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A comparison of seaport logistics systems

*Environmental, safety and economic factors that affect the decisions in buying Ro/Ro
logistics systems*

Masters' thesis

Information systems

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Abstract for master's thesis

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Writer: Fredrik Blomster	
Title: A comparison of seaport logistics systems – Environmental, safety and economic factors that affect the decision in buying Ro/Ro logistics systems	
Supervisor: Anna Sell	Supervisor: Markku Heikkilä
<p>Abstract: The purpose of this thesis is to compare two diverse sea port logistics systems in three different scenarios. The decision-making process will also be included via interviews that were made for the study. Three users of either of the products were asked about their opinion regarding the products and what their decision-making process is based on. In Ro/Ro ports, there are multiple different solutions that can be used. The price differences for them are enormous but the extra costs that each system has can sometimes be forgotten while acquiring new solutions. One of the systems that is compared is the trailer system, and the other is the cassette system. The trailer system has multiple solutions depending on whether it is a Ro/Ro terminal or container terminal. The cassette system is the same in both cases. For the comparison, an excel model has been developed that helps the author in his calculations.</p> <p>The comparison was made with three made-up scenarios where different costs and revenues were calculated in order to see which system was more productive economically. In all three scenarios, the cassette system showed to be the better solution. However, if a company has an existing fleet of a system it might change the outcome of the calculations. In this thesis only totally new fleets were included, meaning that no existing fleet is existing in any scenario of any products.</p> <p>The study will help decision makers in their business by showing them how the two products compare to each other and also highlight their differences. The existing users' experiences of the products could be beneficial when considering buying either of the products. The calculation model that was developed can also be used and with the help of that each company can obtain their own cost and productivity calculations to see which system is more efficient.</p> <p>The study is done through a mixture of qualitative research and artifact building and evaluation process. These methods suit this study, since the qualitative research gives depth and personal insight, while the artifact building and evaluation process make the calculations possible.</p>	
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1 Introduction

Today, large quantities of cargo are shipped worldwide with several types of vehicles. Many products are transported on land by trucks and by air from one country to another. When shipping from one country to another sea cargo is also an excellent choice depending on the size of the cargo. Sea cargo is usually shipped in containers and is charged by the number of containers, compared to air cargo where the cargo is often measured in weight. This means that shipping big and heavy cargo that fits into a container, will probably entail a cheaper price. Sea cargo is slower than air cargo, which means that the cargo must be shipped earlier than if it is shipped by air. Concerning reliability, there are several factors that affect the cargo. Air cargo is often faster, but bad weather can stop the airplane from flying while ships can go on in bad weather. These are the reasons why many companies ship their products by sea, which makes sea ports a large industry. This has made roll-on roll-off (Ro/Ro) ships more popular as the cargo can be rolled on board on diverse types of trailers. There are calculations predicting that the worldwide shipping of loaded containers will rise over 200 million TEU in 2017 and continue growing even more in the future (Port Technology, 2017). This is an increase of almost 7% for the first six months of 2017, compared to 2016. TEU stands for twenty-foot equivalent unit, which is one 20-foot container.

Containerization has emerged since sea ports wanted to reduce work made in the ports and make the work faster so that they could take more ships into their port, thus having better and more efficient business (Kuznetsov, Korshunova, Krolenko, & Oja, 2012). Since then diverse types of container-handling systems have been developed that are used in sea ports. In this thesis, two types of container-handling systems will be discussed. The decision-making process will be presented which occurs when the products are bought and what companies should think of when making their decisions regarding the two trailer types that are presented.

The product development for shipping Ro/Ro cargo started in the late 1960's, when all kind of cargo was shipped on board the ships loose on the deck and lashed individually. This created problems, since the cargo could move around, and all the space on board ships was not used to its full potential. In the beginning roll trailers, which will be described later, were mostly used to move the cargo from around the ports to the ships

but not on board the ships and they barely ever made it on the voyage. They were only used for terminal transports. Later trailers that went on board were developed. That preserved the cargo from any damage during the trip and it also made the turnaround time shorter, which saved money for all the parties involved. However, this process took a long time and it took over 20 years for the trailers to become as established as they are today (Anonymous respondent 1 personal interview, 5.4.2018). Containers were developed that could be placed onto the trailers. They have the benefit of not having to be opened at each point of their journey (Stenkeen et al., 2004). If containers are brought to ports by trucks or rail, they can be moved without being opened. Of course, customs open them sometimes, and then they can also be stacked in the port. However, the benefit is that companies can ship containers from factory to store through many parts of the supply chain without having to do anything to them. In today's world supply chains can be very long and complex, involving multiple parties (Mentzer et al., 2001).

There are many reasons that Ro/Ro has grown to become such a big part of the market. These are cost effectiveness for both ship owner and the shipper. Cranes are expensive and the effectiveness for them is almost the same. This means that port operators can do the same labor with a smaller cost. They do not need to charge as much for the operations when using Ro/Ro as when loading with cranes. The turnaround times can also be reduced, since fewer tasks are needed in the process. When using cranes, the trailers are still needed to move the containers which would require the acquisition of some port operation products. Therefore, Ro/Ro has better reliability on schedules when time is not a problem. In other words, the quality is better for Ro/Ro shipping than many other options. Door-to-door operations are possible for the shipper, since the containers do not need to be packed anywhere in the supply chain other than at the factory and at the end of the chain. This is also possible with cranes loading on and off the containers in today's market, but the price is lower in Ro/Ro operations (Branch, 1998).

The first cassette system was built for transporting paper rolls, shortly later also for steel. Already from the beginning, the cassette systems proved to be a success since they were easy to operate both on board ships and on land. In the beginning, the ships were not built for stowing cassettes on them which meant that in the ends of the ship extra support and lashing were needed so that the cargo would not fall and be damaged. Later, the ship manufacturers started to build the ships so that the cassettes would have a perfect fit without the need of extra support for the cassettes when loaded (Anonymous respondent

1, personal interview 5.4.2018). Anonymous respondent 1 (personal interview 5.4.2018) says that he has been one of the developers for the cassette systems and at their company they noticed that the development of cassettes was a major success both to minimize damage to cargo and to reduce stevedoring costs that they had in the ports.

Many ports are still using the roll trailer system instead of the cassette system, even though it could be more efficient economically to use the cassette system. This of course depends on many factors, such as manning and the size of the port. This study will give the decision makers an insight into what products they should use and motivate the acquisition of innovative solutions. If the port business is small, this study will help show what the limit is for when the usage of roll trailers is recommended. The roll trailer system was developed in the 60's by MAFI. This means that the system is old and, in some cases, should be reconsidered. Even though there have been modifications and development done, the productivity has not changed much lately. Capacity has only grown by hiring more employees and acquiring more equipment, which will lead to larger costs in salaries and investments.

Environmental issues have lately grown into a big issue that both companies and customers value highly. Anonymous respondent 1 (personal interview 5.4.2018) says that during his final years before retirement, a new cargo that has been shipped is burnable garbage. Fredén (2017) says that in 2015 Sweden imported 2.3 million tons of garbage from other countries to make energy from it. This helps us save the planet by shipping garbage to other countries with the help of ships. Using containers for shipping garbage is an efficient way of handling the cargos. This is because the garbage could spread all over the sea, if it were loose on the deck. Another environmental aspect is that having numerous tractors working in the ports pollutes the air seriously, which will lead to global warming and other environmental disasters. Another key factor that port operators value is safety. Safety issues are of high value, since a small cost in having proper ways of working can lead to huge savings in costs that could emerge if the safety standards were not properly followed. For this, some products can be better than others and lead to savings in costs. Some of the risks that can occur in a port are, according to Tseng and Pilcher (2017), oil spills, collisions, grounding, truck accidents, injuries, and personnel going over-board. Reducing these risks will help the port operator save both the environment, and employee health. Up to 80-90% of all accidents are caused by human

factors (Tseng & Pilcher, 2017). These factors are carelessness, fatigue, stress, health issues, mistakes, situation awareness, bad training, and the culture in the port.

This thesis is written for a company that has requested the author to write about the profitability of either buying a traditional roll trailer or newer technology in the form of a transliifter and a cassette. The company is a Finnish company selling different transportation systems based on cassettes and trailers for three main customer groups. The groups are sea ports (hereafter called ports), heavy industry, and container terminals. Although in this thesis mostly Ro/Ro terminals and container terminals will be considered, heavy industry will also be mentioned since the products can also be efficiently used there. The reason for the company having both traditional roll trailers and translifters is that they have recently been bought by one of their competitors that was selling the roll trailer, and the Finnish company had the transliifter from earlier. Since they are now the same company, they want to know when the usage of roll trailers is more cost efficient, and when the usage of translifters and cassettes is more cost efficient for the customers. They have been focusing on only selling their own product for so long that they have only come up with the competitive advantage for their own product. Now they want to know the benefits of both and, thus, maximize their sales and, if both products will help them, grow their market share. This will be done by knowing which product to offer to the customer, and also providing them a reason for it.

All trailers are used with the help of a terminal tractor where the trailer is mounted. Terminal trailers have a direct connection to terminal tractors' fifth wheel. The traditional roll trailer uses a piece called a gooseneck that is connected to the terminal tractor all the time, while the transliifter is a trailer with a fixed gooseneck. The transliifter is steered and driven under the cassette with a hydraulic system which also lifts and lowers the trailer. This means that the driver rarely needs to leave the tractor, which is a safety benefit. When jumping in and out of the tractor the driver is exposed to danger, since there is a lot of traffic and heavy machinery operating around them all the time. However, since the roll trailer is cheaper, it would be more suitable for smaller ports that do not have financial possibilities to spend large sums on their products, and with lower rates of containers coming in to the port. The number of containers coming into the port is calculated in TEU, which stands for twenty-foot equivalent unit. There are containers varying in size from 20 feet to over 50 feet, but the most common is 40 feet long. Some custom sizes are the longer versions of 45 and 53 feet and shorter of 30 or 35 feet.

