NOK
Norway to Japan	Air freight cost	92 270,19
	Air inventory cost	7 623,40
	Air ordering cost	10 625,21
	Air total cost	110 518,79
	Safety stock cost	1 565,65
	Cycle stock	52 157,96
	manufacturing costs	1 855 026,18
	Air total logistics cost	2 019 268,59
China to Japan	Air freight cost	29 682,89
	Air inventory cost	459,33
	Air ordering cost	9 458,53
	Air total cost	39 600,76
	Safety stock cost	94,33
	Cycle stock	9 458,53
	manufacturing costs	223 520,00
	Air total logistics cost	272 673,62
	Total logistics cost by Air	**2 291 942,21**

From the table, the total logistics cost of NI by using air transportation is 2 291 942,21 NOK where 2 019 268,59 NOK is the total cost from Norway to Japan, the shipping orders from Norway to Japan was four and half times per year, on average the review period is 11 weeks.

After optimizing the number of orders, the freight rate becomes the dominant cost of air transport cost with 83%, which means the freight cost is the cost component that managers should focus more when opting for air transport mode.

Air logistics cost from China to Japan was estimated at 272 673,62 NOK, the optimal quantity is 83 units shipped every 4 months.

Because of grouping orders, NI needs to have some safety stock in order to buffer against any demand variability or products deficiency during the replenishment period, exporting from China will not be concerned about the safety stock. On the other hand, the safety cost was estimated at 1 565,65 NOK corresponding to 4 units From Norway to Japan. The safety stock cost, as well as pipeline inventory costs are marginal and this is explained by the fact of the short transit time of transportation by air which limits the effect of potential defects products and eventual demand variability.

6.4 Analysis of the impact of Maritime transport mode

After we analyzed the air transportation, in this section, we focus on the impact of selection ocean transport mode for exporting product to Japan, the ocean transportation is used in both line haul from Norway and from China.

The figure shows the input data for analysis; we have used the same freight cost of 2018 charged by the Japanese 3PL. Even though we got lower freight cost from other freight forwarder, the reason is to find out the cost saved from better planning and managing the transport activity.

Figure 11: Input Data of International Transport by Ocean

Norway to Japan	
inventory carrying cost	25%
Days per year	365
Ocean order cost	1416
Air order cost	2390

products	weight/kg	Cost/ nok	Demand: units	Value/nok	Quantity by ocean / units	σD	Z value	N° of orders by ocea
NI furnitures	4,20	1562,8	1187	1855026,18	104	118,7	98%	11,41
Northern	4,027	1016	220	223541,82	72,09	22,00	98%	3,00

China to Japan	
inventory carrying cost	25%
Days per year	365
Ocean order cost	3000
Air order cost	3202

Freight rate & transit time		Ocean freight rate	Ocean time
		nok/kg	days
OSL	TKY	8,5	60
CHN	TKY	6,75	10

The result is of this model is as shown in table 21

Table 22: Total Logistics Cost of Ocean Transport

Itenerary	The cost structure	Total cost
Norway to Japan	Ocean freight cost	42 394,41 NOK
	Ocean inventory cost	76 233,95 NOK
	Ocean ordering cost	16 161,46 NOK
	Ocean total cost	134 789,83 NOK
	Safety stock cost	15 656,54 NOK
	Cycle stock	20 316,21 NOK
	manufacturing costs	1 855 026,18 NOK
	Ocean total logistics cost	2 025 788,76 NOK
China to Japan	Ocean freight cost	4 530,24 NOK
	Ocean inventory cost	1 293,48 NOK
	Ocean ordering cost	6 427,01 NOK
	Ocean total cost	12 250,73 NOK
	Safety stock cost	212,74 NOK
	Cycle stock	6 427,01 NOK
	manufacturing costs	295 046,40 NOK
	Ocean total logistics cost	313 936,88 NOK
	Total logistics cost by Ocean	**2 097 085,76 NOK**

From the table, the total logistics cost of NI by using air transportation was 2 097 085,76 NOK where 2 025 788,76 NOK is the total cost from Norway to Japan, the optimal shipping quantity is 104 units with in average shipping order per month. This repetitive number of orders is because the non-sensitivity of freight rate to the weight of products and the low freight rate of less than container (LCL) shipping and relatively low ordering cost for each. Contrary to shipping by air, the in-transit handling cost is the dominant transport cost of maritime transportation, the long transport time (two months) and the characteristics of products (relatively high value) make this cost high.

