



MASTER OF SCIENCE THESIS
STOCKHOLM, SWEDEN 2014

Feasibility study for expansion of the existing intermodal terminal in Jordbro

IOULIA CHRISTINA CHRISTIDI



KTH ROYAL INSTITUTE OF TECHNOLOGY
SCHOOL OF ARCHITECTURE AND THE BUILT ENVIRONMENT

Feasibility study for expansion of the existing intermodal terminal in Jordbro

Ioulia Christina Christidi

June 2014
Master Thesis
TSC-MT 14-009

©Ioulia Christina Christidi, 2014
Royal Institute of Technology (KTH)
Department of Civil and Architectural Engineering
Division of Traffic and Logistics
Stockholm, Sweden, 2014

Acknowledgments

I would like to offer my special thanks to my supervisor Behzad Kordnejad for inspiring me to the concept and guiding me in order to complete this thesis research. My examiner Albania Nissan and teachers Anders Lindahl, Bo-Lennart Nelldal and Oscar Fröidh contributed by defining the objective of the thesis in a better way and by giving ideas for further research. I would also like to thank Rune Andersson from Haninge municipality for providing to me useful information and for introducing me to the topic from another point of view.

My opponent to the presentation, Malin Österlind, contributed to this report by making it more comprehensive, which I really appreciate and thank for.

I appreciate the help that all master students gave me and especially Eirini Pierrou, Emeric Djoko, Christoph Krause, Robert Olofsson and Konstantinos Sofos. At last I give special and great thanks to my family for their unlimited support despite the distance.

Abstract

Freight transportation changes in the region of Stockholm lead municipalities to the need of finding ways to maintain and empower their current logistics role in the area. These changes are the operation of the future freight port in Norvik near Nynäshamn, the expansion of Stockholm leading to new freight transportation networks, and the extension of the double track line southern to Västerhaninge station. Haninge municipality is willing to keep the interest of existing companies in its land alive and perhaps increase its' attractiveness by constructing an extension of the terminal in Jordbro.

But before proceeding to that step, the municipality wants to investigate whether companies are aware of these changes and furthermore if they have plans for changing their current goods transportation patterns. It is also interested in finding out the factors that companies consider as the most important when they take decisions about their goods transportation plan. That way the municipality knows what is important for companies and can adjust the supply of infrastructure to their demands.

The main method used for data collection is designing and conducting a questionnaire and for data analysis it is multi-criteria analysis (MCA). The questionnaire also includes questions about the nature of the company and the current ways of goods transportation. Although the number of responders is quite low, some general conclusions could be made. There are two alternatives competing and multi-criteria analysis leads to the selection of the most suitable one. There are several limitations and assumptions which can be overcome by further future research.

Keywords: multi-criteria analysis, weighted summation, intermodal transportation, decision making, Jordbro intermodal station, Norvik port.

Sammanfattning

Godstransporter förändringarna i regionen av Stockholms leder kommunerna att behöva hitta sätt att behålla deras nuvarande logistiker roll på området. Dessa förändringar är framtida godshamn i Norvik nära Nynäshamn, utbyggnaden av Stockholm som leder till ny frakt transportnät, och förlängningen av dubbelspårig linje södra av Västerhaninge station. Haninge kommun vill behålla företagen i sitt land och kanske öka dess attraktionskraft genom att bygga en förlängning av terminalen i Jordbro.

Men innan man går vidare till det steget, vill kommunen att undersöka om företagen är medvetna om den förändringen och dessutom om de har planer på att ändra sina nuvarande varor transportmönster. På det sätt kommunen vet vad som är viktigt för företagen och kan anpassa utbudet av infrastruktur till deras krav.

Den huvudsakliga metoden för datainsamling är att utforma och genomföra en enkät och för dataanalys är multikriterieanalys (MCA). På det sätt ska det exjobb att hitta om det är genomförbar att bygga en förlängd kombiterminal.

Nyckelord: multikriterieanalys, intermodala transporter, beslutsfattande, Jordbro kombiterminalen, Norvik hamn.

Table of Contents

Acknowledgments	3
Abstract	4
Sammanfattning	5
1. Introduction.....	9
1.1. Background.....	9
1.1.1 Future Norvik Port	9
1.1.2. Extension of double track in the branch Älvsjö-Nynäshamn	11
1.1.3 Haninge municipality	13
1.1.4 Goods Transportation in Sweden.....	15
1.1.5 Intermodal freight transportation	18
1.2 Objective and scope.....	19
2. Methodology	20
2.1 Literature	21
2.2 Weighted Summation Method.....	23
2.3 Swing Weighting Method.....	23
2.3.1. Ranking results.....	24
2.3.2. Scoring Results	24
2.4 Qualitative Analysis	24
3. Case study	25
3.1. Questionnaire structure.....	25
3.2. Criteria in the questionnaire	26
3.3 Alternatives construction.....	30
3.3.1. Alternative 1_ Zero scenario.....	31
3.3.2. Alternative 2.....	32
3.4 Limitations.....	34
4. Results Analysis.....	35
4.1. Characteristics of the company/responder.....	35
4.2. Characteristics of current status of freight transportation	36
4.3. Decision criteria for the future planning of freight transportation	39
4.4 Ranking results	40
4.5 Scoring results	42
5. Conclusions.....	43
6. Discussion and Future research.....	44
7. References and Bibliography	46
8. Appendix : Questionnaire	49

1. Introduction

The continuous expansion of Stockholm's region, combined with the demographic expansion has led to the conclusion that more feeding points are needed as well as a more efficient organization of them is needed too. Nowadays the feeding points of Stockholm's region by ships are its surrounding ports of Värtahamnen, Frihamnen, Stadsgården, Västerås, Köping, Oxelösund and Norrköping. The public intermodal terminals are located in Årsta, Södertälje, Eskilstuna, Västerås and Rosersberg. Future Stockholm's regional plan is to join these freight nodes in a more effective way and optimize the freight transportation.

1.1. Background

1.1.1 Future Norvik Port (Port, 2014)



Figure 1 Jordbro and Norvik port locations relating to Stockholm (<http://www.openstreetmap.org>)

According to Stockholm Ports authority, in the future, apart from the existing freight port in Frihamnen, another port is going to operate, in the Southern part of Stockholm (60 kilometres away), close to Nynäshamn port (a couple of kilometres away), in Norvik, the Stockholm Norvik Port.



Figure 2 Future Stockholm Port of Norvik (source: <http://www.stockholmshamn.se>)

There are three main reasons for deciding to construct this new port. The first one is the fact that Stockholm is expanding thus there are growing needs for transporting larger amounts of goods to a larger area, including Stockholm region and Mälaren Valley region. That means that mobility of goods is going to be increased and the infrastructure for current terminals and ports will not be able to handle this increased amounts of goods.

The second reason is that bigger ships are going to dock in Stockholm's region as continental container ships have increased in size. The seabed in Frihamnen is not that deep to accommodate them whereas in Norvik waters are much deeper. Moreover access to the port is more direct and shorter from the open sea of Baltic and waters get less icy during winter so efficiency is increased.

Although the port of Frihamnen is located closely to major consumer and business areas, it is very close to the centre of Stockholm and contributes to congestion charge of the already congested traffic. From that point of view the location of Norvik port is beneficial as freight traffic around Stockholm will be reduced.

The new port is going to have seven quay-berths the depth of which will decrease gradually. The first four which are the deeper ones (16,5 meters depth) will be for container handling and will have a total quay length of around 1400 meters. The next three will be dedicated RoRo quays and will have a total quay length of 555 meters.

The RoRo port will be operated by Ports of Stockholm while the container terminal will be operated by Hutchison Port Holdings (HPH).

The capacity is estimated to be efficient to handle around 300,000 containers annually and a flow of 200,000 rolling goods vehicles. (Port, 2014)

Although the new port is supposed to operate in a more environmental friendly way than other ports, there are some problems with the environmental licensing of the construction. The current status is that Stockholm Port is expecting the Swedish Land and Environmental court to determine the conditions for aspects including noise levels and dredging, as well as the disposal of dredged material.

Characteristics	Port of Frihamnen	Port of Norvik
Container area	<i>11 hectares</i>	<i>25 hectares</i>
loading/unloading equipment	<i>2 container cranes</i>	<i>4 to 5 container cranes</i>
Number of quays	<i>5</i>	<i>7</i>
Number of container quays	<i>1</i>	<i>4</i>
Number of Ro-Ro quays	<i>3</i>	<i>3</i>
Total length of quays	<i>1800m</i>	<i>1400m</i>
Maximum depth	<i>9,5m</i>	<i>16,5m</i>

Table 1 Frihamnen Port vs Norvik Port (Holdings, 2014) (Port, 2014)

Ports of Stockholm will operate the RoRo port, while Hutchison Port Holdings, HPH, will operate the container terminal, as it already does in container terminal of Frihamnen port.

1.1.2. Extension of double track in the branch Älvsjö-Nynäshamn

There are plans for increasing the accessibility to and from Norvik port by improving the existing infrastructure of rail and road network. Swedish Transport Authority plans to extend

the double track network from Hemfosa to Tungelsta station (Trafikverket, 2012). Tungelsta is the second station southbound from Jordbro station. Until now the part from Älvsjö to Västerhaninge is double track. From Västerhaninge to Nynäshamn there is single track and traffic involves mainly commuter trains. After the operation of Norvik port, greater freight loads are expected to be transported in the branch Älvsjö- Nynäshamn so the National transport plan includes an extension of double track from its current length.