1.1 Presentation of problem

When buying the products companies want to know what products they should buy to keep their business profitable. If they buy the cheaper product just to save money on the investment, it could lead to loss in earnings later on, since the more expensive product can help them save costs on other fronts and produce more money from their business in the ports. When buying the products there are many costs that the buyer should take into consideration such as equipment costs, service costs, and manning requirement (Kuznetsov et al., 2012). The cassettes need more maintenance, but the costs are lower than maintenance of the roll trailers. When using the cassette systems ports can reduce their number of employees, since the cassette system is more efficient. These are all some major factors that should be taken into consideration when making decisions regarding what products to buy. The boundaries for the thesis will be the Ro/Ro ports and container terminals, even though the industry field will also be presented.

When investing in new or buying more of existing logistics systems, the timeframe in which the products will be bought can also have an impact on the cost calculations. The products that will be presented in this thesis have almost the same life span. This means that investing in the more expensive, the profits and business need to be bigger to make up for the loss in investment.

1.2 Purpose and research questions

The purpose of this thesis is to examine when the acquisition of roll trailers or the cassette system is beneficial to port operators. It will also include the environmental aspect and safety aspect. The thesis can be used by the port operators to help them decide which products to buy. To achieve the purpose, the research questions asked will be:

1. Which product is more efficient economically?
2. How is the decision-making process in ports regarding new systems or products carried out?

3. What problems could occur when implementing new systems and how to tackle them?

The reason that this study is made is that there is little previous research on the subject. There is research done on the port operations but not a direct comparison of the two products that will be compared in this thesis. This study will, hopefully, open new gates towards these two products and comparisons between them. As mentioned, it will work for the possible customers as a guideline for which products to buy, but also for the companies selling the products as a manual in which way they should go when selling their products. The sales team at the company will benefit from the study. They will also have a guideline for how to establish an information system that will help them calculate the benefits from the diverse products. The use of a calculations model will be much more efficient, since it will show the benefits and actual budgets that are needed when using any of the products.

1.3 Goals

The aim of this thesis is to come up with a solution that can be shown to the possible customers when selling the products and help them make their decision when buying the products. For this an excel model will be created that will help make the calculations needed for the study. The hypothesis for when the cassette system will be more profitable is that a port needs at least 100 movements weekly to be economically profitable. Moving one container out and a new one in is counted as one movement.

1.4 Presentation of method

The method used in this thesis will be a mixture of qualitative research, and artifact building and evaluating methods. These methods are suitable since the decision-making process is based on personal thoughts of a certain product. Even though it is possible to show data over costs and how they will evolve with different solutions, the decision is still based on personal feelings. For the study, a survey will be conducted. The answers that will be received from the survey will include personal thoughts of the respondents

(Malhotra & Birks, 2006). These personal thoughts imply a qualitative research method. The quantitative research will be done by creating a model for calculations regarding which product to buy.

1.5 Disposition of the thesis

This thesis consists of eight chapters. In the first chapter the topic has been introduced and some background information to the decision of the topic has been presented. In the second chapter, the two diverse types of trailers and logistics operations systems are introduced and differences in them are brought forward. After the two different solutions have been introduced, the different usage areas are explained. The products can be used in different areas, even though this thesis will concentrate on port operations. In chapter four, game theory will be presented as well as how the practices apply to port activities. Chapter five presents the research method. Here the methods used are presented and the reason why they have been used in order to obtain a better view of the problem. The sixth chapter will consist of the interviews with companies that are currently using either of the products, or both simultaneously. The benefits from the different products will be shown which will help decision makers make their own decisions in the future. Chapter seven will include the empirical research where decision-making and the cost analysis will be presented as well as the excel model that is being developed. The calculations will be presented that are being done with the help of the model. In the final and eighth chapter, the conclusion for the thesis and further study topics will be presented.

2 The two trailer types

As mentioned earlier, this thesis is written for a company that is manufacturing and selling two diverse types of trailers. There are some big differences between them in functionality. The cassette system is a newer type of trailer that has more high-tech features which can be controlled by the driver from the tractor. Since there are big differences in the technology, the price also differs significantly. In this chapter, the two products will be presented where the features and differences will be discussed, and what to consider when buying these products. This will help understand the possibilities with each system, and will help future customers make their decision about which products to buy.

When deciding what product to buy, companies should consider the different costs that will emerge from the purchase. As mentioned, the purchase cost itself is not the only cost that will emerge from the acquisition of new products, but also terminal development costs, maintenance costs, manning costs and operational factors are crucial factors that should be taken into consideration. Terminal development costs are costs for utilizing land and paving costs for the storage area. Maintenance costs are costs that will come no matter which product is bought, but the sum varies depending on the product. Manning requirement also varies depending on the product that is used, and if a company can have fewer workers doing the same job it will save a great amount of money. This is because the costs for employees are high when all extra costs are counted in. Operational factors are versatility of equipment, and the ability to be employed for different activities in the terminals (Kuznetsov et al., 2012). The decision should depend on requirements and demand in the port.

2.1 Translifters and cassettes

The cassette system was initially developed to move paper rolls and metal coils in ports, but later it has been used for more tasks and today there are different kinds of cassettes that are suitable for the movement of different items.

The use of translifters and cassettes has grown lately, since the use of them is easy and fast. A cassette can be stored easily close to the place where it will be loaded. Once it is loaded, it can be picked up by the translifter. The cassette does not need to be on the translifter all the time. This means that the tractor with the translifter can drive all the time and have barely any waiting time. The translifter's functions are based on a hydraulic system and controlled by a programmable controller. It can be lifted up or lowered down when needed. The movement of cassettes is done by driving the translifter under the cassettes and lifting the cassette up. This can easily be done by automated translifter technology, since the tractor driver only needs to drive close to the cassette and the translifter assists in driving under the cassette. This means that the work will be easier for the driver. When the translifter is under the cassette, it will be lifted with pressure. When arriving to the destination the translifter can be lowered and it will leave the cassette in place. There are several types of translifters that can lift different amounts of weight. The most common translifter in ports has a 90-ton lifting capacity.

The translifter can also be used in heavy industry, where products such as steel coils are transported inside the industry area. For this use there are bigger translifters that can carry more weight. There are translifters that can go up to 200 tons of weight. Since the translifter can carry so much weight, it is a better solution than a normal truck. The translifter can carry up to three times more weight, which means that more can be carried at once with lower costs. Only one tractor, translifter, and driver is needed compared to three trucks and drivers. When using three trucks it would also lead to more standing still for the trucks and drivers, unless there were more staff to load on and off the trucks. Using more trucks will also lead to more air pollution from the trucks. There are also some special cassettes that have tipping loading platforms that enable the movement of sand and other small loose material. When using these tipping cassettes, a special translifter is needed that has a lift in the front which makes the tipping possible.

The translifter is easy to drive and control because all axels are steerable. This makes the translifter safer and easier to maneuver in smaller places and sharp corners compared to the trailers. On board ships stacking the cassettes close to each other is easier, since the translifter can be steered. Driving under the cassette is also easy, since the translifter is assisting it. It has sensors that help the driver doing his or her job. This also makes the job quicker which saves money for the parties involved in the business. The only drawback the translifter has on board ships, according to Anonymous respondent 1

(personal interview 5.4.2018), is that it needs double the length when loading or unloading, because the trailer needs to be driven away from under the cassette. This means that it needs at least 19 meters of space to operate, which can create problems in small ships. The length comes from the total length of the tractor and the translifter plus the length of the cassette.

Regarding safety issues the cassette system is better, since it has a camera in the back of it which gives the driver visibility behind the containers. When having two containers stacked on each other it is impossible to see behind them which could lead to dangerous situations if there was a person standing behind it when loading the ships. The translifter is connected to the tractor on a fifth wheel which results in most of the weight going on the back wheels. To tackle this issue a product has been developed that is connected to the tractor in the middle of the chassis that gives all four wheels the same pressure and more traction to the ground. When driving up ramps on board ships traction is needed since the ramps can be up to ten degrees steep, and wet. Having pressure on all four wheels ensures fewer hazardous situations and more efficient work. It is more efficient, since the speed can be held at normal driving speed without causing the tractor to bounce or slip.

When loading the cassettes into the ship they do not need to be lashed onto the boat, since they can be block stowed, which means that they are loaded so close to each other that each cassette is giving the cassettes next to it the security that is needed. If there are some loose materials like paper rolls or metal coils they are lashed onto the cassette (Anonymous respondent 1 personal interview, 5.4.2018). This means that no extra time is needed for lashing on board and it also gives one extra slot per shipment for cassettes.

The maintenance of the cassette systems is different from the roll trailers, since they are built differently and are working in diverse ways. The parts that are most in need of service are the cassettes, since they can be damaged when driving the translifter under the cassettes. Even though there are sensors that assist in driving the translifter under the cassette, some errors are possible if it is done too fast and the sensors do not react fast enough. There is little space between the translifter and cassette on either side. This means that metal must be welded onto the cassettes, since erosion is common. Other parts that need maintenance often are the feet. They have rubber pads under them which give traction to the ground, but when ships are moving small movements can occur that tear

the rubber parts. Collisions between cassettes while loading them onto ships are also common if driving them too close to each other while backing them into position. The cassettes that are already loaded onto the boat are standing still on the deck while cassettes being moved are lifted approximately 20 cm higher. This means that if collision happens between them, the hard, sharp and strong upper edges of the loaded cassette will tear the middle part of the feet of the moved cassette that are not as strong. When lowering down the cassette the feet might become bent over from the heavy weight of the cargo. Even though there are some issues regarding maintenance, these are problems that can be avoided, if enough caution is used while loading the cassettes (Anonymous respondent 1 personal interview, 5.4.2018).