The air logistics cost from China to Japan was estimated at 272 673,62 NOK, where the optimal quantity was 83 units every 4 months.

Form the table above inventory cost is high, NI needs more safety stock in order to buffer against any demand variability as well as transport time variability knowing that ocean transportation is less reliable transport mode among the others. The safety cost from Norway to Japan was 15 656,54 NOK corresponding to 40 units of safety stock level, the same cost is lower from China to Japan because of the short distance. The safety stock cost, as well as pipeline inventory costs, are significant and NI has to consider the inventory cost (pipeline, in-transit and safety cost) in the maritime transport mode selection for long distances.

6.5 Discussion

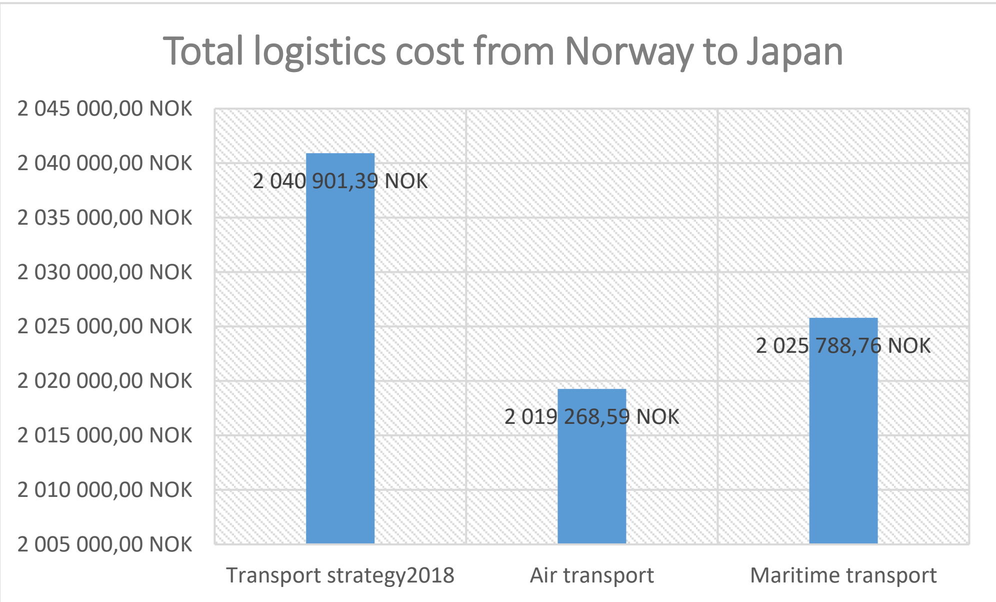
In this section, we will compare and analyze the two-transport mode with the transportation strategy of the last year, based on this comparative analysis, we will build our recommendation to NI about transport planning, transport mode selection and transported quantity that make the exporting products of the network more efficient.