The current problem with the traffic in this branch is punctuality. Small delays in the beginning of journey are increased as travel time passes and that affects the traffic of other trains entering this branch from Ostkustbanan, Svealandsbanan, Västra stambanan and Mälarbanan. What is more, the travel time between Nynäshamn and Stockholm (66 minutes) is far too long to compete with other modes of transportation. Considering that freight trains also travel through this branch, unexpected delays are increased.

After the construction of the extension of double track the network will be less vulnerable when problems occur as well as trains with different speeds will run more efficiently. That will happen because double track is a more effective measure than having trains waiting in the stations. That way when freight trains run with commuter trains, the punctuality of both will be increased. Furthermore if the extension is completed until Nynäshamn, the capacity will increase and will allow trains with different direction to use different tracks from the beginning of the journey. Thus, when freight trains run with commuter trains, the punctuality of both will be increased. (Region, 2009)



Figure 3 Nynäsbanan from Jordbro to Nynäshamn (source: Trafikverket)

1.1.3 Haninge municipality

Haninge municipality is located in the northern border of Nynäshamn municipality from where the railway and motorway lead to Stockholm. It has industrial areas and business parks along the rail tracks as well as along the major motorways crossing it. The companies' domains vary from foods and drinks distribution, road construction materials, and logistics centres etc. Some major companies are Coca-Cola, Dagab, Posten, Lagena and Osram. Apart from private companies, state companies are located there as well.

The majority of the companies are located in Jordbro Business Park, but there are also other companies located outside this business park.

There are several ongoing projects in this municipality which aim to accommodate the increasing number of new inhabitants as well as the facilities of new companies. These projects involve the construction of whole new residential areas with their surroundings, extension of existing residential areas, public buildings (kindergartens, schools and medical centre), road construction with asphalt works and water and sewage pipes construction.

There are many areas unexploited in Haninge municipality and as there are decisions for using them it can be said that the municipality wants to actively participate in the wider evolution of Stockholm and attract potential businesses to locate their facilities there.

There are approximately 230 companies located in Jordbro area (municipality) which have various business domains. There are involved in manufacturing, sales, management and consulting, transport services, trading construction equipment and building materials etc. The extent of their facilities area varies; from small offices of few square metres to extended areas with buildings and plain areas for storage.

The eastern borders of Jordbro Business Park are the rail tracks that lead to Stockholm. Some companies are located next to these rail tracks while other companies, which are in the inner business area of Jordbro, do not. Yet, in this western area, rail tracks exist and border with some of the companies there. The purpose is that some companies use wagons to transfer goods to and from their facilities directly. Haninge municipality is responsible for the maintenance of the tracks; however companies do not pay a fee for using them.

The existing terminal in Jordbro is used by two companies only, Green Cargo and Rush Rail (according to National Transport Authority). It is located within the business part of Jordbro along the rail tracks. The current technical equipment is a forklift which operates in the transshipment of goods to and from the wagons. The area of the terminal nowadays is not used much; however some companies deposit containers in the free space of the terminal. Haninge municipality is willing to extend the existing area taking some more land from the municipality's green area that borders with the terminal.



Figure 4 Layout of Southern part of Jordbro business park with rail tracks (source: Håringe municipality)

1.1.4 Goods Transportation in Sweden

The map below shows the traffic of freight loads in Mälaren region and in the region southern to Stockholm. The major intermodal terminals are also shown and in these areas goods are transhipped from rail to road and vice versa.



Figure 5 Traffic freight loads in Mälaren region (Source: Haninge municipality)

The main road freight flows are three: the south path where freights go from Stockholm to the south through Södertälje, Nyköping and Norrköping, the one that goes around Mälaren lake where freight pass through its major cities which are Stockholm, Västerås, Södertälje and further in the west Örebro, and the northern path where freight is transferred from Stockholm to the north through Rosersberg.

To the contrary the main rail freight load is detected away from Stockholm, in the central part of Sweden and its direction is south to north and vice versa. In Hallsberg there is a rail branch that goes to the east to Stockholm through Katrineholm, Flen, Södertälje and Årsta.

The aforementioned intermodal terminals are evaluated through different criteria in order to rank their importance. The criteria considered are the following: (Source: Haninge municipality)

- Geographical depending on the location of the terminal and its proximity to Sweden's demographic centre of gravity and the widest possible markets,
- Infrastructure depending on the versatility, accessibility and sustainability in logistics infrastructure (roads, railways, port and combined terminals)

- The volume of additional logistics space over the past five years
- The accumulated range of logistics services
- The cooperation climate and the networking within the region
- The price and the availability of the pre-planned land for new establishments

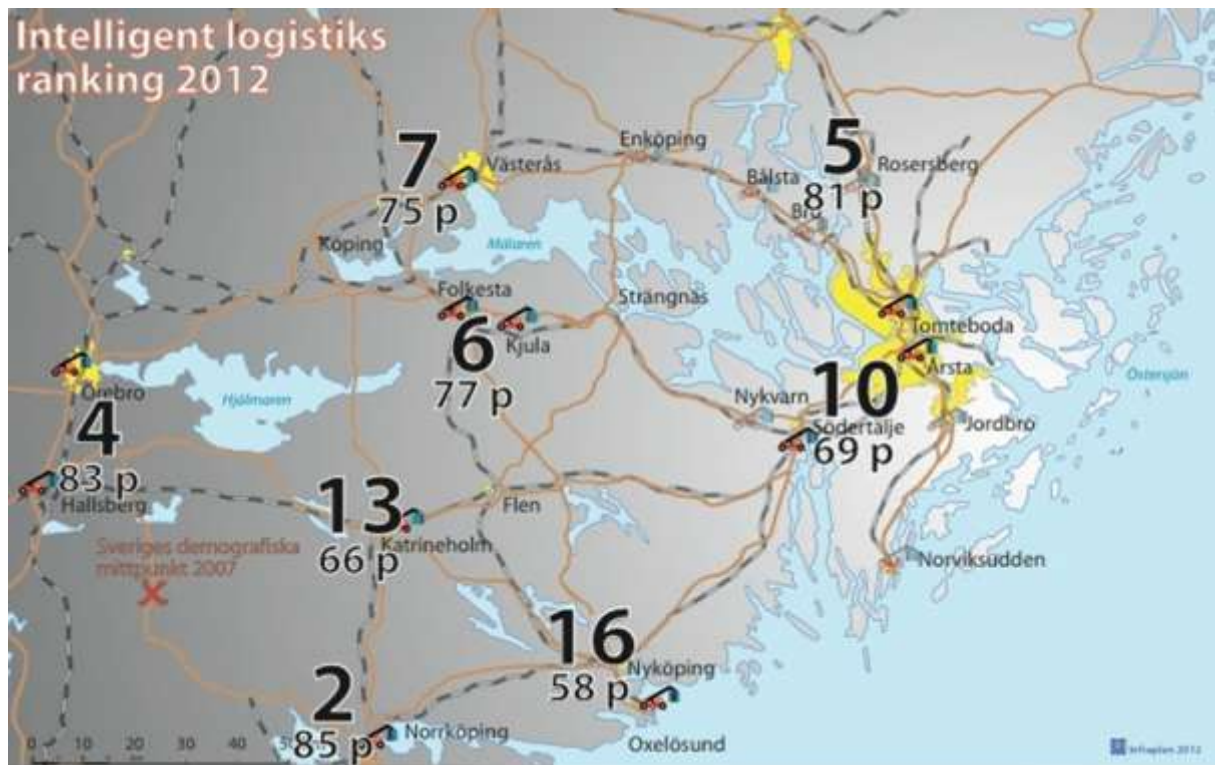


Figure 6 Ranking of the most important Logistics centers (source Intelligent Logistics /Haninge municipality)

As it can be seen from the small number which indicates the points (p), the most important logistics centre that came out through this ranking is Norrköping and that can be explained by the fact that major freight load is passing from there and also because it is located near the port, so totally there are three major transportation modes with which freights can arrive to that place. The next most important logistics centres are located around Mälaren Lake and these are the region of Örebro, of Arlanda, Eskilstuna and Västerås-Köping and afterwards, with 69 points Stockholm Syd-Södertälje. Last in the list are Katrineholm and Nyköping. This map illustrates the centres of gravity of current needs for freight transportation. Jordbro is located near Södertälje and Årsta. From figure 5 one can see that there is significant road freight mobility from E4 and E20 to the east where trucks meet road 73 which connects Nynäshamn with Stockholm.

There are potentials for increasing the importance of Jordbro terminal as the connection between road 73 and E4 and E20, many businesses might move from Slakthusområdet to Jordbro, and because municipality is positive to improve the importance of the area in terms of logistics. (Larsson, 2012).