The top part of the cassettes is not as easily damaged as the feet on the side. However, there are some issues regarding them also. If a forklift is used to move the cargo from the cassettes, the forks are scraping the material which requires maintenance every now and then. Other damage that can occur is if something is forgotten on the cassette, e.g. twist locks and something else is loaded into the cassette leaving the twist locks between cargo and cassette. According to Anonymous respondent 1 (personal interview 5.4.2018), plywood is the best material for the cassettes decking since they have good friction and it is lower than normal timber.

The empty cassettes can be stored onto each other in piles of up to six on each other without extra lashing, if higher lashing is recommended. This is more than roll trailers, since the cassettes do not have wheels under that might start rolling and, thus creating damage or dangerous situations. When stacking the cassettes, a forklift with enough lifting capacity is recommended, since the visibility is decreased to the top cassettes in this situation. The usage of reach stackers is good, if the piles are not higher than three cassettes on top of each other. If they are higher, the driver might not see the ISO-holes where the reach stacker should put its twist locks and if he/she misses the holes, the cassette might become damaged. Therefore, a forklift is required for getting down the cassettes that are on top, and once a few of them are taken down a reach stacker can do the rest (Anonymous respondent 1 personal interview, 5.4.2018). Having many stackers and forklifts to do this is not efficient and many ports want to reduce the number of machines used in their port and to only have a forklift is an appropriate solution.

When asked about the advantages and disadvantages for the cassette system Anonymous respondent 1 (personal interview 5.4.2018) said that the advantages for a cassette system is that a cassette is much cheaper to buy than a roll trailer. It is also easier to drive and the functions that the transliifter has are far superior compared to the roll trailer. Since the cassette is open in both ends it can be loaded from both ends and it does not matter how it is driven under the cranes. When loading loose material on cassettes, they can be loaded starting from each end since it has four feet, one in each corner, and are stable. While the roll trailer needs to be loaded starting from the front due to having wheels in the back. The load on the cassette can also be higher than on the roll trailer. The maintenance of the cassettes is not either periodic, since they have no moving parts, and the maintenance is made once needed. The cost of these repairs is also cheaper than on a roll trailer since it is mostly metal plates that are welded onto the cassette to make it more stable and durable.

The disadvantages that Anonymous respondent 1 (personal interview 5.4.2018) brought forward regarding the cassette system is that for handling a cassette a transliifter is needed. This transliifter is far more expensive than a gooseneck that is required for moving a roll trailer. Also, the price of a roll trailer is much cheaper than a transliifter. When using the cassette system at least two transliifters are required for moving the cassettes. The reason for this is that if one of the transliifters breaks down, one more is needed to fulfill the task. This means that the investment of the system is expensive, and it takes time before it has paid itself back. Moreover, as mentioned, it also needs much more space to operate compared to the roll trailer.

In image 1, a cassette system is visible. As the image shows, the cassette is open from both ends which gives it the possibility to be picked up from any direction. The transliifter is never detached from the tractor while in use. In image 2, there is a special cassette that has been mentioned that can tilt the cassette to dump what is on it.



Image 1: A cassette system. Translifter connected to the terminal tractor and a loose cassette (source: NT Liftec Oy)



Image 2: A special cassette with lift for industrial use (source: NT Liftec OY)

2.2 Trailer systems

Since a traditional roll trailer has fewer high-tech components than a translifter, it has been in use for a longer time. It is a simple trailer with only one thick metal plate where the container or loose cargo is loaded, with wheels under it so that it can be moved. Since it is much simpler than a translifter, it also has a significantly lower price which is another reason for it being used more often. The main difference between the translifter and the

roll trailer is that when loading the roll trailer onto the ship the tractor will leave the whole trailer on board, driving off with only the gooseneck that is connected from the tractor to the trailer.

The usage of roll trailers in heavy industry is not as good as the usage of translifters. This is because the roll trailer does not withstand the same amount of weight as a cassette and translifter. Storing heavy cargo for a long time on a trailer would result in elliptical tires since too much pressure would be on them. The tires are solid rubber so that they require less repairing compared to tires filled with air but becoming oval is a main issue.

The roll trailer has fewer technological features than a translifter and it also lacks the ability to steer the wheels. This makes maneuvering the trailer more difficult than a translifter. If the roll trailer is positioned slightly in the wrong position, it must be backed up and then driven again to the right spot. This takes time which can be very costly if the process is done often. The reason this can be costly is, firstly, that it takes time and, secondly, that fuel is consumed by the tractors and unnecessary driving will consume more fuel. The amount for one correction is not much but when done often it will lead to great amounts.

The safety issue of the roll trailer is in stevedoring operations in some way better but in other ways worse than the cassette system. Roll trailers lack the ability of double stacking which makes its center of gravity lower. This means that the trailer would not as easily fall over when driven and this again is a positive aspect of safety. Having the containers fall over could lead to major accidents and if any cargo is broken it would lead to other costs that are avoidable. Since it lacks a camera in the back of it, the visibility behind the trailer is non-existing. This means that if a stevedore is standing behind the trailer, he or she is not seen and might be run over by the trailer and tractor which would lead to injuries, or even death.

When rolling a roll trailer on board a ship it must be lashed to the ship. This means that space is more limited than with the cassette system. The roll trailers cannot be block stowed, since the wheels might start moving. This creates some problems if the cargo that is shipped is big and the vessels cannot take it all on board at once. This leads to more roundtrips which again leads to more costs for shipping companies in the form of labor hours and fuel. When loading a roll trailer, it must be loaded from the front because of its wheels. When standing on the ground the roll trailer has a foot in the front of it where it

rests. The wheels are on some roll trailers positioned at the back end while on others about three quarters back. Loading cargo on them starting from the back could cause the trailer to tilt if the weight was unevenly loaded. Then the attachment of the trailer would be difficult, since the gooseneck would not reach into the hole in the trailer.

The fact that a gooseneck is only a small piece of metal with no moving parts makes it cheap. One gooseneck per terminal tractor is needed to operate in a port. A port needs at least two translifters to ensure the continuous operation. This makes the investment of a gooseneck much cheaper and in smaller companies where the profit would not be big enough, the roll trailer system would be more profitable. This can be counted as earnings minus investment equals profit. The roll trailer is also cheaper than a cassette, but the maintenance of them is more expensive. Anonymous respondent 4 (personal interview 5.4.2018), who is working for a company that manufactures roll trailers, said that on long journeys that take weeks from one port to another the roll trailer can lose its oil from bearings because of vibration. This would make the movement of them difficult since the wheels would not roll. This means that if roll trailers are used on long journeys the bearings and wheels need more maintenance. Another issue on long-distance voyages is that the wheels might become elliptic because of the high pressure.

In image 3, a setup of a roll trailer mounted to the tractor is shown. The part connected between the tractor and trailer is called a gooseneck. To move roll trailers, the gooseneck is needed. To buy more roll trailers is not necessarily needed to move more cargo, whereas more goosenecks might be needed to move an increased amount of cargo. The price of a gooseneck is not high which makes the purchase of them more lucrative than translifters. There are different types of goosenecks that can withstand different weights.



Image 3: Roll trailer with gooseneck and tractor (source: MAFI)

2.3 Differences of the port operation systems

Both systems discussed above have their advantages and disadvantages and in this chapter they will be compared to make it more visible what the differences are and how it will affect the decision in making an order for either one of them. The advantages and disadvantages are gotten from the interviews and from previous studies.

As mentioned, a main difference in the two products is the price. For the price of one transliifter and cassette one could buy four to five roll trailers. This is the price that many look at and do not remember the other costs that come with the systems, such as manning costs and maintenance costs. When having to use more manning the costs for each year will be almost the same, depending on what the average wages are in the country or area. Using more roll trailers will lead to using more tractors, which also affects the price, in both acquisition costs and running costs. The running costs are, for example, fuel and service of the tractor.

Because the two products are so different from each other it makes the comparison of them difficult. However, since they are not similar they have different advantages and disadvantages which makes the comparison easier and the possible buyers' decision easier. The cassettes where the containers are loaded are basically the same as roll trailers, but without wheels (Mäkelä, 2010). When handling a cassette, the transliifter is used to

move it, which makes them one system together. As mentioned, the transliifter has more moving parts and more high-technology features. This increases the cost, which will have a significant impact on the decision whether to buy it or not. With the high-tech features comes more safety and environmental savings since it gives the driver a better visibility behind the transliifter and the company can reduce the number of tractors while keeping the same amount or more of containers moving. Considering these features that the products have it would be easy to say that if a company has the financial possibilities and is environmental friendly, it wants to invest in the cassette system. However, that requires much more money and the payment of the investment is either longer or greater per annum. The main reason for buying the roll trailer is to save money on the acquisition, or if the yearly TEU is not big and the space on the ships are limited. The cost of a gooseneck is cheap compared to a transliifter.