6.5.1 Transport Mode Selection Comparison

- **From Norway to Japan**

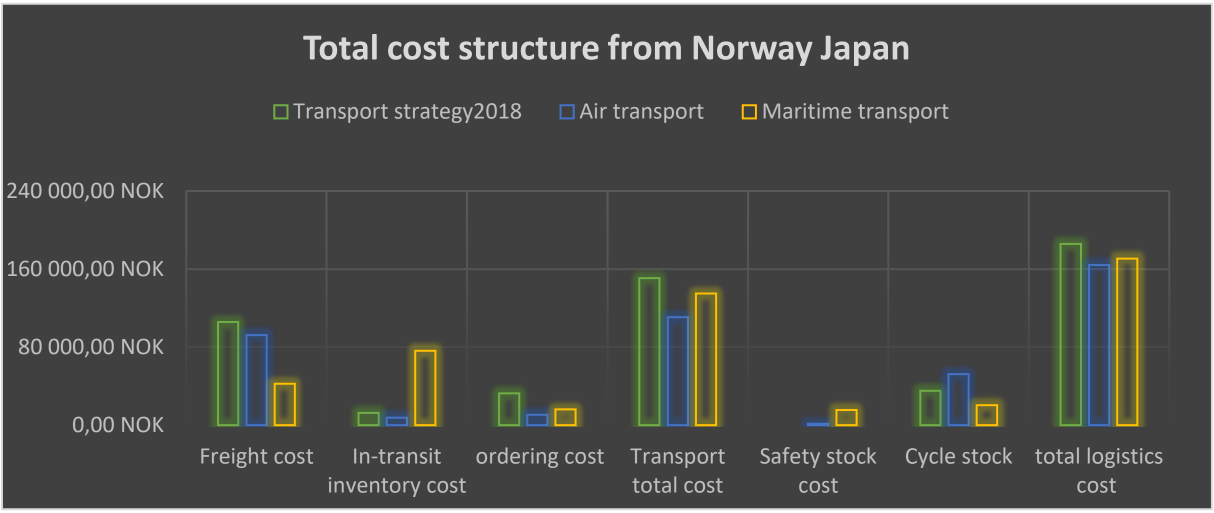
The figure shows a histogram of the Total Logistics Cost of NI transport strategy 2018, Air transportation and ocean transportation from Norway to Japan.

Figure 12 : Total Logistics Cost from



From the figure, using air transport mode with grouped orders in which each order size is on average of 1000 kg or 267 units is the most efficient transport mode, this policy would help NI to save 21 632,80 NOK. Even more, using planned order in air transportation is also more efficient than maritime although the freight cost of maritime is two times cheaper than air. The figure below shows the cost structure of each transport mode without considering the manufacturing cost since its which is the same for all transport options.

Figure 13: Total Cost Structure from Norway to Japan



This figure shows how maritime transport cost is higher than air transport. While it has the lowest freight cost on average more than half the freight cost of air, maritime has 10 times more in-transit inventory cost than air for three reasons:

- It is a slow transport mode with high variability,

- The value of the products transported is high (1 855 026,18 NOK), the average value is 372 NOK/KG

- The nature of products (fashionable items) which has a relatively high capital cost (25%)

After taking into consideration the demand variability and grouping orders, NI has to deal with safety stock, we notice that the safety stock level required for opting for air transport mode is marginal due to the low transport time. In other hand, maritime need more safety stock level which in turn increase the safety cost. Hence, it makes the ocean transportation less competitive than air.

The transport cost of air transportation is 110 518,79 NOK, it is 36,38% lower than the current transportation strategy (2 040 901,39 NOK) and **21,96%** lower than maritime transport (2 025 788,76 NOK). Which make air transportation the efficient transport mode for NI from Norway to Japan.

We observe as well that there is no significant difference in term of total logistics cost between the two transport mode and knowing that the freight rate is not fixed and maritime transport time is unstable. We come to question of when ocean transportation can take over air transportation in term of efficiency from Norway to Japan. To answer to this question, the table below represents a sensitive analysis of the impact of air freight rate and ocean transit time.