1.1.5 Intermodal freight transportation

Intermodal freight transportation is the utilization of two or more transportation modes for transporting goods from the origin point to a destination point. That originally includes an intermediate point where the transshipment of the goods from the one mode is done to the other mode. The change of modes is caused by several reasons. There might not be infrastructure to accommodate the vehicles of a certain mode either to destination or to origin point so there is need to choose a combination of transportation modes which is adequate for the given infrastructure. Another effect of intermodal transportation is the fact that at terminals larger amounts of goods can be grouped and transported together in larger vehicles resulting into more economical transportation. What is more, fuel consumption and emissions are reduced because less energy is consumed for transportation of the same amount of goods. Taking these factors into account, companies take into account intermodal transportation when they do the decision making.

But there are other factors that determine their final decision. For instance the frequency of the service, the speed of the service, the availability of handling equipment, the ability to meet particular packaging requirements, security considerations can be determined factors. (2005)

As different transportation modes participate in intermodal transportation, it is crucial to detect and utilize the best characteristics of each mode so as to optimize the whole procedure. For example trucks can reach a wider range of destination and origin points than trains do, but trains on the other hand can transport larger amount of goods to longer distances without stop for fuel charge.

Overall, the main intermodal transportation benefits are the lower costs for long journeys, the reduction of road congestion and the reduced emissions and fuels consumption.

1.2 Objective and scope

The objective of this study is to conduct a feasibility study for the expansion of the existing terminal in Jordbro. Taking into account that many changes will take part in this area and also the fact that Haninge municipality is an active municipality that looks forward to participating in any changes occurring near its area, this study will try to picture the current freight transportation trends that companies in Jordbro have and the next step is to analyse whether an expansion of the existing, unused terminal, is feasible.

The goal for Haninge municipality is to maintain and increase the attractiveness of Jordbro as a logistics centre by providing new alternatives that will ease the companies located already there in terms of their freight transportation modes. The new expanded intermodal terminal in Jordbro aims in increasing the capacity of transporting quantities of goods by transporting them by rail than by road. That is a more environmental friendly way to transport goods. Moreover, as far as companies that already have rail sidings and use wagons for loading and unloading units from and to their facilities are concerned, the new terminal gives them the opportunity to conduct transshipments with better technological equipment and to not have the responsibility for maintaining this equipment (forklifts, gantry cranes etc.).

The goal of this study is to examine whether different parts, the companies located in Jordbro in this case, are also willing to change their current freight transportation system and evolve it according to the general evolution of the area.

2. Methodology

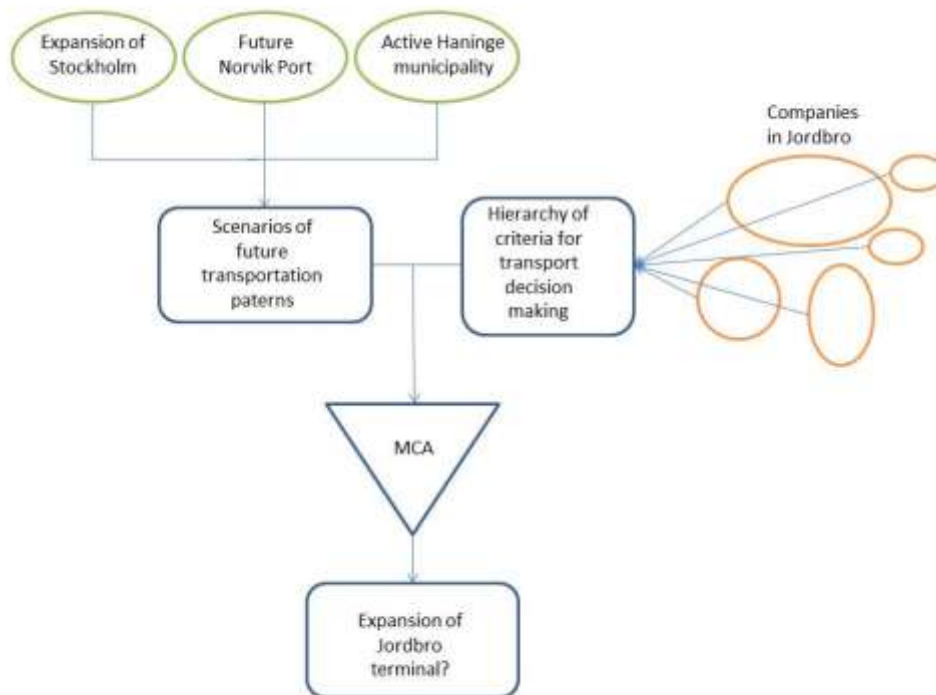


Figure 7 Flowchart of the project

The figure above illustrates the steps that were followed in this thesis in order to result to a conclusion whether it is feasible to expand Jordbro terminal. First of all a study of the background is conducted in order to define the current freight transportation status of the wider area of Stockholm and particularly of Haninge municipality. That includes the major upcoming projects of infrastructure which are the construction of Norvik port and the expansion of the double track rail of Nynäsbanan which is a part of the general growth of Stockholm. What is also taken in to account is that Haninge municipality is willing to remain an attractive location for companies and by that it wants to facilitate them by offering a part of its land for expansion of the existing terminal in Jordbro.

There are several factors on which the feasibility of the expansion of the terminal depends. At one side there is authorities' (Haninge municipality, Swedish authority of transportation, Stockholm Ports etc.) willingness to invest in infrastructure and on the other hand there are the companies that are going actually to use this infrastructure. This study focuses on the companies' preferences for freight transportation attributes that will eventually form the proper plan for infrastructure as long as demand is concerned. Thus, as source for data

collection are considered the companies that have business activities in Jordbro and are more affected from any changes of infrastructure in this area. Their preferences are going to play key role in the multi-criteria analysis though which it is going to be defined whether companies would use an expanded intermodal terminal in Jordbro.

2.1 Literature

Literature search orientates to different fields as it is essential to have a global perspective of the topic of combined terminals. The sources differ chronologically and topologically in order to achieve objectiveness. Apart from interviews with people in responsible positions in Haninge municipality and the Swedish Transportation Authority it is essential to take information from articles and papers that will help in defining the objective of the study, the methodology of collecting data and the conduction of the questionnaires and finally the analysis of these data.

Some articles are useful for acquiring technical information concerning terminals while others offer pure theoretical knowledge sometimes through describing experiments. The literature helps both in improving the existing knowledge but what is more in problem definition, its solution and the explanation of the results.

Taking into account the transportation changes in the area of Stockholm and the willingness of Haninge municipality to participate and take advantage of that, several alternatives exist on how can that be achieved. The selection of the most suitable alternative though is not an easy task as many factors have to be evaluated through the decision making process. Due to the fact that the impacts of every alternative can be valued in terms other than monetary, the choice of Cost Benefit Analysis (CBA) solely is not the suitable one.

Multi-criteria Analysis is a method that can evaluate different types of factors which makes it suitable for the analysis of this case study, as some factors e.g. level of control a manager feels s/he has for the company, cannot be monetized. What is more, in multi-criteria analysis different parts can participate and contribute by expressing their opinions and preferences. That way, they state their preference for weights of criteria given to them. The most commonly used methods for multi-criteria analysis in transportation problems are the following: (Guhnemann, 2008)

- The weighted summation where the performance of an alternative is quantified through specific units. It is the most used and simple method.
- The lexicographic ordering, where one must first select the most important criterion and then rank the alternatives according to the performance of this criterion in them.
- Electre (concordance-discordance analysis), which is mostly applied for environmental management problems
- Evamix where cardinal and ordinal data are separated in the performance matrix, applying algorithms suited to each level of measurement. Evamix makes paired comparisons for the projects and combines ordinal and cardinal scores to attain an overall performance score.
- REGIME
- Analytical Hierarchy Process (AHP),
- Multiple Attribute Utility Approach (MAUT), and
- Ideal Point Approach (ADAM).

The weighted summation method as well as AHP, MAUT and ADAM can also be considered as additive methods. These methods are tested for their adequacy. A method is considered to be adequate if it has four main characteristics namely transparency, simplicity, robustness and accountability. A method is considered to be transparent if it is understood and well interpreted by decision makers. A method is considered to be simple if it can provide a crisp and well-defined method to represent complex and multidimensional decision situations. A method is considered to be robust if it can be used to analyze inputs related to the performance of different transport initiatives and to produce simple output, able to evaluate direct and indirect effects of the initiatives. Accountability of multi-criteria analysis methods means that the methods must be able to be used to track back the decision through different stages of the process. (Amilia Aldian, 2005).

According to (D. Tsamboulas, 1999) and (Amilia Aldian, 2005) the suggested method for transport problems that involve the decision from the public sector is the additive method as it is robust and it solves the problem of ranking the criteria given to the responders. However there are not considerable differences among the different methods of MCE since their major difference is the extent to which results are processed (Guhnemann, 2008).

In this study the method used is the weighted summation as it has lower complexity than the others and mainly it is robust and effective. In addition it allows interpreting the results

according to different responders' characteristics. For example there can be a different analysis for companies that state that currently use exclusively trucks and companies that use exclusively rail.

2.2 Weighted Summation Method

Each alternative is described by different criteria. Responders, who are asked to rank and evaluate just the criteria and not the alternatives, assign specific values to these criteria. Each scenario gets a utility (aggregated values) through the value the responders have assigned to their criteria describing it.