The fact that the cassette system needs more room to operate makes it less attractive on board ships where the space is limited and turns are not possible. However, if possible to back up the trailer and cassette into its place the use of them are more effective even though if the space is limited. The movement of the transliifters is better than the roll trailers, because the wheels are steerable which makes it easier to handle in tight corners and when rolling the containers into their place. The fact that a cassette needs a transliifter to be moved is a drawback because of the price of investing into a transliifter. The fact that two transliifters are needed makes the investment even bigger. While the gooseneck has basically no moving parts that can break makes it possible to go through the processes with one gooseneck (Anonymous respondent 1 personal interview, 5.4.2018). The investment of two goosenecks would still be much cheaper than two transliifters, in case any damage happens and a new gooseneck would be needed.

The Finnish technological research center VTT has made a study in 2010, where the environmental impacts of both products were compared. In the article, Mäkelä (2010) writes that one of the benefits the cassette system has is the more efficient space usage. While having a more efficient use of space it means that the shipping company can ship more cargo on one trip. Up to 14% more cargo can be loaded on board the ships with the cassette system. When calculating emission from ships it can be linked to the emissions and count tons of cargo divided by emission. This gives how much emission is generated for each ton. The amount of emission for each ton of cargo is higher, since one trip generates as much emission regarding what is on board. Savings in emission can be up to

13% of emission per net ton cargo. In gross weight of the cargo the savings are between 7 to 10% (Mäkelä, 2010). However, this means that the ships need to be fully loaded to have these savings.

The study made by Mäkelä (2010) also shows that since the cassette system is more efficient in loading and unloading the ship it would lead to lower emissions from the ships. This is because the ship needs to stand still for a shorter time, meaning that it can cruise at a slower speed since it has more time to go from port A to port B. When driving with lower speed, less fuel is consumed which means less emissions. By using smaller amounts of fuel, shipping companies can save a great amount of money, since the fuel costs are high as well as the emission taxes.

The company that this thesis is written for has a customer in the Mediterranean Sea. They have made their own study regarding emission savings from changing the system from an even older system than roll trailers to cassettes. The old system that was in use was very slow to work with and that is why they wanted to change the system. The study shows that after changing the logistics system they saved 42% in emission (Gruppo Grendi, 2018). This major difference comes from the fact that they could remove one vessel from shipping their cargo. Another reason for reducing their emission is that the cassette system allowed them to drive another route from the starting point to the end. The new route was more by sea than by road. The use of trucks, with high emissions, could be decreased. This result shows the significant difference in emission between ships and trucks. One ship can load many containers while one truck can only move one, or two, trailers at time. The productivity in this case grew by over four times. In this case, productivity means loading and unloading times. The cassette system made the loading processes much more efficient. The loading and unloading times were reduced to one fourth of the time that was invested in it earlier. With the old system this time was approximately 15 hours, while the cassette system allowed them to do it all in four. This made it possible to decrease sailing speed. The sailing speed reduction was possible since the route changed and because of the more efficient loading time (Scorza, 2016). The main reduction was the earlier mentioned emission reduction, which can be converted almost directly to fuel savings, meaning that 45% savings was noticed on reduction in fuel (Gruppo Grendi, 2018). The change of port logistics system allowed the company to change the size of the containers. The containers that they started using were 24.5 feet long and they saved the company nine percent in emission because the reduction in travels

was nine percent. The total reduction in emission, after the change in container and more efficient labor, was then counted as 47% (Gruppo Grendi, 2018).

When deciding on which product to buy the investor needs to remember some crucial factors. These factors are: how long time will the investment be paid off on, how will it affect the profitability, buying more products can lead to greater discounts, and the cost of employees. All of these can have a great impact on the economy of the company in the long run. When using the cassette system, manning requirements are not as high, which leads to smaller costs in employees.

The depreciation time for the products can be different due to the differences in price. IRS (2018) describes depreciation as an annual allowance for the wear and tear, deterioration, or obsolescence of property. This means that depending on the size of the investment, companies can depreciate their products and gain tax deduction. Since the investment for one transifter plus cassette is bigger than one gooseneck and roll trailer, the tax deduction is bigger for the cassette system. Also the amortization for the products can have differences depending on the company's decision. They can choose to use certain years for their products or then a certain sum that they use yearly for amortization for their products.

3 Different areas of use

This chapter will introduce the different areas where the products can be used in sea port logistics. There are more possibilities to use the trailers than only sea ports, but this thesis will focus on ports and their surroundings.

The trailers can be used in different kind of areas. The most common are ports, heavy industry, such as metal and paper industry, and container terminals. In the ports, the trailers are used to drive containers on board and off the ships. These ships are called roll-on roll-off ships, since they have a ramp where the trailers can be driven on to the boat. A traditional roll trailer will be left on the boat, since containers will be stacked on the trailer while a transliifter will drive the cassette with the containers on it and leave only the cassette on to the boat. This means that not as many translifters are required as cassettes or roll trailers. Both of the trailer types can also be used in container terminals where cranes are loading on and off the ships. In heavy industry, there are different kind of cassettes where heavy metal coils can be driven around to different places in the industry area. In the container terminals, the different kind of trailers can be used to move the containers between different handling locations.

All these areas that are mentioned are well suited for translifters and roll trailers, since they can be loaded and easily picked up by the yard tractor. In case of an enormous number of containers, or other heavy duty that needs to be moved around, the transliifter with cassettes could suit better, since the cassettes can be loaded and easily picked up by the transliifter, while it takes a little bit more time to attach the roll trailer to the gooseneck. If the number of containers is small, roll trailers could be a better solution, since it has a lower cost and therefore give economical savings.

The areas where the products are used are mostly ports. In the ports there are different sides where the products can be used. These are called land side and quay side. A port is an extremely complex area where many different players are taking part in the operations. If one of the players taking part in the port operations has some issues it could lead to problems in the entire port's activities. This could lead to great economic problems for parties involved in port operations. Also, the parties not having any issues in their functions are affected by this. The different parties that are involved in operations in ports are according to Talley et al. (2013):

1. The port operator
2. Shipper third party brokers
3. Shipping line agents
4. Harbor pilots
5. Towage companies
6. Governmental customs

The port operator is the main player in the operations, but they are helped by other parties. Shipper third party brokers can for example be freight forwarders. They are taking care that the cargo is driven forward from the port and take care of the logistics in the port. Shipping line agents are the ones that help the staff on board ships with different tasks, while they are in the port. They can for example bring them food, drive their clothes to laundry or do other important tasks that must be done. Harbor pilots help the ship cruise into the port. Some ports are difficult to navigate to because of various factors, such as traffic or low water. In these cases, the harbor pilot will cruise the ship the last part of the voyage into the port. Towage companies also help the ship reach the port and its destination. They are doing the same job as the pilot, but the way they work is different. Here the towers do not enter the ships that arrive but tow the ships with a smaller boat to port. The customs are working land side where they scan the products that enter the country of any illegal products or substances.

Some ports do also have logistic centers where the containers are being packed. Here loose cargo is shipped to and then once containers are available they are being packed. The cargo is divided so that the cargo that needs to be shipped into a certain port is in the same container as other products of a destination. When the container has reached its final port, it is unpacked, and the products can easily be shipped forward to their destinations. This makes the shipping of small quantities easier and cheaper, since they are packed into a container among other cargo and shipping companies charge per container. Some products that are bigger can also be shipped on board ships loose on deck. This method is called Sto/Ro, which stands for stowable roll-on roll-off. Here the products are driven onto the ship on roll trailers or cassettes and then discharged from the trailer or cassette, to pack tight without empty room on board the ship.

3.1 Water side

Roll-on roll-off ships are ships where it is possible to drive on board through a ramp. There are several types of Ro/Ro vessels such as vessels where trains or yard tractors and trailers can drive on board (Wijnolst & Wergeland, 1997). This study will only focus on the ones where a roll trailer or cassette system is used. These ships are loaded via a ramp where the yard tractor pulls or pushes a container mounted to a trailer on board. When the boat reaches the other ports, it will be unloaded in the same way. The opposite of Ro/Ro ships are Lo/Lo, which stands for load-on load-off. The Lo/Lo ships are usually loaded from the side with a crane. Diverse types of Ro/Ro ships are used such as, ferries, freight, Ro-Pax, car carriers, combined carriers such as container Ro/Ro, and Ro/Ro Lo/Lo. There are also cruise ships that are Ro/Ro ships. Depending on the type of ship, the number of decks vary. A ship that is only meant for Ro/Ro and not normal passengers have more decks for containers, while cruise and Ro-Pax ships have limited room for containers and more room for passengers. The number of decks can also vary depending on the amount of cargo. Some ships have hostable decks that can be lowered down or lifted according to needs. The ships have a ramp in one end that can be lowered where it is possible to drive on board.

Depending on the distance the boat is cruising the size varies. The ships are often custom built for a certain purpose (Wijnolst & Wergeland, 1997). The ships can have many decks, which means that the tractor and trailer needs to have certain properties in order to be safe to drive. The weight needs to be put evenly on the tractor for it to maintain traction to the ground, and not lift up the front wheels in uphill. Internal ramps usually have an angle of approximately seven degrees. While loading on roll trailers and cassettes there are some differences. The roll trailer has to be lashed to the boat, while cassettes can be driven so close to each other that lashing is not needed, unless the weather requires them to be. This means that more cassettes can fit inside the boat, therefore giving it more tons of products transported per trip.

The cassette system has some drawbacks on the usage of it regarding efficient use in both ends of a ship. As previously discussed the cassette systems requires around 19 meters of space to be used which creates some empty space normally in the front, since the ship is formed as a cone to go through water efficiently. However, the usage of space is more

efficient than with the roll trailer, something that needs to be remembered while loading the ship. When calculating the number of containers going on a ship this factor has to be taken into consideration. Block stowing is neither possible if the walls of the ship are not aligned in the same direction as the containers because of the cone shape. This happens mostly in the bow of a ship.