Table 23: Sensitivity Analysis Table

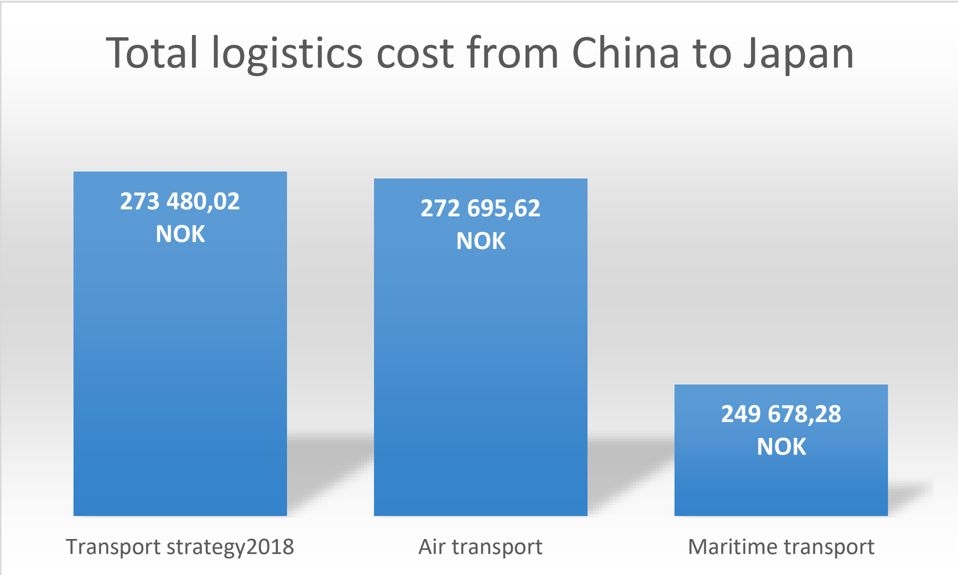
Air freight rate NOK/KG	Maritime transit time (days)					
	50	55	60	65	70	75
16,00 NOK	Air	Air	Air	Air	Air	Air
16,74 NOK	Maritime	Air	Air	Air	Air	Air
18,00 NOK	Maritime	Air	Air	Air	Air	Air
19,00 NOK	Maritime	Maritime	Air	Air	Air	Air
19,50 NOK	Maritime	Maritime	Air	Air	Air	Air
20,50 NOK	Maritime	Maritime	Maritime	Air	Air	Air
21,00 NOK	Maritime	Maritime	Maritime	Air	Air	Air
21,50 NOK	Maritime	Maritime	Maritime	Maritime	Air	Air
22,00 NOK	Maritime	Maritime	Maritime	Maritime	Air	Air
22,50 NOK	Maritime	Maritime	Maritime	Maritime	Air	Air
23,00 NOK	Maritime	Maritime	Maritime	Maritime	Maritime	Air
23,50 NOK	Maritime	Maritime	Maritime	Maritime	Maritime	Air
24,50 NOK	Maritime	Maritime	Maritime	Maritime	Maritime	Maritime

By varying the air freight /kg and ocean transport time, the result shows that if the freight rate by air is 16,5 per kg, shipping by air is more advantageous knowing that there is a lower probability that ocean transportation transit time goes below 50 days from Norway to Japan. Maritime transport becomes efficient when freight rate is 16,74 NOK/K based on the condition the transport time is at its minimum (50 days). Thereafter, the more the freight rate charged by air, the more the ocean becomes advantageous, and inversely for lead time, until it reaches air freight rate of 24,5 NOK/kg, at that level exporting product by sea is the most efficient solution from Norway to Japan, knowing that it is unlikely transit time be more than 70 days.

- **From China to Japan**

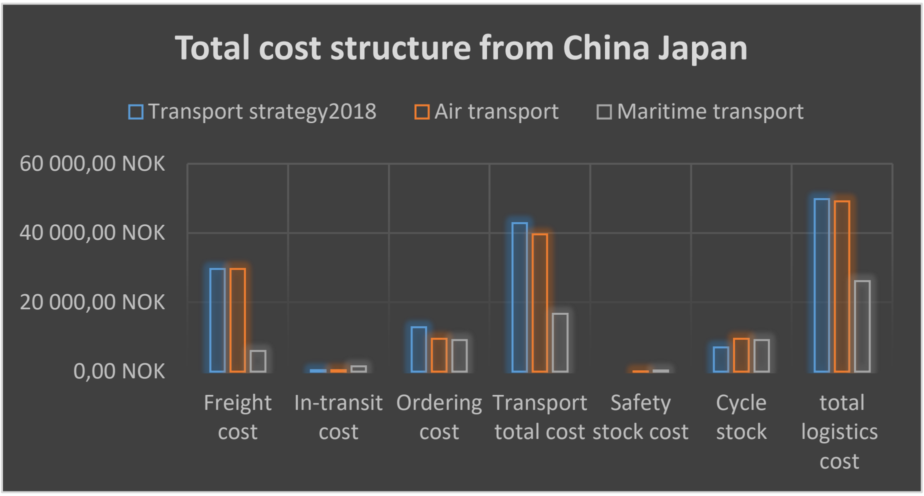
The figure shows a histogram the Total logistics cost of NI transport strategy 2018, Air transport and ocean transportation from China to Japan