These criteria are selected from the researcher in a way that there are independent from each other up to a great point. Thus, a change of a criterion does not influence other criteria to change as well. This is a very important step that is studied carefully because any strong correlation among the criteria might lead to wrong results.

After defining the criteria, the next step is to define the indicator for each criterion. By assigning a maximum and a minimum value in the indicator it is more comprehensible for the responder to understand the unit that the researcher measures the criteria and the range of the change each criterion can take.

2.3 Swing Weighting Method

This is a part of analyzing the weighted assumption method. After defining the criteria, the indicators and the range of values of the indicators, the next step is to rate these criteria. The swing weighting method is used in this case as the responders have to decide which criterion they consider to be the most important comparing to the next more important. In other words it means that the responders have to choose the criterion that they want it first to change from its worst value to its best value. Thus, the most important criterion has the value of 100% (of importance) and the second criterion in the rank should have a reduced importance comparing to the first one, e.g. 70%. The third ranked criterion has to be compared with the value of the previous criterion in the ranking (the second in this case) and the value assigned in the third criterion has to be equal or less with the value of the second one. That way, after the

responders assign for each criterion a value, the researcher will know the relative importance for each criterion.

The next step is to proceed in the analysis. A test of normality is undertaken for the rank using appropriate software. The result of this test shows that non-parametric tests are used for further analysis, as this test does not make the assumption that data have normal distribution.

2.3.1. Ranking results

In this step, researchers use only the ranking of the criteria from the responders. A pair-wise comparison is made, which means that criteria are compared in pairs for every response so that in the end there can be found the criteria which are most often stated as more important over the other criteria. These dominant criteria are the ones that are primarily assorted as the ones that the researcher focuses on. (Guhnemann, 2008)

2.3.2. Scoring Results

In this step what is taken into consideration are the values that responders have assigned to each criterion. It is expected that the results will show the same dominant criteria but it is also possible that other criteria are considered as important. In this stage values assigned to criteria are summed up and then descriptive statistics are conducted (ibid). The weights are then produced by normalizing the mean values of the criteria.

2.4 Qualitative Analysis

Additionally a more qualitative approach is needed in order to identify the nature of the parts involved in the multi-criteria analysis. The collected data produce the weights that each criterion takes according to companies preferences. However it is still not defined how much each criterion contributes to form each of the two scenarios. For example punctuality and cost of consignment are two independent criteria that describe a scenario. However a change in punctuality might influence much more the performance of a scenario than a change in cost of consignment. This difference has to be pictured so that the two alternatives consider differently the weights of their criteria. However there is no source from literature about these

differences that could be properly incorporated in the case study, so a more quantitative method is introduced.

Through the alternatives description there will be produced a table showing the trend of each alternative in case of change of each criterion. Afterwards the weights of criteria from companies' preferences will be summed for each alternative by either a positive or a negative sign.

3. Case study

This section analyses the questions of the survey, the expediency of these questions, the categorization, the selection of the criteria and finally its limitations. The full survey can be found in the annex. There are several options for collecting data such as telephone calls, interviews, questionnaires etc. The method that is selected for this study is the questionnaires as the companies feel that way more secure because their plans and schedules are more protected since they complete the questionnaire anonymously.

3.1. Questionnaire structure

The questions are grouped in three categories. The first one concerns general questions for the company in order to identify the nature of the company, the size, the business area they operate and their location. This information is important because in the stage of the analysis, the answers of different groups of companies will be assigned with different weights. This is because it is more important when a big company with 250 employees expresses interest for a change than one small company with 2 employees' and much lower freight mobility. Furthermore, it is important to know the position in the company the responder has in order to classify the rightness of the answers he/she may give. Answers are much more accurate when the responsible of the Logistics or Supply chain department answers than the secretary or another person.

The second category involves questions concerning the characteristics of the current status of freight transportation. What should be found is the current freight activity of the companies located in Jordbro transported to and from their facilities. What is more, companies are asked to answer about the accessibility they have to rail (thus they are asked whether they have rail

sidings next to their facilities), about what transportation modes they use for their freight transportation and moreover to the share of each mode.

There is a special question from which one can find out why a company with accessibility to rail tracks, does not use them, and uses other transportation modes. That way one can find out the patterns companies have and relate them to the accessibility with different transportation modes. In this section companies are asked to select the type of packaging of their goods, which can be swap-bodies, semi-trailers, containers or other. That information is useful for understanding the equipment used currently for loading and unloading and which is the possible technical equipment that could be used in the expanded Jordbro intermodal terminal in case it is found to be feasible to be built.

Finally in this section companies are asked to indicate the market areas where their goods are transported to and from their facilities in Jordbro. It is interesting to record the main routes of goods transportation and analyse why they consider Jordbro is the best location for their facilities. Additionally companies have to answer whether they use terminals in their goods transportation. In the analysis part, one can map the main terminals Jordbro companies use which is very important as until now what is already known are the busiest terminals all over Stockholm and Sweden independently where are located the companies the goods of which are loaded and unloaded in these main terminals. Thus, that way, one can identify the terminals that are the most competitive to the potential Jordbro combined terminal. To conclude, from this section researchers can map the current main freight routes and their transportation mode share as well as the main terminals used.

The third category of questions has to do with the decision criteria for the future planning of freight transportation. This is the time when responders are informed that Norvik port is about to operate in 2015 and taking that into consideration they state whether this is going to affect the transportation of their company's goods in terms of quantity, selection of path or mode of transportation.

3.2. Criteria in the questionnaire

Afterwards, responders taking into consideration the changes in the logistics and goods transportation map of the wider area of Stockholm, they rank the importance of the criteria given that their company would take into account in the future decision making for the modes of goods transportation and logistics. As mentioned before the alternatives are two so the

criteria that best describe them are the change of distance of consignments, the reduction of degree of vulnerability of a mode of goods transportation, the reduction of environmental impact of the goods transportation, the cost of changing the current goods transportation and logistics system, the increase of reliability, safety and punctuality, the decrease of control level when a company is now using unimodal transportations and in the future uses multimodal (obliging the company to transship its goods through a terminal which is controlled by others) and the decrease of cost per consignment. Because of the fact that there are limitations from the software used when delivering the questionnaire, the criteria should be up to five, and so some of the criteria are merged while others are neglected. Thus, the responders are required to rate the following five criteria, from the most important to the least important.

- (C1) The decrease of distance of consignments.

When a company chooses to change the transportation mode for transporting its goods from road to rail or vice versa, it is obvious that the length of the consignments will change as there are different paths to follow from origin to destination with different transportation modes. In case of unimodal transportation the distance is shorter than in intermodal because there is no distance for feeder.

- (C2) The reduction of the environmental impact of the freight transportation.

Different types of vehicles emit different amounts of GHG. For example big trucks with light load emit more than smaller trucks with the same load. Also when goods are needed to be transported for a certain distance but the vehicle is small, the vehicle has then to be loaded twice or as many times as are needed so as all goods are transported from one origin to destination. In that case empty haulage is an additional cost which could be avoided if a vehicle with larger load capacity could to the transportation at once.

- (C3) The cost of changing the current freight transportation and logistics system (cost for equipment, education, mistakes, loss of control, cost for adaptation in new patterns and technologies).

When a company faces the dilemma to adopt a new technology, it is of great concern the time that the company will adapt this new technology. During this period there is high probability of mistakes to happen, misunderstandings, conflicts, wrong communication, and the sense of not having the control of the situation. Moreover there is the cost of buying the new cars and of educating the personnel to use the new

equipment or to adapt to this new transportation pattern. So although companies might show interest in adopting new transportation patterns, they might not consider these extra costs. This criterion shows the willingness to change their current patterns.

- (C4) The increase of safety and punctuality.

Increased congestion on road causes high probability of road accidents. Additionally the more loadings and unloadings the goods have the more chances for them to get damaged. Due to the fact that goods are not placed in the same position as it happens to unimodal transportation, but technical equipment such as cranes relocate them to different transportation modes (e.g. from trucks to trains), the danger of an accident which results to the damage of goods is increased.

Punctuality is an indicator which shows whether goods have arrived to a point on the scheduled time. It is an important indicator as goods arrival is dependant to other phases in the production, manufacturing or sales procedure. When there is congestion in the road or the rail there is high probability for delays. Single tracks also cause delays and punctuality is jeopardized.

- (C5) The decrease of cost per consignment.

The cost includes the investment and maintenance cost of the vehicles, the personnel employed, the transshipment costs (when in terminal the cost for transshipments of the terminal and/or the fee for storage of the goods), the cost of fuels consumed etc.

Criteria are categorized in three groups as shown in the table below:

Economic	Transportation	Environmental
C3 & C5	C1 & C4	C2

Table 2 Criteria groups

There are three types of measuring each criterion:

- *Monetary* where monetary values can be derived (here C3, C5)
- *Quantitative* where monetary values cannot be derived, but impacts can be quantified in non-monetary units (here C1, C2, C3, C4), and
- *Qualitative* where impacts cannot be quantified and are assessed on a scale (usually 7 points) (here C3).

Here C3 measurement can be considered monetary as the supply of new equipment can be measured directly into money, quantitative as the impacts of the possible communication mistakes the first days of the implementation of the new transportation system can be quantified and finally qualitative as the willingness of changing the existing situation cannot be quantified for a personal perspective, and it can only be assessed on a scale.