Image 4 illustrates the loading of cassettes and roll trailers on board a ship. From the figure it is possible to see the capacity that a ship can have and how it will affect the loading of cassettes and roll trailers. Image 5 illustrates the stowing of the roll trailers versus the block stowing of cassettes.

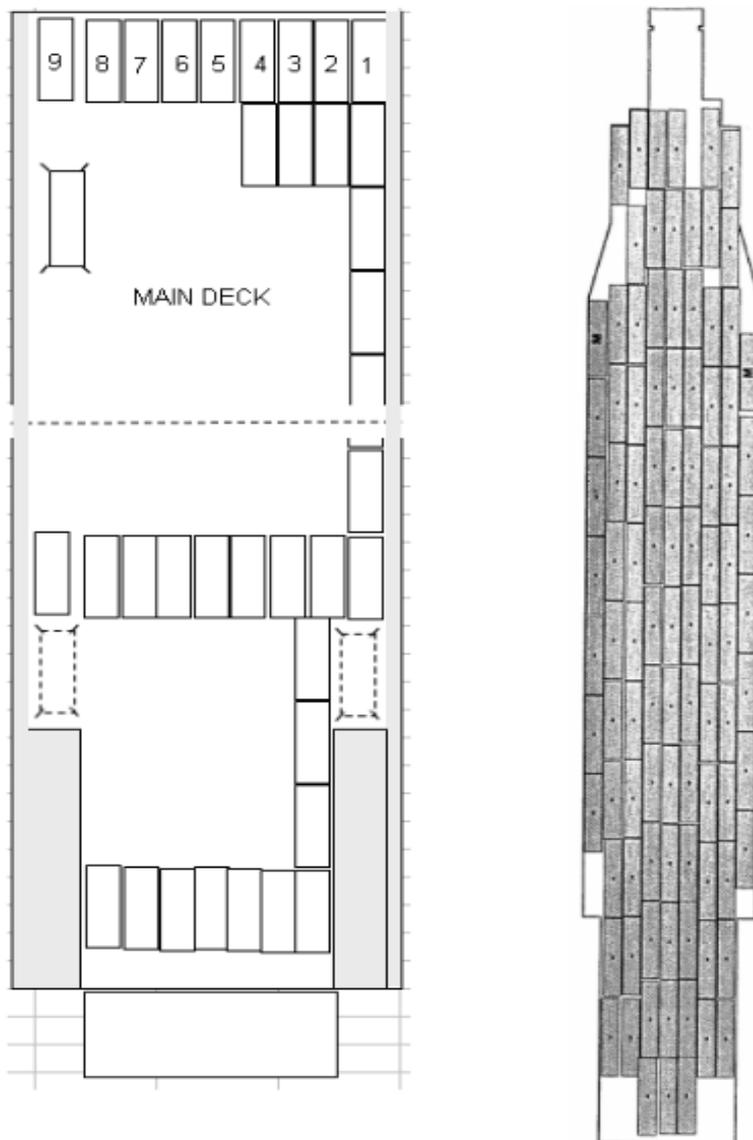


Image 4. Stowing on board ships (Mäkelä, 2010)

From image 4 it is possible to see that in case the roll trailers are used the area required per trailer is both wider and longer than the cassette system needs. This visualizes how the loading of ships is done with different systems. The figure also visualizes the statement that has been made, that by using the cassette system the loading will be done more efficiently. In image 4 the front visualization is clear and the empty unused space between trailers are visible, while block stowing is utilizing more space on board ships. Image 4 is only a possible solution for stowing containers on board a ship and there are multiple ways in which it can be done. Image 5 visualizes the stowing of cassettes and roll trailers where the lashing is made. This shows that more space is required for the lashing of roll trailers.

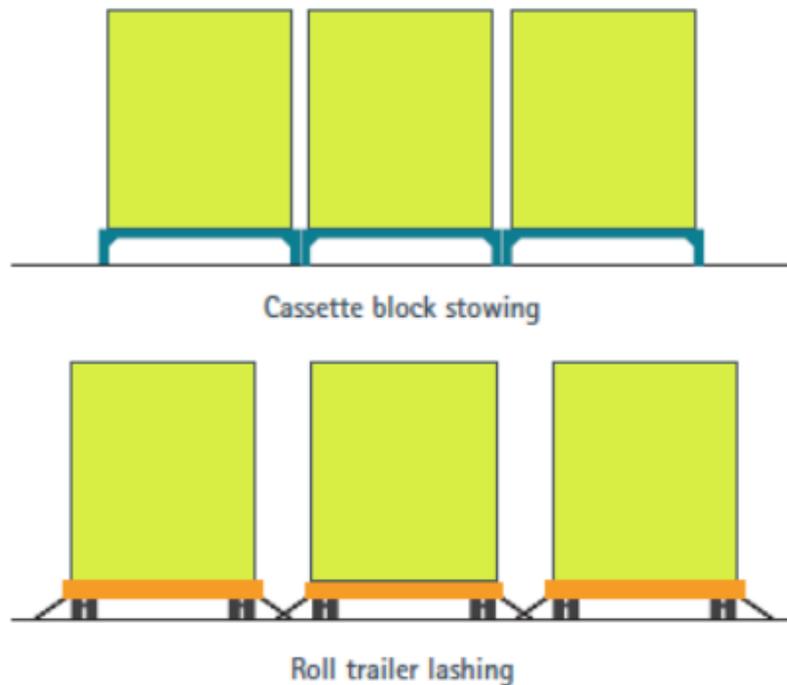


Image 5. Roll trailers lashing vs. block stowing of cassettes (Mäkelä, 2010)

3.2 Land side

The ships are loaded and unloaded in each end of its route. The ports have a huge work in keeping track of all the cargo and that is why each container has a number, so it can be followed and sent to the right customer. Moving around these containers can be done in

many ways. Depending on the size of the port, different container carriers are used. Many big ports use a combination of many ways to keep track and send the containers to the right destination. For moving around one container at the time, some ports use straddle carriers. They are either three high or four high, which means that they can carry one container over either three or four containers, thus making them actually four or five containers high. For bigger parks of containers ports use RTG cranes, which stands for rubber-tired gantry cranes. These are bigger and used for fields where the containers are stacked for storage before they are sent out. RTG cranes have one lane on one side that is empty of containers and it is meant for trucks and tractors to drive there when loading on a container. Some ports use cranes that run on railway tracks instead of rubber tires. These cranes are called RMG. The RMG cranes are unloaded in the end of the field or by having empty lanes on the side of the crane. One cassette can be loaded before it is picked up which would fasten up the work. In automated RMG terminals the use of cassette system has increased.

Having the terminal trailers or cassettes waiting in a place close to the crane where it can be loaded, would help save time. The cassettes or trailers would be left there while other cassettes or trailers are moved away and when arriving back to the unloading area one empty trailer or cassette would be brought to the loading area. Trains arriving to the port are coming on the land side. There are usually cranes that are lifting the containers off the train and onto the cassettes or roll trailers. From here the containers can either be driven to the container yard, or directly onto the ship.

As mentioned, there sometimes exists areas where the containers are packed. These facilities are situated on the land side where the cargo from road or rails is brought. This allows the job to be done away from the busy port. Thus, not being in the way of any other operations that are done quay side. The packaging of cargo in ports is often made on behalf of the customers. The customers are in this case the importers, exporters or the forwarding company, not the port.

As discussed earlier, many of the operations in ports are done land side. Talley et al. (2013) describe the players that are taking part in the operations. The ones that carry out their functions on the land side are, shipping line agents, and customs. The rest of the ones taking part in the process also operate on the sea side. The shipping line agents can also do their business on the sea side while delivering the goods to the ships that are

ordered, but they mostly operate on land. The customs are mainly working on the land side. The functioning of the ports is highly depending on their efficiency to inspect the cargo coming in. This means that in case they want to do efficient work, the containers must be dropped off efficiently. When dropping off a container another one must be taken out, since the space is limited, and if too many containers are left there they will run out of space. Here both the roll trailer and cassette system can be efficient. When dropping off one cassette or roll trailer another one can easily be picked up again and driven out of the customs area. This gives the customs more space for their operations, making the work more efficient.

The terminal offices are also often land side. This is where the planning and leading of the operations is done. Some of the tasks that they are doing is not related directly to the containers. Other tasks that are on their responsibility is marketing and sales, maintenance and finance. In the marketing and sales, they must know what systems are used and what benefits it has compared to the other options. Finance together with operations makes propositions or decisions over new investments. Maintenance of the different systems is also a task that is done land side. If any of the products has some problems or it is broken, they are fixed in the maintenance area landside (Boske & Cuttino, 2002). This means that operations on land side are as important as the operations done sea side. If the land side is having any problems in sales, marketing or service, it means that the sea side will have fewer or possibly no tasks to do, leading to a loss in profit.

Many ports today have free trade zones, meaning that there are different laws and regulations regarding taxes. This makes the shipping possible from one country to another via other countries without paying customs fees and taxes to the country that they are going through (Branch, 1998). The transshipment without any extra customs or handling fees has lead to better unit prices, which increases the volume of cargo.

“The successful partnership between the shipowner and port authority creates a synergy which focuses continuously on meeting the needs of the shipper and identifying new opportunities and strategies to develop the market.” (Branch, 1998, p. 181)

This means that port operators should keep good partnership with authorities in a country in order to make the shippers experience better and, thus attracting more customers for both parties. Together they can become a bigger player in the market. The process time

will also be shorter if the partnership is good and companies and authorities work together and know what happens in the port.