Figure 14: Total Logistics Cost from China to Japan



This figure shows that maritime transportation is clearly the efficient transport mode from China to Japan, the total logistics cost of maritime is 9,5 % lesser than the last year total logistics co**st and 9,2 % than the air transport which is really** huge cost saving. We notice as well that there is a minor improvement by optimizing the quantity to be shiped, instead of shipping three times per year, three times is the optimal number of shipping orders which made this marginal improvement. The reason for this is that the annual shipping quantity is not large enough to make any substantial improvement. The figure below shows the cost structure of each transport mode without considering the manufacturing cost.

Figure 15: Total Logistics Cost Structure from China to Japan



This figure reveals how maritime transport out-perform air transportation in the freight cost. it is five times lesser which indicates a higher competitive advantage over air Transportation, even though the inventory costs (in-transit, safety stock, and cycle stock) are higher but it is insignificant because of the short distance from China to Japan which in turn limits the cost impact related to lead time.

6.5.2 Intermodal Transportation

This part focuses on intermodal transportation. Intermodal transport has recently become a popular area throughout the transportation industry. Longer distance shipments are particularly suitable for intermodal, the longer the distance the greater the opportunity to save cost for the company. It is a transport method that integrates advantages of different modes of transport that aims at achieving an effective combination of cost, delivery time and service quality. In this study an email was sent to potential 3PLs to request for quotation from Oslo-Moscow-Tokyo, and Oslo- Guanzhou-Tokyo route for intermodal freight cost and as well as other route for an efficient intermodal transportation from Norway to Japan. This was later followed by a telephone interview of the three selected respondents with regards to freight rate and transit time. The aim of this was to gather different transport cost and transport time from 3PLs to enable us compare them to the status quo. The answers we received were similar in nature, below is an answer from a 3PL.

“We cannot organize that kind of transport within a reasonable amount of money compared to the total transit time. The shipment would have to move from the terminal in Oslo to two or three different terminals before reaching its final destination, between each terminal the cost of changing from one mode to the other will make this transportation inefficient”.

Another Logistics services provider respondent that, “considering the size of the load, intermodal mode of transport from Norway to Japan specifically, Oslo to Tokyo is not a realistic solution to reduce costs for the firm.

Literature on intermodal transportation asserts that intermodal transportation is usually suitable for intermediate and finished good in load units of at most 25 tons. Even though intermodal transportation has the capacity to save the Norwegian Icons some money, and the distance from Norway to Japan is long enough, the size of the order to be replenished does not support the use of this mode of this mode transport since intermodal transportation moves products in a containerized form to minimize the cost per unit of a product. Moreover, intermodal transportation is more suitable when there is continues flow of products in a similar quantity with a higher frequency.

6.5.3 Proposed Transportation Model

Based on the analysis of the total logistics cost of different transport mode we build our proposition to NI in order to design an efficient international transport model that minimizes the global supply chain of exporting the manufacturers' network to Japan.

- Using air transportation from Norway to Japan and maritime from China to Japan is the most efficient transportation network strategy for NI.

- For air transportation, the freight cost is the main cost part of transport cost. Therefore, NI has to focus on reducing it, and this could be done by better planning the ordering shipment.

- From Norway to Japan, we have noticed that in some circumstances, the ocean transportation could be more efficient than air transportation. Therefore, we recommend that NI request for freight quote for both transport mode and make decision based on the freight cost and transport time. Using TLC would be a useful metrics for such decision.

- Just changing the transport mode and focusing on freight cost is not enough. NI has to minimize the number of orders for both line haul, from Norway to Japan, it would better to ship average 1000 KG of products four times per year, by doing this the freight rate would be lower because of the weight, and also the ordering cost will be reduced due to the limited number of orders exported. This policy will not have a big impact on inventory cost since the transit time is low.