The next step is to find indicators for each criterion and then address a worst and a best value, according to the best and worst value each criterion can get from both alternatives.

The change of distance of consignments cannot be measured as it is not known a priori the current distances of consignments. If one would suppose that a company in Jordbro is international and transports its goods currently by truck from and to Frihamnen, then this truck covers a distance of 38,1km in approximately 42 minutes (Alternative 1). On the other hand, considering that the future Norvik port will service the majority of the current freights transshipment and that there is going to be rail connection between Norvik port and the extended Jordbro terminal, the distance covered by rail will be 35,6km in around 37 minutes (Alternative 2).

So the total reduction of the distance will be 6,56%. But since not all the companies will use the aforementioned route, this range of 0% to -6,56% for the criterion C1 with indicator kilometres cannot be used. The same pattern is followed for the next criteria.

The reduction of the environmental impacts can be actually measured if in alternative 1 is considered that the companies use road than rail transportation. It is found from studies that the rail freight transportation emits considerably much less greenhouse emissions than the road transportation.

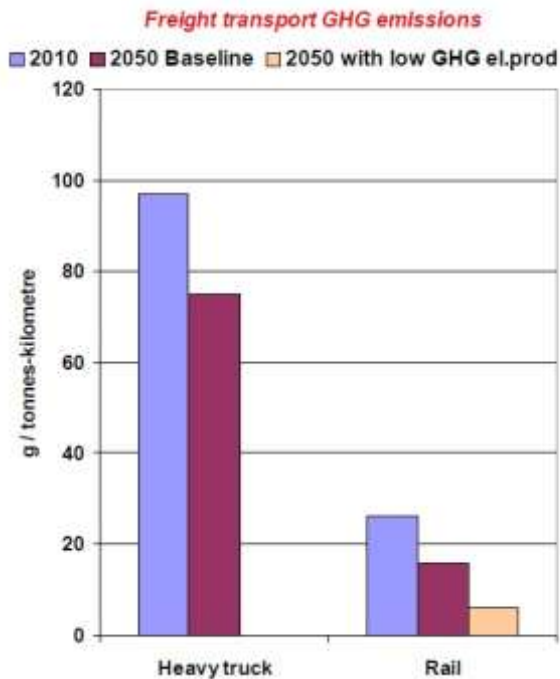


Figure 8 Freight transportation GHG emissions (Bo-Lennart Nelldal, Transport research arena- Athens 2012)

But since there are no data available before the survey on whether companies use trucks or rail (since some companies have already rail sidings next to their facilities and conduct loadings and unloading directly to wagons), the range of the indicator (GHG emissions) of this criterion cannot be indicated either. After all if a range of an indicator is put for some criteria and for other criteria no indicator and their range is put, this is considered to be partial.

Responders will have to rate a number of criteria that they consider as most or least important to change when deciding the transportation mode for their goods transportation. Nevertheless, it is not asked whether the responders should consider the strategic, tactical or operational plan as different types of companies consider different time frames for the above type of plans.

3.3 Alternatives construction

When designing the strategic plan of a company many factors play significant role. Each company has its own freight transportation system and it is sometimes difficult to interpret and incorporate the problems of one company into the problems of another company as the perception to the problems differs. In this case study, another problem is how one can produce

a hypothetical scenario where Norvik port operates and at the meantime there are increased needs for transportation in the greater area of Stockholm. The comparison of the alternatives is conducted by comparing the effects of each criterion. There is no comparison in absolute terms but in relative terms, so the final trends shown in table 3 are only useful for comparison and don't have any further meaning.

What is more, a value of a criterion might change in one of the two alternatives in the future, but when one compares it with the value of the same criterion in the other alternative, the change might be the same, so it will be considered as no changed. For example when comparing the cost of a consignment in both alternatives, there will be an increase in the price of fuels, but because the same fuel can be used in both alternatives, no change in the fuel price and by extension to cost of a consignment will be considered.

3.3.1. Alternative 1_ Zero scenario

The zero scenario and the first alternative is that although Norvik port operates and there are major freight transportation changes in the wider area of Jordbro and Stockholm, the companies will keep having the same pattern of freight transportation as they have now. This scenario is better described for companies that until now have a unimodal transportation model and they use solely trucks.

In that case the distance of the freight transportation will remain the same as today since no changes occur. If a company uses an itinerary with a specific transportation mode, the distance of freight transportation remains the same as long as the transport mode is the same and the origin and destination point as well.

In terms of environmental impacts, there might be an increase of the environmental footprint because congestion in the main roads will be increased and the same distance will be covered in the future in longer time, increasing the emissions and the fuel consumption. Although more environmental friendly fuels can be used from trucks in the future, what is taken into account in this study is that comparing to intermodal transportation unimodal has higher environmental impact.

There will not be any cost for additional change of the current logistics plan because the same transportation patterns are kept.

Taking into account that when transportation depends solely to one mode, the transportation system is more vulnerable in case of unpredicted situation, punctuality is jeopardized. For example is there is a technical problem with the truck that carries the goods, what is affected is the punctuality of the arriving good in the total length of the route. So taking into account that the trucks will use roads that will be more congested in the future years, the punctuality is affected negatively. Safety of the transported goods will increase because of the higher congestion on the roads but at the same time if it is compared to intermodal transportation when more transshipments lead to more chances for goods to be damaged or missed, the total indicator of safety will remain the safe.

At last, the cost of transportation will remain the same as long as the transportation mode is used.

3.3.2. Alternative 2

The second alternative is that Norvik port operates and there are major freight transportation changes in the wider area of Jordbro and Stockholm, so companies are interested in using an intermodal terminal where goods arrive there by rail and then they are distributed to their facilities by trucks and vice versa. By using the intermodal terminal, goods are transported from the facilities of the companies to the area of the terminal and then they are loaded to freight wagons. Alternatively, there can be unimodal transshipment, from truck to truck but that might be rarer as it is not financially reasonable to employ different trucks to cover the smaller distances. In this alternative companies that use solely trucks will tranship their goods from the trucks to wagons in the terminal but companies that already have intermodal freight transportation will either use both the previous terminal and Jordbro terminal, or there are going to use only Jordbro terminal but there are going to change the route of the consignments. There are also case when companies that were supplied from Frihamnen port or another destination before, in the future there will be supplied from Norvik port, so goods will be transferred from Norvik to Jordbro by rail and then the distribution to their facilities will be done by truck.

In any case Haninge municipality is willing to subsidise the extension of the terminal by improving and strengthening the pavement, purchasing the appropriate technical equipment such as cranes, mounted cranes, gantry cranes or more forklifts depending on the extent of the extension, and by occupying additional area from the northern part of the terminal, which

belongs to the municipality and has the right to exploit it. At last there could be a second entrance to the terminal so that trucks avoid turnovers and congestion within the terminal is avoided.

The distance of the goods transportation will be generally increased because the majority of the companies currently use trucks that go directly from origin to destination and there are no transshipments. There can be cases though as described in 3.2 (criteria in the questionnaire) where the distance will be decreased by ca.6%. Depending on the answers from the questionnaire whether the companies use the port in Norvik or not, this case will be taken in to account. So no safe statement can be made until results from questionnaire are assessed.

The environmental impact will differ from alternative 1 because according to studies intermodal transportation has less environmental footprint than unimodal transportation.

There will certainly be costs for changing the current freight transportation and logistics system because companies will invest in the education for the new systems and for buying new software for controlling their goods transportation. There will be external costs for the mistakes that will occur in the first period of the implementation of the new plan. In addition a company loses the sense of control when it shifts from direct unimodal to indirect intermodal because in the second case the company's transportation of goods depends on the good operation of the terminal. Punctuality is more likely to be achieved because in case there is a fail in one transportation mode, the system can adapt and recover from it as there are alternative ways to transport it.

In intermodal transportation punctuality is higher because the transportation system is less vulnerable to changes as transportation does not depend solely to one mode.

At last, the change of cost of transshipment depends on how long is the freight transportation. In case the total length of transportation is less than 500km there will be a decrease of cost in alternative 2, as the intermodal transportation costs less for the freights per ton transported.

Each of these two alternatives mentioned before is described by the utility of several criteria. From the information retrieved from the questionnaire and through a process there can be an estimation of which alternative is acts better from the other.

	Alternative 1	Alternative 2
C1: <i>Distance of consignment</i>	-	↑
C2: <i>Environmental impacts</i>	-	↓
C3: <i>Cost of adaptation to new transport patterns</i>	-	↑
C4: <i>Punctuality and Safety</i>	↓	↑
C5: <i>Cost of Transportation</i>	-	↓

Table 3 Criteria's behaviour in Alternative 1 and 2

3.4 Limitations

This survey has several limitations. From the total number of 230 companies located in Jordbro, only 110 were accessible for sending a form via e-mail. For those there is also a possibility that only a low number will answer and if they do there is an even smaller possibility that the person who answers is aware of the subject and answers correctly.