3.3 Container terminals

Container terminals are ports where the ships come to unload and load by Lo/Lo. There are big quay cranes that usually move on rails. They have long booms that can move over the whole ship to reach the far side of the ship to the outside cells of containers. The terminals sometimes have direct access to either railroad or then highway trailers can drive under them to continue the containers journey towards its destination. They do also have container storage areas, where the containers need to be moved. This can be done in many ways, for example by terminal trailers or cassette systems. Here the cassettes and trailers can be stored under the cranes that are unloading the ship and the tractors with translifters can drive the containers to the storage area. Terminal trailers are also an effective way and it would be done in a similar way as the cassettes. The terminal trailer is stored under the cranes and the tractor picks up the trailer that has a container on it.

Small container terminals can sometimes use mobile harbor cranes. They are normal cranes that can be moved. The reasons for these being used in small ports are that the need of them might vary, and the movement can be done in case it must be used elsewhere. The cost of cranes are enormous and small ports might not have the financial possibilities to buy many, making them buy mobile harbor cranes. The movement of the mobile harbor crane is either on wheels or with crawlers. In case it has crawlers, some other vehicle is needed to move the crane.

3.4 Container yards

Ports usually have a different number of containers coming in and going out. This leads to a port having a so-called store, which is the number of containers that are stored in the port waiting to be shipped away. There are two ways in which containers are coming in to the port, by land and by sea. The ones coming by land are called export cargo, and the ones coming by sea are called import cargo (Kuznetsov et al., 2012). Diverse types of

vehicles have different rates of cargo that they can handle at one time. If a big ship is coming in with hundreds, or even thousands of containers, that means that the terminal operator needs to have full control and order enough trucks or trains to ship the containers forward in the supply chain. However, this is often not the case, since not enough trucks or trains are available at the time needed.

Another reason for building up store at the port is unevenness of vehicle arrivals. The arrivals are often fluctuating around a mean time. Ships coming in by sea to the port arrive at one a certain time and the trucks cannot be waiting there, since it is expensive to have them waiting in the port. Therefore, they come in a little bit later to the port. This means that first a surplus is created when the ship arrives, and when the trucks arrive a deficit is created. In order to keep the same store value a surplus has to be created again (Kuznetsov et al., 2012).

Kuznetsov et al. (2012) describe the number of store at a terminal at any given time as $E(t)$, and the containers coming in by land as $L(t)$, and the cargo leaving by sea as $S(t)$. This gives the equation $E(t)=L(t)-S(t)$, which rarely is 0. That means that the cargo coming in usually waits for a certain time before being loaded on the ships. In a perfect terminal the store would always be returned to the mean store value. Although, since the ships coming in also have a difference in their capacity of containers, this seldom happens.

A third reason for having container yards is that some companies want their containers inspected before they start shipping them forward towards their destination. Alternatively, there is some paper work that needs to be done once the containers have arrived in another country. The containers might also go through customs before they can be shipped towards the end customer. If the end customer has too little storage space for their containers the containers can be stored in the port, for a fee, until more space is available. These are all reasons that have made the container yards general in ports (Kuznetsov et al., 2012).

There is also the opposite part, import, when containers are coming by sea into the ports and trucks or trains are not there yet to pick up the containers to their next destination. This also builds up on the store that is in the terminals. Since a boat cannot be loaded and unloaded at the same time, since some containers need to be moved before new ones can be driven into the boat, a greater store is built up before the number of containers starts

decreasing. This means that in the container yard there are two ships loads, but once the ship is loaded and it has sailed away there is only one left waiting for further shipment. Consequently, there should always be one shipload per ship in the terminal waiting for shipment. When a vehicle, ship; truck or train, is coming in to the terminal it will bring as many containers as it takes away (Kuznetsov et al., 2012).

Another reason for container yards to exist is because of transshipment. Transshipment is when cargo is gathered from many smaller ports to one big hub port. From there it will be shipped forward a longer route to another area or country. The smaller ports that are shipping their cargo to the big hub port are called spokes or feeder ports (Kuznetsov et al., 2012). Sometimes the cargo has to wait for the next ship to arrive and, thus stand still in the container yard waiting for the next ship to come. If the bigger ship going on the longer journey is already waiting, the yards are not needed, but this is rarely the case. It could also be because of a gateway shipping pattern that there are container yards. In this case the containers and cargo are shipped by road and rail instead of sea to the port.

In container yards there are different solutions that can be used in order to move the containers as needed. There are two different types of cranes where one is moved on rails and the other on tires. There are some differences in how these will work in collaboration with the roll trailer and cassette system. There are also other solutions that are working on the same purpose as the roll trailer and cassette system. The cranes feeding the cassettes and roll trailers are as mentioned moved on either rails or rubber tires. The rubber-tired gantry cranes can stack the containers up to six high. This means that it can have six high and move one seventh over it. If it is seven containers high there is no room for any other containers to be moved over them. Since the crane is moving on tires, there is no need for any tracks on ground that could make the driving under the crane difficult. Consequently, the terminal tractor can drive straight under the crane and it only has to pick the container up move slightly to the side and drop it down on the trailer or cassette. The width under the cranes is up to five containers wide which leaves a sixth empty line where other vehicles can drive and pick up the containers. The rail-mounted gantry cranes have the same height and width as the rubber-tired cranes. However, since there are rails on the ground that makes the driving under the crane more difficult, and that is why the unloading happens at the end of the container yard. There are some cranes that have an extra feature on them that makes the driving under the cranes possible on the side, and not in one end. This is a cantilever extension on the crane that makes it possible to move

the containers outside of its legs (Kuznetsov et al., 2012). Having terminal tractors drive under the cranes is a safety risk. Driving close to the containers might be dangerous if any accidents happen and the containers would fall over. While using rail mounted gantry cranes there is a lower risk of containers falling over the terminal tractor. Other safety benefits from the rail mounted cranes are that the terminal tractors are not driving in the same area when going to the waterside and landside which means less traffic (Cargo systems, 2007).

The differences in the two systems productivity are clear. The RMG solution offers automated cranes, called automated stacking cranes (ASC). Their benefit is that they do not need manning to be operated. This saves costs for the port. They are also faster and can move up to 3 times faster than the RTG. A RTG can move up to 120 meters per minute while a RMG ASC can move up to 300 meter per minute. The capacity of container storage is also higher for the RMGs because it has no driving lane that needs to be kept empty.

4 Game theory and differentiation strategies of ports

This chapter will introduce the concept of game theory. It is taken into this study, since competition between ports is described as a cooperative or non-cooperative game (Xu et al., 2015). If an area has multiple ports, the competition between them will be high and the port operators must react fast to what their competitor does, or make their own moves in order to see how the competitor reacts.

Game theory is used to describe the competitive situation between companies to maximization of profit in a company. This means that ports are competing of the same customers and to attract them to their port they need to be able to fulfil their desires. If a shipping company has its cargo loaded with one type of trailer, the port that is loading and unloading the ship needs to be able to do this. This means that if a ship that comes with cassettes comes to the port, the company operating in the port needs to be able to unload the cassettes. The game theory aspect comes in here, since ports want to differ from their competitor in some way making them more appealing to the customer. There are different ways a company can differ from their competition. Porter (1985) describes these as cost leadership, differentiation and focus. Cost leadership means that a company has the lowest prize. It has to have a prize that is at the industry average or close to it. Differentiation means that a company seeks to be unique in the industry. The uniqueness is rewarded with a higher than average prize. Focus means that a company must in a narrow target market seek either a cost advantage or differentiation advantage in its target segment. The different companies taking part in the operations are called players. Each player needs to be aware of the other players' decisions and strategies in order to make their own decisions. For example, two ports operating close to each other should decide if they want to have the same ways of operating, or if using diverse types of trailers would lead to bigger profits for both, since they would not compete of the same ships. This could lead to something called Pareto efficiency which is named after an Italian economist Vilfredo Pareto who said that there is no way for one player to rearrange its way of working without making it worse for someone else. Games where two or more players are working against each other in their own favor are called non-cooperative (Xu et al., 2015). Business usually is non-cooperative in the sense that a company wants to maximize its own profit, and this can only be done by taking it from someone else (Raouf & Al-Raweshidy, 2010). Business games are often extensive games which means that

one player knows the other players actions and decisions, except in the beginning when they haven't made their first decision regarding products to use. During this game the players can also make new decisions which will change the way of the game. Here the players can also see the benefits another player is getting from one decision (Raouf & Al-Raweshidy, 2010).

Games between ports and shipping companies on the other hand can be co-operative when they both want to minimize the total costs and maximize the total profit. Here all players need to be co-operative, referring to the port that the cargo is shipped from, the shipping company, and the company to which the cargo is shipped. There are also more companies involved in both ends in the whole supply chain. The cooperation can of course be bigger than just the ports and shipping company. Other companies taking part in the game can be the ones whose products are shipped by sea.

In game theory there are two other types of games that are distinguished from each other. One is a so called normal form game, and the other is called extensive form game. The difference between these is that in the normal form game all the actions are made at the same time. In the extensive form game timing has been introduced (Al Nowaihi, 1995). Usually the games are extensive form games, since the players cannot make their moves at the same time. Players want to know the movements of their competitors before making their own decisions. In extensive form games, there is a game form called repeated games. Here the players all do the same move over and over again (Al Nowaihi, 1995). This is not a game that is easily recognizable in port games, since the movements are all identical and players want to make new decisions regarding orders. The number of cargo shipped worldwide is also growing, which means that the actions in the game cannot be the same repeatedly.