- The low freight cost and the short distance from China to Japan are main reasons for NI to choose ocean transportation and the optimal number of shipments is three.

The table below shows how NI can save cost by opting the proposed transport model.

Table 24: Total Logistics Cost: Transport Model 2018 vs Proposed Model

	The cost structure	Transport model 2018	Proposed model	Saved cost
Strategic Network	Freight cost	135 284,00 NOK	98 250,29 NOK	38%
	In-transit inventory cost	13 117,89 NOK	9 154,50 NOK	43%
	ordering cost	45 278,00 NOK	19 780,53 NOK	129%
	transport cost	193 679,89 NOK	127 185,32 NOK	52%
	Safety stock cost	0,00 NOK	1 880,07 NOK	-
	Cycle stock	42 133,33 NOK	61 313,29 NOK	-
	manufacturing costs	2 078 568,18 NOK	2 078 568,18 NOK	-
	total logistics cost	2 314 381,41 NOK	2 268 946,87 NOK	2%

This table focus on the strategic network of NI which combines all costs from the two line-haul. NI could save **45 434,54 NOK** in transport cost which represents **52%** less than 2018 and could save more than **2%** of total logistics cost of all network which is a significant cost reduction. The principal source of cost reduction comes from ordering cost, NI can reduce approximately 130% of the fixed part of shipping just by optimizing their number of orders by year by going from 14 number of orders to 4,5 from Norway to Japan by air and from 4 orders to 3 from China, this policy of grouping orders will help also to reduce the freight cost. However, the inventory costs of cycle stock will increase because of the size of quantity shipped and NI needs to invest more in warehousing by keeping some level of stock.

6.5.4 Recommendations

Beyond the recommendations proposed for the international transportation, other recommendations might be suggested to NI, which has a complex global supply chain to manage, which constitutes of several manufacturers from different part of Norway, Based on the observation and interview conducted with NI and some manufacturers, we believe that NI, as well as all manufacturers members of the network, should focus on the following points in order to ensure the efficiency as well the effectiveness of their global supply chain:

1. NI and all manufacturer have to invest in creating a common ERP system for their activity in Japan, database should be constructed to contains all information related to the products of each manufacturer destined to Japan, the information is about

- The production cost,
- Product weight,
- Products dimensions,
- Warehouse cost,
- Inland transport cost, selling price, revenue.
- The international carrier partner (s)
- The transport time and cost of each transport mode and each itinerary.
- Revenue (by store and by region in Japan)

All these data has to be updated if necessary and it constitutes of the main resources for any logistics planning and decision more specifically transportation.

2. By building ERP system, the forecasting could be used to plan the quantity that should be shipped for each replenishment period, and the level of safety stock, thus NI will not need to wait until the orders received from customer to start shipping, it helps to have a proactive approach which leads to optimizing not just transportation cost but also the inventory costs and all global supply chain.

3. Building a common ERP system also has the potential of reducing ordering processing time since the existing method shows that when a customer in Japan orders for a products, the stores in turns forward the order to Norwegian Icons office in Norway and then

Norwegian Icons send the order to the particular manufacturers to replenish Norwegian Icons in Oslo before the international transportation.

4. The quantity for shipment and the number of orders has to be adapted to some indicators and parameters such annual growth and seasonality, for instance, the result of analysis revealed that the quantity to ship every three months by air from Norway to Japan is 267 units, nevertheless, this quantity could be more or less depending on seasonality indicator for each quarter.

5. Based on the quotation received from various 3PL for transport from door in Guangzhou seaport to Tokyo seaport, we found out that freight prices based on weight and volume are expensive. Therefore, It is preferable for NI to alter the current 3PL which is in charge of international transportation from China to Japan to another 3PL and preferable the 3PL which is charge of transportation from Norway to Japan, we got from them a low freight cost and more than that, NI could build a strong relationship and could get more than freight costs such as high service and more flexibility.