Furthermore companies that are located only in the area of Jordbro are incorporated. It is a great assumption to consider solely companies which are located in Jordbro as the only companies that would use Jordbro terminal because there might be companies which are located further than Jordbro but are willing to use it when transporting their goods. In addition when presenting the factors for the decision making, their indicators are missing. This results in misunderstanding of how much a factor can really change and to what units this can be measured. For example when one has to select the importance of two criteria but has in his/her mind that one criteria can change far more than the other, then maybe s/he can be biased by this wrong assumption and make a wrong choice. Also only five criteria are selected as the most important according to literature but there is always the possibility that companies consider additional factors as important in the decision making.

The strict time frame functions negatively because in larger time frame more companies might be able to have answered and a supplementary questionnaire could have been delivered to them in order to clarify the frame of the two alternatives.

4. Results Analysis

From 110 questionnaires sent, only six companies responded (5,45%). In the following sections all answers will be shown and commented.

4.1. Characteristics of the company/responder

1. Which is your company's main business activity?	5. How many people does your company employ?	3. In which business area is your company operating?
Pharmaceutical producer.	250	International
Welding of wrought iron and stainless steel. Renovation of bridges. Construction of elevator frames	12	Stockholm & Mälaren Valley
Sale different stuff. Like electronics and home stuff	2	Local
production of metallic doors and windows	13	National
mechanical workshop	7	Local
Trading	20	National

Table 4 Answers to questions 1,3 and 5

Out of six responders two of them respond that their company is involved with construction of metallic frames, one with the sales of electronics, one is a pharmaceutical producer, one that there are mechanical workshop and the last one that is doing trading. There can be a categorization of the companies by saying that small companies that employ less than 10 people operate in a local business area, medium companies that employ up to 50 people operate in a national business area whereas companies that employ more than 100 people operate in an international business area.

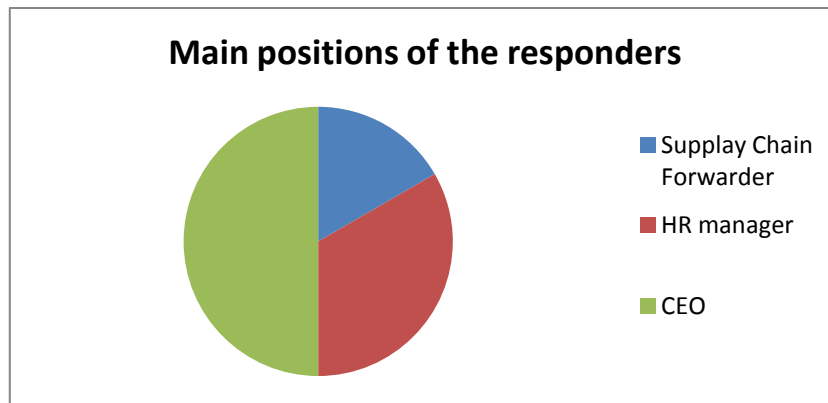


Figure 9 Answer in question 6

Half of the responders were the CEOs of the companies and they all came from small and medium sized companies. Human resources managers were the 33,3% of the responders that came solely from medium sized companies and just in the big sized company the questionnaire was answered by the supply chain forwarder.

All companies are located in Jordbro Business Park apart from one, the smallest.

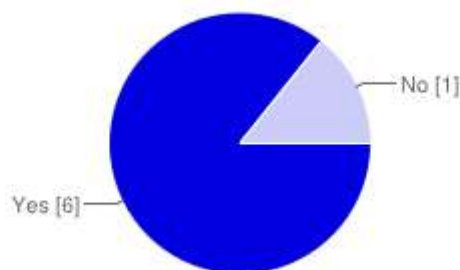


Figure 10 Answer to question 2

All companies answer that they are shippers or freight forwarders, so there is no freight forwarder answering.

4.2. Characteristics of current status of freight transportation

7. Which is the quantity of goods transported from your company's facilities?	8. Which is the quantity of goods transported to your company's facilities?
360	400
from 100kg to 10000kg	from 100kg to 10000kg
Post	Post
20	15
8	6
2000	2000

Table 5 Answers to question 7 and 8

Most of the companies state that there are transported more goods to their facilities (+11%) than from their facilities. The answers are supposed to be in ton units.

9. Please specify all the transportation modes your company uses when transporting goods.
Truck and air.
We have a truck that is used at the company. We engage, Trucks, small cars, freight buses and DHL freight cars
Car
trucks
truck
Truck

Table 6 Answer to question 9

Most of the companies use solely trucks for their goods transportation. One company though uses just a car and this is the smallest sized company that sends its goods by the post. One medium sized company apart from using its own vehicle hires other vehicles such as trucks, freight buses, small cars and the services of DHL.

The 33,3% of the companies that responded have rail sidings next to their facilities but they do not use them for loading and unloading goods. The pharmaceutical company states that due to the nature of their products Good Distribution Practices (GDP) recommends other

modes of transportation than rail. Thus all companies support that the 100% of their goods are transported by trucks and 0% is transported by rail.

15. In the case of intermodal freight transportation, which terminals of Sweden does your company use for the transshipments of its goods?
No ones in particular.
Freight busses go to their own terminal
Car
-
no
unknown

Table 7 Answer to question 15

Answers to question about the terminals companies use are not clear. One company does not state the terminal by saying that it is not a known one, so it is supposed that it is a private one and/or a very small one. The big sized company has not a fixed terminal where goods are transhipped and the company that employs freight busses uses the terminals that are adequate for those vehicles.

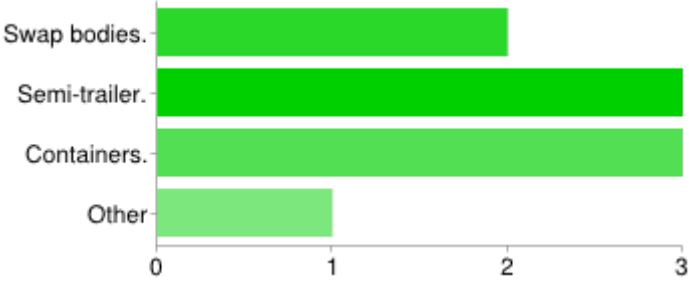


Figure 11 Answers in question 16

The last two questions in this section refer to the origin of the goods coming to Jordbro and the destination of the goods that are transported from Jordbro. There is a variation of answers this time and what one observes is that in the majority of cases, is that when companies get materials/goods from international locations, they usually send their goods to international

destination points. Only in one case a company receives goods from international points but delivers its good just in Sweden.

17. Please indicate the main market areas (coordinates or address) of the points of origin of the goods transported to your company.	18. Please indicate the main market areas (coordinates or address) of the destination points of the goods transported to your company.
Asia, Europe and Sweden.	Asia, Europe, North America and Sweden.
Transportations take place all over Sweden	Stena steel (company) Huddinge steel ABC Solution
Dont know	Dont know
all over Sweden	all over Sweden
Mälaren	Mälaren
Taiwan through Veenendaal, Holland Skyllberg, Sweden Gnosjö, Sweden	Spread over Sweden

Table 8 Answer to questions 17 and 18

4.3. Decision criteria for the future planning of freight transportation

The first question in this section asks directly the companies if the operation of Norvik port and the future improvements of the transportation infrastructure will affect the way they currently transport their goods. Four out of six companies are sure that these changes will not affect the way they currently transport their goods. One company answers that they don't know, which means that they have either not yet concluded to their future way of transporting goods or their level of planning is just operational and not tactical nor strategic. Only one company states that if they start with regular own import from Far East which is planned it probably will decrease costs. What can be derived from these questions is the inflexibility of adapting new transportation patterns even in a theoretical level.

The next question is about the ranking of the criteria given. The table below shows the results.

Responders	c1 (distance)	c2 (environmental impacts)	c3 (cost of adaptation)	c4 (punctuality and safety)	c5 (cost of transportation)
a	5	3	4	1	2
b	3	2	2	1	1
c	5	4	3	1	2
d	3	4	5	2	1
e	5	3	4	2	1

Table 9 Ranking of criteria from responders

Unfortunately one of the responders, the smallest sized company, did not rank the criteria so there are five left to analyse their results. The responders are shown on the left and the numbers show the ranking of each criterion. Number 5 is assigned to the least important criterion and number 1 to the most important criterion.

4.4 Ranking results

In this study no specialized software was available for the test of normality, and what is assumed is that these five observations are actually the most representative observations from a larger sample group. This is because it is not adequate to test such a small sample of five observations whether they have normal distribution.

So, for every responder a ranking table is created where pair-wise comparison takes place (Tables 10 to 14). The criteria in the columns are compared with criteria in the rows so that the sign in the table show whether the criterion in the column is higher (+) or lower (-) ranked than the criterion in the row. Looking Table 10 in the cells of the third column it is described the pairwise comparison of importance that responder “a” did between criterion 3 and all the other criteria. For example responder “a” considers criterion 3 to be more important than criterion 1 but less important than criteria 2,4 and 5.