4.1 Games between ports

Ports do business to maximize their profit. In order to maximize their profit, there are some different solutions for them to work according to. One possible option to consider is to establish a strategic alliance with other ports. This would help the port grow and it would improve the competitiveness of the ports. This would help the alliance grow in the market (Xu et al., 2015). Pricing is an important factor when shipping companies make

their decision about which ports to choose for their business. By having lower price than the competitor, ports can be lucrative for shipping companies to come there for unloading and loading. Other factors that are important are the products used. As earlier mentioned, ports differentiation leads to the usage of different products. In this study the roll trailer and transifter has been studied. That is why they will be the alternatives for decision even though there are other to choose from.

As already discussed, there are two different ways for companies to do business. Either they can do non-cooperative work, or they can do cooperative business. In non-cooperative business there are more pressure for the company to stand out as the best solution for shipping companies to choose. This can be done by cost leadership or differentiation. Cost leadership will give all customers low prices which will increase the throughput in the port, while differentiation will add specific features or services that gives added value. Even though price is an important factor when shipping companies are choosing the port to load and unload in, they are also considering the time that it takes for the port to do its work. If a port is known for being much faster, they might be chosen even though their price is higher. The more efficient work comes with a higher price. When doing non-cooperative business, it means that the port needs to make its own strategic plans about which products to invest in and this might affect the development of the port (Xu et al., 2015). This is because the revenues are not as high as in cooperative business. That leaves smaller amounts of money for developing the business, and uncertainty in what the competition will do as their next move.

A cooperative way of doing business is according to Xu et al. (2015) the best way. This is because when doing business together the development of the ports is going forward in a faster manner than without cooperation. The cooperation will also reduce costs. When buying port operation systems a big amount will give more discount than buying small amounts at the time. Cooperation also allows the companies to have higher price on their business. This gives the ports higher revenues, thus higher profit. This does not mean that ports can start deciding on which shipping company to use and then have high prices, since this a form of cartels and are in general illegal. However, if all the ports let the shipping companies freely decide which port to use by having the same price for every company, it is legal. The aim of cooperation is as mentioned to maximize profit, this can be achieved by allocating the revenue between companies participating in the alliance. If the allocation of revenue is not done properly it can lead to negative impacts on the

alliance. That is why this needs to be focused on when having an alliance. This distribution of resources does not have to be equal in terms of money, but requires an equitable allocation where all parts are acknowledged.

The pricing of port operations can be used to create higher or lower demand. This is important in both competitive and cooperative business. This will in cooperative business lead the customers in a certain direction, while keeping in mind that it cannot be illegally done (Xu et al., 2015). A demand too high for the port operator to manage will lead to higher prices which will lower the demand to a level that is manageable. If the demand is too low the price will decrease to increase the demand. If the demand is high in a port the equipment used needs to be efficient in order to fulfill the customer's needs. This means that loading and unloading needs to be efficient. This requires the right type of equipment and right amount of employees. A third important factor in the game is the location of the port. The location needs to be at the right location in order for the shipping company to choose the port. That means that it needs to be at the right distance from the final destination and have the right distance from the starting port. If the distance for sailing is too long it will lead to higher costs for shipping companies in fuel costs. This will lead to them choosing another port that has a shorter sailing, therefore saving fuel.

In this thesis the effect on national or areal economy has been discussed. Hidalgo-Gallego et al. (2017) discusses the differences in private and public ports. Private ports have the main mission to create revenue, while public ports also want to create spillover for the local economy. This factor does also affect the decision in what products to buy and how much to invest in new operation systems, such as cassettes and roll trailers. When two ports that are in different regions compete against each other the government in the region has to make decisions that will affect the port. Will it help it to grow the market share in the area or not. All of this matter when making decisions in how to develop the port.

If the companies taking part in the game are small, all the decisions that are made in other companies have a greater impact. If they have a small revenue and profit all the decisions regarding lower prices or implementing other operating systems will affect the level of the competition, and the small revenue and profit will be even smaller. If the competitor is increasing its price it will have the opposite effect (Al Nowaihi, 1995). This means that smaller ports should even more often go into alliances to maximize their profits, or chose differentiation.

If one company owns all the ports in a certain area, it is a so called multi plant monopoly. Here the company owning the ports could decide on whether to open or close plants. If they are the only ones doing business in an area and there are no other players to compete with, it is called a monopoly. If the ports that are working in a certain area are merged into one firm a multi plant can also arise (Al Nowaihi, 1995). In cartels shutting down ports is not possible because the cartel does not own the port.

5 Method

The method that will be used for this thesis is described in this chapter. Chapter 5.1 discusses the selection of the research method and why that method is chosen. Chapter 5.1.1 discusses the actual methods and they will be presented, and chapter 5.1.2 discusses the reliability of this study. Chapter 5.2 discusses the artifact building process. Last part of the chapter, 5.3 discusses the data gathering process. These topics will be discussed to give an insight in the selection of research methods and show how the study is carried out. The final part of this chapter will describe the data collection of the study.

5.1 Selection of the research method

Parasuraman (1991) describes marketing research as a set of techniques and principles where one is systematically collecting, recording, analyzing, and interpreting data. This data can be used to help companies develop themselves in the market. The methods used when doing marketing research can be divided into two separate methods. The two methods usually used for marketing research are qualitative and quantitative methods (Parasuraman, 1991; Malhotra & Birks, 2006). Quantitative research is in contrary to qualitative research based upon bigger data collections where many different samples can be presented numerically (Parasuraman, 1991). Qualitative research on the other hand seeks to encapsulate the behavior, experiences, and feeling of the respondents and consumers. This means that there will be more own opinions in qualitative research than in quantitative research (Malhotra & Birks, 2006). No matter what method is chosen the researcher aims to:

1. Discover new facts or verify and test old facts
2. Analyze their sequences, interrelationships and causal explanations
3. Develop new scientific tools, concepts, and theories which would facilitate reliable and valid study of human behavior (Krishnaswami & Satyaprasad, 2010).

Based on the facts mentioned earlier in this chapter a qualitative research will be conducted. The study will include both interviews and artifact building approaches. These methods will be presented later on in the study. With a mixture of these two types of research methods the author will be able to both verify old facts, and test new facts. An artifact will be developed that will help the company in their future by aiding them make calculations regarding the products. The human nature will also be studied partially regarding decision-making.

Research design can be divided into two types of design. Explanatory and conclusive design (Parasuraman, 1991; Malhotra & Birks, 2006). These can further be divided into more categories. Explanatory design can be divided into qualitative and quantitative exploration. Conclusive design has more designs that can be used. They are, causal research and descriptive research. Here the latter can be divided into cross-sectional design and longitudinal design. Finally, cross sectional design can be divided into multiple cross-sectional and single cross-sectional (Malhotra & Birks, 2006). From these methods conclusive design will be chosen, since it tests and studies hypotheses and examine relationships. Parasuraman (1991) also defines the research purpose for conclusive research as a way of verifying insights and aiding the selection of different actions. The purpose of this study is to create an aid for decision makers to help them make their decisions regarding the products to acquire.

Järvinen (2004) has also made an illustration over how research can be made. He has named them research approaches and as Malhotra and Birks (2006) Järvinen has divided them into various categories. Research approaches are divided into approaches studying reality, and mathematical approaches. Approaches studying reality are divided into two sub sections where one is called *ones stressing what is reality* and the other one is called *ones stressing utility artifacts*. Since an artifact is going to be developed, it will be explained more deeply. The sub section is divided into two sections where one is an artifact building approach and the other is an artifact evaluating approach. Both approaches will be used, since an artifact is developed to help the sales team sell the products described in this thesis. Furthermore, the evaluation of the artifact will be done, since we want to know how much it will help the consumer make the decisions.

Setting up research questions is according to Bryman and Bell (2011) important, since it will guide the literature search that is made during the study. It will also help setting up

the research questions and deciding on what data to collect for the study. By having proper research questions, it will also help analyzing and write the results that are obtained from carrying out the study. Before doing a study, the researcher must identify a problem, discussed in chapter one, and then the outlines for the study has to be set (Malhotra & Birks, 2006).

5.1.1 Qualitative research

Conducting a qualitative research is suitable when the number of respondents is small. The purpose of a qualitative research is to identify a certain phenomenon. Since the method uses small samples of data gathering, it means that it is flexible to carry out when the respondents give their own opinions to the questions that they are asked (Bryman & Bell, 2011). The fact that respondents are giving their own thoughts and feeling for a certain matter means that if the answer is given in a certain way it will also be interpreted by the researcher and that might create problems. If the respondent means something but cannot find the exact words he or she might say something else by using other words unaware of how it will be interpreted by the researcher.

5.1.2 Artifact building and evaluating approach

In order to carry out the research, an artifact will be developed calculating the the profitability of the two systems. For the calculations some basic variables are received from the company that will use the calculations model in the future. Järvinen (2004) describes the artifact building process as a process where a certain new information system is built. In the information system that is built measurements and calculations can be done. These measurements and calculations can be used to gather data over the products that are compared. When building a new artifact some important questions to think about are whether it is actually possible to do it as planned. Sometimes there exists criteria for the information system that is not feasible.