6. Norwegian Icons should consider transporting to other ports other than the port of Tokyo which has been the existing port of destination for all shipment of the Network, an interview with Logistics services providers about different freight cost for different ports in Japan shows that the Osaka Port is cheaper than Tokyo Port. This can be explored by the company when orders from that areas are ship Directly to Osaka instead of Tokyo.

7. We found out in total landed cost analysis that renting spaces represent 47% of total warehouse cost, and since NI will require more spaces for safety stock, thus, they need to make trade-off between the new cost charged by Japanese 3PL and the cost of investing in owning their own warehouse, a deep study on this project should be emphasis in order to beneficiate on the cost saved from aggregate orders.

8. Management of the network should consider implementing synchromodal transportation strategy in its transportation planning, by integrating this system, the organization contributes to sustainable development of transport and reduce the exhausting of gasses by coordinating with other actors of the in the field.

6.5.5 Managerial Implications

As Norwegian Icons becomes internationalized, complexity in its supply chain also becomes more challenging. Integrating supply chain synchronization on the entire chain by introducing and implementing new system information in planning and operating the business will lead to higher order fulfilment and improve service levels, increase operational efficiency, increase competitiveness and reduce risk. Norwegian Icons should consider proactive management of the export process based on activity planning rather than reactive approach that consists of waiting for orders to be fulfilled, Delivery is an important part of the order fulfilment process and keeping customers informed about the order and shipment status plays an important role in improving customer services and experience. The existing policy of Norwegian Icons does not provide a mechanism to guarantee an accurate concurrent execution and, as a result, it is not possible to coordinate and synchronize different processes in the ordering and fulfilment processes of the network. Supply chain synchronization strategy has the potential of providing real-time, end-to-end visibility over the entire chain.

6.5.6 Limitations of the Study

Due to the lack of information about the volume of products exported to Japan, this study did not consider the volume of product transported in our calculation, the most reliable unit of measure to consider in calculating freight rate is Volume weight known as well dimensional weight. Likewise, the study did not incorporate the lead time variability in total cost calculation, even though the study assumed triangular distribution of lead time, but did not include it because the impact on decision making is insignificant. Quantitative data on intermodal transportation from Norway to Japan is also a limitation to this study.

7.0 CONCLUSION & FURTHER RESEARCH

7.1 Conclusion

The purpose of the study is to design an efficient international transportation of exporting High-quality Norwegian products to Japan. Transportation efficiency can be measured in many ways, which can lead to different conclusions. The literature states that costs, time and service level are fundamental variables in the choice of transportation modes, it can be established that cost and time variables turn to define the mode of transportation. On the other hand, distance, transport flows and freight volumes are more associated with infrastructure location and distribution focuses, while the loading unites characteristics such as maximum weight, size and damage are related to planning models for loading unit allocation. Again, the review identified important progress in the existing international strategy research that has increased the understanding in this area of research. Yet, it also reveals that many of internationalization remains fragmented with gaps in both theory and methodology. Here, intensive research should focus on how transportation mode affects the stock level and inventory costs of small and medium enterprises (SMEs).

The results shows that, changing transport mode is not enough. Therefore, NI has to reduce the number of orders for both destinations. Focusing just on transport mode is not enough to make the whole supply chain efficient, it must be associated with the impact of each transport mode on inventory cost, consequently, a tradeoff between these costs is important.

The literature review indicates that for high value items it is more efficient to use fast transport mode. However, our results showed that it is instead relative to some variables which was the distance in our study. We found out that transportation by ocean is more efficient than by air for NI products which are high value because of the short distance from China to Japan, this short distance restraint the different between transport modes in the transit time, thus the cost related to transport time has lower impact on the total transport cost.

7.2 Further research

Further research should consider other variables which are not considered in this study in order to optimize the global supply chain of the “Corporate Network”, this latter has strategy of international expansion in Europe and USA. Therefore, the model has to integrate the duty costs and tax costs. In addition, the fixed cost of building a warehouse should be taken into consideration, this decision would have an impact on the international network decisions of routes and transport modes and the whole global supply chain design.