Responder a	c1	c2	c3	c4	c5
c1		+	+	+	+
c2	-		-	+	+
c3	-	+		+	+
c4	-	-	-		-
c5	-	-	-	+	

Table 10 Ranked criteria from responder a

Responder b	c1	c2	c3	c4	c5
c1		+	+	+	+
c2	-		0	+	+
c3	-	0		+	+
c4	-	-	-		0
c5	-	-	-	0	

Table 11 Ranked criteria from responder b

Responder c	c1	c2	c3	c4	c5
c1		+	+	+	+
c2	-		+	+	+
c3	-	-		+	+
c4	-	-	-		-
c5	-	-	-	+	

Table 12 Ranked criteria from responder c

Responder d	c1	c2	c3	c4	c5
c1		-	-	+	+
c2	+		-	+	+
c3	+	+		+	+
c4	-	-	-		+
c5	-	-	-	-	

Table 13 Ranked criteria from responder d

Responder e	c1	c2	c3	c4	c5
c1		+	+	+	+
c2	-		-	+	+
c3	-	+		+	+
c4	-	-	-		+
c5	-	-	-	-	

Table 14 Ranked criteria from responder e

	c1	c2	c3	c4	c5
c1		4	4	5	5
c2	1		1	5	5
c3	1	3		5	5
c4	0	0	0		2
c5	0	0	0	2	

Table 5 Total ranking of criteria

Afterwards in Table 15 what is shown is the total amount of times that responders ranked each criterion more important than other criteria. Looking for example at column 2, what is shown is that criterion 2 is stated four times (or by four responders) that it is more important than criterion 1, three times that it is more important than criterion 3 and it is never stated that it is more important than criteria 4 and 5.

As a result C5 (cost of transportation) and C4 (safety and punctuality) are the most important criteria for the responders.

4.5 Scoring results

	c1 (distance)	c2 (environmental impacts)	c3 (cost of adaptation)	c4 (punctuality and safety)	c5 (cost of transportation)
a	10	50	30	100	70
b	13	27	27	100	100
c	10	50	70	100	90
d	50	40	20	80	100
e	20	75	30	80	100
minimum	10	27	20	80	70
maximum	50	75	70	100	100
mean	20,6	48,4	35,4	92	92
Std. Deviation	15,15	15,76	17,68	9,80	11,66

Table 16 weights of criteria form scoring of responders

Table 16 shows the answers of responders and below the descriptive statistics. As it seems C4 and C5 have the same mean value but minimum value of C4 is higher than minimum value of C5, and that brings C4 to the position of the most important criterion.

Mean values are then normalised so as to produce the final weights of the criteria according to responders preferences. The weights are shown in table 18.

	c1	c2	c3	c4	c5
mean	20,6	48,4	35,4	92	92
weights	7,14	16,78	12,27	31,90	31,90

Table 6 Final weights of criteria

Taking into account Table 3 we can make a qualitative merge of this and the weights. Since there are not available measurements for the change of the distances, environments impacts, costs for adapting new technologies and strategies, for the increase of punctuality and changes in costs, it is assumed that all criteria affect to the same extend alternative 2 when they change.

Thus, the proper sign is put in front of every weight before there are summed up. In case the sum is over 0, that means that alternative 2 is more suitable than alternative one. If the opposite happens, alternative one is more suitable than alternative two.

In the qualitative summation of the weights what are taken in to account are table 17 and table 3. The trends of the criteria in alternative 2 don't show the sign that corresponds to these criteria in the equation. The signs in the equation depend on either the effect of the criteria in alternative 2 are positive or negative.

So the distance (c1) is increased in the second alternative and this plays negative role in the decision making. Environmental impacts (c2) are less in alternative two so that counts positively. The same does the decrease of cost of transportation (c5). As far as cost of adaptation (c3) this has certainly a negative effect to the decision making but the increase on punctuality and safety (c4) have a positive effect.

$$Sum = -7,14 + 16,78 - 12,27 + 31,90 + 31,90 = 61,17.$$

The result shows that alternative 2 outweighs zero alternative.

5. Conclusions

This study elaborates companies' preferences and analyses them so that authorities can have a useful tool to either proceed or study again the case of expanding an intermodal terminal. Haninge municipality is facing a future with great changes in freight transportation and in transportation infrastructure so municipality should think about how it can accommodate these changes. Companies on the other side state the factors that influence them the most before taking a decision. This is the tool that this study is using for connecting the demand on one side with the supply on the other side.

Although companies do not show interest in changing their current patterns of freight transportation, there are other factors that show that maybe in the future there will reconsider the dilemma of shifting from unimodal to intermodal transportation. Sometimes when a transportation plan is not clear and most of the entire adequate infrastructure is not completed nor operates, it happens that companies do not involve that plan to their strategic plan.

From the results it is derived that the most important factor that companies take into consideration when deciding their future goods transportation is punctuality and safety. Afterwards it is the environmental footprint of the transportation and then the cost of adapting new transportation patterns. At last, what companies stated as the least important to consider is the length of the consignments. This is a surprising result as distance is considered to be one of the most important factors in the decision making. That could be explained by the fact that half of the companies that answered operate in a local business area so changes in the distance of consignments cannot be significantly high.

Alternative two is not significantly more suitable than alternative one. Further research for making a more suitable alternative might be needed. Apart from the construction of an extension of Jordbro terminal, what can be done is a full extension of double track until Nynäshamn, construction of larger roads near Jordbro and attraction of companies with larger amount of freight transported.

In case Jordbro terminal is expanded, there are many civil works that should be conducted as the terminal is not used currently to its full extend and there are some signs of abandon. For example the ground should be reinforced so that it can take higher loads. One more entrance can be designed so that manoeuvring of trucks inside the terminal is reduced. At last, technical equipment for loading and unloading such as gantry cranes is essential because a large part of companies use containers as loading units.

6. Discussion and Future research

As it cannot be clearly stated whether an extension of Jordbro terminal is feasible to be constructed, more research should be conducted. Companies that are not located solely in Jordbro area can be considered because they are still potential companies that might want to use Jordbro intermodal terminal for their freight transshipment. There are no data available concerning which companies are willing to use Norvik Port. While having that information, it will be then very important to conduct a study with these companies as sample of responders so that demand on the rail or road in the wider area of Norvik port can be calculated.

What is more a better construction of the questionnaire could lead to more responses. The reason the majority of the companies have not answered might be the fact that there were many questions (21) and also only a qualified person with deep knowledge of the logistics of

the company could answer. The solution of a future survey could be that questions from the first two groups of the questionnaire can be excluded, mainly these that refer to annual loads of goods transferred. Thus responders do not have to search for numbers in their records. To the contrary questions that have to do more with the decision making process and the priorities that companies set in order to choose their policies could be increased. The way also the questionnaire was delivered can change and instead of being delivered by mail, phone surveys can be conducted. That way validity of answers is increased as the responders feel more responsible for what they say instead of what they write without signing it. Validity is increased also by the fact that the questionnaire will be answered by a responsible person and perhaps not by a person who has secretariat duties. The only drawback of this method is that much time is needed, which in the case of this study, it was very limited and impossible to perform the survey in another way.

Supposing that there is a need for extension of the existing terminal in Jordbro, a future research could include a survey again, but this time for defining the extent to which this terminal can be expanded. This is a more microscopic research with more technical aspects as responders will have to state a more clear preference on the margins they have in punctuality, travel time and safety. This is the second step once the decision for expanding the terminal is taken. Having from this research as input the amount of loading units transhipped in the terminal every year, the handling equipment can be defined as well as the number of them.

Such a construction would affect not only the area of Jordbro but of the whole region of Southern Stockholm. The neighbour terminals in Årsta and Södertälje will be affected. Particularly in case freight from Norvik is heading to the south region of Stockholm, then there will be a increased load in the roads connecting motorway 73 and E20. This is because freight will be transported by rail from Norvik till Jordbro and then it will be put into trucks so that they go to the southern Stockholm region through E20 (figure 1). This pattern will decrease the traffic in Årsta terminal as there will be less freight transported so far from Norvik. In case goods from Norvik are transported in the northern part of Stockholm, Jordbro terminal doesn't worth more to be used than Årsta terminal because near Årsta there are located roads that have more capacity than the roads near Jordbro. Trains arriving in Årsta will unload freight and after freight will be loaded to trucks. Trucks which depart from Årsta can use directly the ring road of Stockholm while if trucks departed from Jordbro, they would use road 73 contributing that way to more congestion. This parameter has to be taken seriously in to consideration when conducting the feasibility study.

7. References and Bibliography

Amilia Aldian Michael A.P. Taylor A consistent method to determine flexible criteria weights for multicriteria transport project evaluation in developing countries. [Journal]. - [s.l.] : Journal of Eastern Asia Society for Transportation Studies, 2005. - Vol. 6.

Amilia Aldian Michael A.P. Taylor A consistent method to determine flexible criteria weights for multicriteria transport project evaluation in developing countries [Journal]. - [s.l.] : Journal of the Eastern Asia Society for Transportation Studies, 2005. - Vols. 6 pp. 3948-3963.

Associates Meyrick and Submission to transport networks inquiry - Characteristics of intermodal terminals. - Australia : [s.n.], 2006.

Athanasios Ballis John Golias Comparative evaluation of existing and innovative rail-road freight transport terminals [Journal] // Transportation Research: Part A. - 2001. - p. 19.

Athanasios Ballis John Golias Comparative evaluation of existing and innovative rail-road freight transport terminals [Journal] // Transport research Part A 36. - [s.l.] : Pergamon, 2001. - Vol. A. - pp. 593-611.