APPENDIX

Appendix 1: Product cost

Manufacturer	Product Category	Manufacturing Cost/unit
Northern Lightening	Birdy Wall Short	1077 NOK
	Birdy Wall Long	992 NOK
	Birdy Table	1220 NOK
	Birdy Floor	1600 NOK
	Dokka	840 NOK
	Dahl	1373 NOK
	Butterfly	840 NOK
Heymat	Door mat S (60 x 85)	1150 NOK
	Door mat M (85 * 115)	2100 NOK
	Door mat L (115 x 150)	2500 NOK
Fjord Fiesta	Multibench Krobo	4475 NOK
	Bench (krobo)	2000 NOK
	Accessories	625 NOK
	Cushion (chair)	405 NOK
Tonning & Stryn	Chairs	2200 NOK
	Tables	2000 NOK

Source: NI price list provided by the network members (2018)

Appendix 2: Air Freight rate per KG

Air Freight cost NOK	Weight KG	AirFreight rate NOK
600	15	**40**
960	31	**30,97**
9084	356	**25,52**
2500	76	**32,89**
7735	169	**45,77**
4421	100	**44,21**
2712	75	**36,16**
9791	638	**15,35**
16206	87	**18,5**
5452	234	**23,3**
20036	910	**22,02**
5452	100	**54,52**
18500	1000	**18,5**

Source: Shipping invoices of 3PL (2018)

Appendix 3: Fjord Fiesta products characteristics

Product Category	Annual Demand	Manufacturing Cost	Annual Value
Multibench Krobo	2 units	4475 NOK	8950 NOK
Bench (krobo)	15 units	2000 NOK	30000 NOK
Accessories	1 unit	625 NOK	625 NOK
Cushion (chair)	1 unit	405 NOK	405 NOK
Fjord Fiesta	**19 units**	**2104 NOK**	**39980 NOK**

Source: Fjord Fiesta sales document (2018)

Appendix 4: Northern products characteristics

Product category	**Annual Demand** **UNITS**	**Manufacturing cost** **NOK**	**Annual value** **NOK**
Birdy Wall Short	60	1077	64 620,00
Birdy Wall Long	48	992	47 616,00
Birdy Table	66	1220	80 520,00
Birdy Floor	48	1600	76 800,00
Dokka	360	840	302 400,00
Dahl	84	1373	115 332,00
Butterfly	60	840	50 400,00
Northern	**726**	**1016,1**	**737 688,00**
Northern Norway	506	1016,1	514 146,18
Northern China	220	1016,1	223 541,82

Source: Northern sales document (2018)

Appendix 5: Heymat products characteristics

Product Category	**Annual Demand**	**Manufacturing Cost**	**Annual Value**
Door mat S (60 x 85)	180 units	1150 NOK	207 000,00 NOK
Door mat M (85 * 115)	267 units	2100 NOK	560 700,00 NOK
Door mat L (115 x 150)	204 units	2500 NOK	510 000,00 NOK
Heymat	**651 units**	**1962,67 NOK**	**1 277 770,00 NOK**

Source: Heymat sales report (2018)

Appendix 6: T&S products characteristics

Product category	**Annual Demand**	**Manufacturing cost**	**Annual value**
Chairs	6 units	2 200,00 NOK	13 200,00 NOK
Tables	5 units	2 000,00 NOK	10 000,00 NOK
T&S	**11 units**	**2 109,09 NOK**	**23 200,00 NOK**

Source: T&S sales document (2018)

Appendix 7: Aggregated data of network members

Line Haul	Manufacturer	Manufacturing cost	Annual demand	Annual value
From Norway to Japan	Northern	1 016,10 NOK	506 units	514 146,18 NOK
	Heymat	1 962,67 NOK	651 units	1 277 700,00 NOK
	Fjord Fiesta	2 104,21 NOK	19 units	39 980,00 NOK
	T&S	2 109,09 NOK	11 units	23 200,00 NOK
	Total NI furntiture	**1 562,79 NOK**	**1187 units**	**1 855 026,18 NOK**
From China to Japan	**Northern**	**1016,1 NOK**	**220 units**	**223 541,82 NOK**
Both itenerary	**NI total value exported**	**1477,30 NOK**	**1407 units**	**2 078 568,00 NOK**

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