Bo-Lennart Nelldal Evert Andersson Mode shift as a measure to reduce greenhouse gas emissions [Journal]. - Athens : Elsevier, Transport research arena- Athens 2012.

Crainic Tolga Bektas Teodor Gabriel A brief overview on intermodal transportation [Report]. - [s.l.] : Cirrelet, 2007.

D. Tsamboulas G.S. Yiotis and K.D. Panou Use of multicriteria methods for assesment of transport projects [Journal]. - [s.l.] : Journal of Transportation Engineering, 1999. - Vols. 125, No. 5.

Edoardo Marcucci Luisa Scaccia Mode choice models with attribute cutoffs analysis: the case of freight transport in the Marche region [Journal]. - [s.l.] : European Transport \ Trasporti Europei, 2004. - Vols. n. 25-26 (2003-2004): 21-32.

Fei Jiang Paul Johnson, Christian Calzada Freight demand characteristics and mode choice: An analysis of the results of modeling with disaggregate revealed preference data [Journal]. - [s.l.] : Journal of transportation and statistics, 1999.

Guhnemann Mary Kimble City Mobil: Towards advanced transport for the urban environment, 5.1.2 - Weights for use in Multi-Criteria Analysis [Report]. - European Union : European Commission, 2008.

Gwo-Hshiung Cheng-Wei Lin, Serafim Opricovic Multicriteria analysis of alternative-fuel buses for public transportation [Journal] / ed. Policy Energy. - [s.l.] : Elsevier, 2005.

Holdings Hutchison Port Container Terminal Frihamnen [Online] // Hutchison Port Holdings. - Hutchison Port Holdings, 2014. - 01 06 2014. - <http://www.hph.com/globalbusiness/business.aspx?gid=216>.

Koednejad Behzad Marknad för regional kombitrafik i Mälardalen [Report]. - Stockholm : KTH, 2012.

Kordnejad Behzad Regional Intermodal Transport Systems: Analysis and Case Study in the Stockholm-Mälaren region [Book]. - Stockholm : KTH, 2013.

Larsson Gunnar Localisations of Logistics Centres in Greater Stockholm [Report]. - Stockholm : KTH, 2012.

municipality Haninge Sök företag i Haninges kommun [Online] // Haninge Kommun. - Haninge Kommun. - 04 06 2014. - <http://www.forreg.nu/haninge/search.aspx?s=jordbro&t=0&m=>.

Port Stockholms Stockholm Norvik Port [Online] // Stockholms Hamnar. - Stockholms Port, 15 04 2014. - 04 06 2014. - <http://www.stockholmshamnar.se/en/Under-construction/Stockholm-Norvik-Port/Why-build-a-new-port/>.

Region Stockholm Nynäsbanan, dubbelspår, etapputbyggnad Tungelsta-Hemfosa [Online] // Länsstyrelsen Stockholm. - Region of Stockholm, 14 October 2009. - June 2014. - http://www.lansstyrelsen.se/stockholm/SiteCollectionDocuments/Sv/samhallsplanering-och-kulturmiljo/infrastruktur-och-it/infrastrukturplanering/objektsbeskrivning/9_Nynasbanan%20_Tungelsta_Hemfosa.pdf.

Romeo Danielis Edoardo Marcucci, Lucia Rotaris Logistics managers' stated preferences for freight service attributes [Journal] // Transportation research Part E 201-215. - [s.l.] : Elsevier, 2004. - Vol. E. - p. 13.

Simona Bolis Rico Maggi Adaptive stated preference analysis of shippers' transport and logistics choice [Report]. - Wien : 38th Congress of ESRA, 1998.

Trafikverket Trafikverket [Online] // Trafikverket. - Trafikverket, March 2012. - June 2014. - <http://www.trafikverket.se/PageFiles/69331/Folder%20Hemfosa-Tungelsta.pdf>.

What is intermodal freight transportation. - [s.l.] : Taylor and Francis, 2005.

ΑΝΔΡΕΑΣ ΜΑΛΟΒΙΤΣ ΙΩΣΗΦ ΚΟΚΚΟΤΗΣ Συγκριτική μελέτη πολυκριτηριακών συστημάτων αποφάσεων για τη λήψη αποφάσεων σε πραγματικές περιπτώσεις. (Comparative study of multicriteria decision support systems for decision-making in real cases. [Book]. - Athens : National Technical University of Athens, 2013.

8. Appendix : Questionnaire

Edit form - [Jordbro intermodal terminal questionnaire] - Google Forms

<https://docs.google.com/spreadsheet/gform?key=0Ai8-Ik8aEJWFdH..>

Jordbro intermodal terminal questionnaire

Instructor: Julia Christidi

Date: Spring 2014

My name is Julia Christidi and I am working on my master thesis in a study concerning the feasibility of a potential extension of the intermodal terminal in Jordbro. It is vital to gather information from companies that are located in the wider business area of Jordbro so as to find out the current goods transportation model of the companies and what is more how the Norvik port operation in 2015 is going to influence the current situation and if an intermodal terminal in Jordbro can play a major role in the goods transportation network of the area.

All of your answers will be kept strictly confidential.

It will take approximately 7 minutes to complete it.

Thank you in advance for your time.

Page 2

After page 1 [Continue to next page](#)

I. Characteristics of the company (1 to 6)

1. Which is your company's main business activity? *

2. Is your company located in Jordbro Business Park? *

- Yes
- No

3. In which business area is your company operating? *

- Local
- National
- International
- Other:

4. How is your company related to its own or other companies' goods transportation? *

- It is a shipper or a freight customer (either sends or buys the transport services).
- It is a freight forwarder.
- It is a transport operator.
- It is the owner of a transshipment facility.
- It is an operator of a transshipment facility.
- Other:

5. How many people does your company employ? *

6. What is your main position at your company? *

Page 3

After page 2 [Continue to next page](#)

II. Characteristics of current status of freight transportation (7 to 18)

7. Which is the quantity of goods transported from your company's facilities? *
(annually in metric ton)

8. Which is the quantity of goods transported to your company's facilities? *
(annually in metric ton)

9. Please specify all the transportation modes your company uses when transporting goods. *
Please state the type and the size of vehicles if available.

10. Are there any rail sidings next to your company's facilities? *

- Yes
- No

11. If you answered yes in question 10, do you use them for loading and unloading goods?
If you don't use them, please motivate your answer. If you use them, please indicate the percentage of the goods loaded and unloaded that way, comparing to total goods loaded and unloaded in your facilities.

12. Does your company use trucks for transporting goods to and from your company's facilities? *
If yes, please indicate the percentage of the goods loaded and unloaded that way, comparing to total goods loaded and unloaded in your facilities.

13. According to your last year's deliveries, please indicate the percentage of freight that was

transported entirely by rail (without any transshipment to any other mode). *

Please indicate also the average distance of these rail freight transportations.

14. According to your last year's deliveries, please indicate the percentage of the freight that was transported entirely by road (without any transshipment to any other mode). *

Please indicate also the average distance of these road freight transportations.

15. In the case of intermodal freight transportation, which terminals of Sweden does your company use for the transshipments of its goods? *

Ports and airport terminals are included

16. What type of loading units are used for the goods when there are about to be shipped from the departure point? *

- Swap bodies.
- Semi-trailer.
- Containers.
- Other:

17. Please indicate the main market areas (coordinates or address) of the points of origin of the goods transported to your company. *

18. Please indicate the main market areas (coordinates or address) of the destination points of the goods transported to your company. *

Page 4

After page 3 [Continue to next page](#)

IV. Decision criteria for the future planning of freight transportation (19 to 21)

In question 20 you have to rank the importance of the criteria you take first into account in the decision

making of freight transportation modes.

Afterwards in question 21 you state the relative importance of these ranked criteria. You set the value 100% of importance for the first ranked criterion and then you set the importance of the second criterion by comparing it with the previous one. For example if the second criterion is half important than the first one, you set 50% of importance. Next, you set the importance of the third criterion comparing it with the second one etc. For example if the third criterion is merely the same important as the second one (which value is 50%), you set a value of 48%.

Please notice that as you go down in your ranked list of criteria, the value of importance should be reduced.

19. Do you believe that the operation of the new port in Norvik (starting in 2015) is going to affect the transportation of your company's goods (in terms of quantity, selection of path or mode of transportation)?^{*}

Please motivate your answer.

20. Taking into consideration the changes in the logistics and goods transportation map of the wider area of Stockholm, please rank the importance of the following criteria that the company would take into account in the future decision making for the modes of goods transportation and logistics.^{*}

Please assign just one unique number for each criterion (C).

	Least important	Fourth most important	Third most important	Second most important	Most important
(C1) The decrease of distance of consignments.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(C2) The reduction of the environmental impact of the freight transportation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(C3) The cost of changing the current freight transportation and logistics system (cost for equipment, education, mistakes, loss of control)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(C4) The increase of safety and punctuality.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(C5) The decrease of cost per consignment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

21. Please assign a relative value of importance for each criterion.^{*}

E.g. C4 100%, C2 70%, C5 35%, C1 33%, C3 10%

Thank you for your time!

In case your are interested in learning the results of this survey, don't hesitate to contact me through the same e-mail the questionnaire was sent. The results will be available in July 2014.

TSC MT 14-009

www.kth.se