When building a new information system, four steps are important to keep in mind. These are according to Järvinen (2004) *always analysis; dynamic requirements negotiations;*

incomplete, usefully ambiguous specifications; and continuous redevelopment. *Always analysis* means that the analysis of information systems needs to be continuous. The organization needs to overlook the market and development in order to change their artifact accordingly. This means that this stage needs to be ongoing throughout the whole lifecycle of the information system. The service can in other words not be cyclical, when at one time analysis is done and then implementation. Both of them needs to be done simultaneously. *Dynamic requirements negotiations* means that, since the information system is built for the end user it has to be discussed with them so that they can specify the requirements. User satisfaction is an important aspect of the whole process. *Incomplete, usefully ambiguous specifications* entail that the specifications for the artifact building have to be exact and feasible. If the specifications are too large or unambiguous the information system will not work efficiently. The goal for an artifact building process is a set of specifications where the specifications are easily modified and open-ended. *Continuous redevelopment* basically means that the information system needs to be in continuous development to fulfill its purpose. This will prevent the system from being obsolete and ensure the development of new information systems in the future.

After the artifact building process comes the evaluation process. The artifact is evaluated by some criteria or specifications that where set in the building process. This process should in other words answer the question: How effective or useful is this artifact. By other means the use of the information system needs to be easy and effective. All the information needs to be easy to access all over the system. Filling in new data must also be made easy. The information that needs to be easy to access in this case is the price and cost for different task with different solutions (Järvinen, 2004). For the evaluation of the artifact, the end user is contacted to ask their opinion over the system and how it will be implemented into their business. This will help to develop the artifact according to their needs. By contacting the end user, changes are easy to implement if needed and their benefit from the artifact is much higher.

5.2 Reliability of the study

The reliability of the study has some drawbacks, since the respondents are giving their own personal thought and feelings in a certain matter. The data gathering process in a qualitative study is informal and the respondents are chosen by the researcher. This means that the researcher can affect the results by choosing respondents that are known to give certain answers. Other reasons for giving critic to the qualitative studies are, as mentioned earlier, the researcher's interpretation of the gathered data by the researcher (Kuada, 2008).

When considering whether a result is reliable or not, there are three factors that are involved in measuring reliability. These three factors are stability, internal reliability, and inter-observer consistency. Stability means that a result is stable over a long period of time. This means considering if there are some fluctuations in different variables that affect the result. In this study, factors possibly affecting the reliability of the study are for example the price on raw materials or labor costs that can change over time, thus changing the total result for which product is more cost efficient to buy. Internal reliability means that the answers received from the respondents tackle the same question. If some given answer would affect other answers that they are giving, this would create a problem and the study would not be reliable. The last factor, inter-observer consistency means that the interpretations of the answers must be consistent in order to have reliable data (Bryman & Bell, 2011).

The reliability of this study is ensured by having proper discussions with the respondents and making sure that their answers are interpreted properly by asking them if anything is unclear. The study will also be read by the companies involved in the study, in order to make sure that they can approve the study and are able to give feedback on things that they are concerned about.

5.3 Data gathering

For conducting the study, data will be gathered from various participants. The participants were chosen from customers that are using either trailers or the cassette system. Three

respondents were first contacted by phone and the study was presented. During the phone call their interest in participating in the study was asked and they agreed. An email with the questionnaire was sent to them and they had some time to fill in their answers. Interviews were made regarding the products and the experiences the customers have about them. The companies that were contacted are companies that are currently using either the cassette system, roll trailer or both. The reason for contacting these specific companies is that the company that the thesis is written for has recommended them. One of the contact persons has been retired for about a year but has been working with the products for over 30 years, which means that his knowledge of them is wide. The interviews were conducted during the spring 2018. Because the respondents are based all over Europe the interviews were conducted over email and one of the respondents was met personally. Using email is easier than phone calls because written text can be seen, which makes it easier to interpret, and the material will not be lost. If the interviews were made over phone calls, the calls should have been recorded and the length of them could be long.

One of the respondents do not have experience over the roll trailer system, but he has considered it when changing over from an old system to the new system, which in this case turned out to be the cassette system. Their opinions will include the reasons for choosing the cassette system over the roll trailer and the benefits they have received from using them. The other respondents have experience from both systems and their answers will be used to evaluate the differences that has been seen in actual use.

Other means that will be used to gather data is the excel model, made for calculations. To have all the calculations right, simulations are made that will reenact real world scenarios where companies are deciding which product to acquire. For these calculations, some numbers are received from the company selling the products, such as the price for the products and service costs. The costs used in the calculations will be approximations and indicative, since the costs and revenues that ports have are individual and, in many cases, competitive secrets.

The interviews will be semi-structured interviews where the respondents all answer the same questions, but discussion that is not scripted regarding the questions is possible (Qu & Dumay, 2011). If a conversation with one respondent is going in a certain direction, some part will be discussed in more detail than others. Even though the interview is done

over email using a questionnaire, some further questions will rise, and they might be individual depending on the answers. The interview that was made face to face was more open because there was much time to discuss the two products and their thoughts and experience regarding them. This method also allows the researcher to broaden the questions to gather more valuable data. All the data and information that is available regarding the two products will help conduct the study. All the respondents will be anonymous to prevent any leakage of information regarding the companies.

6 Case companies

The companies used in this study are as earlier mentioned customers for the company that is selling the trailers presented in the thesis. They are currently using one or two of the available systems. The reason that they are using these products will be presented in this chapter. Also, their experiences regarding maneuvering and using the products will be discussed. This chapter will go through the companies that were used for the study and the answers that were given in the interviews.

6.1 Interviews with roll trailer and cassette system users

The interviews for this thesis were as mentioned done by email. The reason that email was chosen was due to the distance between the author and the respondents in some cases. Email was chosen over telephone calls because it is easier to have the answers if they are on email than if they were given over the phone. The assurance of getting the answers correct is higher, since the documents are easier to handle when they are on written documents than spoken over the phone. If any problems would occur the phone might lose the recorded calls, but on email it is less likely to be lost. In the following part the interviews will be analyzed, and the respondent's answers will be presented.

6.1.1 Company A

The first company is an Italian company that is operating a ship line between Sardinia and Tuscany. In both ends they are also operating the port and therefore they are part of the whole logistics chain. They have been using Ro/Ro vessels for over 20 years. For loading the containers, they used to use forklifts and top spreaders. The operation in ports was previously done by driving the cargo on board in smaller loads at the time. This was time consuming which is expensive when much work force is needed, and the revenue is not coming in when ships are standing still. The product that they are using currently is the cassette system. They have special built cassettes and translifters that match their

needs in Italy, where, their containers are a bit longer than normal. The reason that they chose this system is the operating speed, and professionalism at the manufacturing company. Their vessel is supposed to go three times a week on the line. Since the productivity in the ports was not that good, only approximately 30 pieces per hour, it meant that they had two vessels to manage the schedule. The operations with one vessel would have been possible by sailing at a faster speed, which would have used much more fuel. After introducing the cassette system their productivity raised to 120-130 TEUs' per hour. The increase in productivity was +428%. This reduced time in port from over ten hours to only about three hours, which calculates as a reduction of 75% in time savings. This meant that the company could lose one of the leased vessels. This lead to enormous cost savings. The sailing speed is also much lower now than it would have been using only one vessel with the previous system (Anonymous respondent 2, personal interview 7.5.2018).

The productivity and consumption were dramatically improved. As mentioned productivity increased considerably when changing from an old system to the cassette system. How the situation would have changed by using roll trailers is impossible to say but the company did their calculations audit which showed that the cassettes were more efficient. The biggest savings came from the possibility to reduce the number of employees and reduction of fuel consumption. This was possible since they could end the lease of one vessel. That made the reduction of staff possible, since one ship crew was only needed compared to the previous two staffs at a time. Reducing sailing speed from 21 knots to 15 knots does also save fuel. Preparations for loading and unloading the ship became more efficient. This was because the preparations could be done during daytime and there was less moving around of the containers. Being able to do the preparations on daytime made the work for terminal operations easier. This means that the company did feel that the implementation of the product has a positive effect on their business. Even though they have had many positive effects from the product they believe that there are many possible developments that could be made to make the operations more efficient. Using the cassette system also gave them possibilities to ship more diverse material than before. Now they have the possibility to ship marbles, steel, and other cargo that is good for their business. The amount of increase in cargo that is possible to ship on one vessel is up to 125% more than before with the old system (Anonymous respondent 2, personal interview 7.5.2018).

The cost for implementing the cassette system was big, since they had to buy all the products at once. The products included translifters and tractors as well as the cassettes. This is a negative side, since the company must either take a loan to be able to implement or go to their own money reserves, and spend them on a product that they have no experience of. Spending that much money on a specific product is always a risk. In case any errors would occur, the money has already been spent and could not be gotten back in any way. Either resell or have deals that makes testing of the product possible. This company had a six-month trial where they had both the cassette system and their old system in work at the same time. They think that the transition was difficult, which could be explained by the fact that they had completely other ways of operating the port earlier. The transition from roll trailers to cassettes, or vice versa, could be easier, since tug masters are already in the port, and Ro/Ro operations with them are familiar (Anonymous respondent 2, personal interview 7.5.2018).

Another reason that the company values the cassette system highly is the fact that it saves the nature. Using the cassette system enabled them to remove one vessel which has less emission. The amount of cargo on one vessel is also higher, since the stacking is easier which leads to lower rates of pollution per tonnage of cargo. Safety was also a main issue that they managed to tackle. The maneuverability of the transliifter is good which means that fewer people are needed close to the operations which leads to fewer injuries. Economic reasons are also of high value. Their calculations showed that in their case the use of over 50 cassettes was cheaper than if they would have used roll trailers. This is because for each cassette they use, they should have bought a roll trailer. And the price for a roll trailer is higher than the price of cassettes. Even though the price for a transliifter is much higher than for a gooseneck this solution was cheaper in the end. That is because they do not need that many translifters to fulfill their needs (Anonymous respondent 2, personal interview 7.5.2018).

They have been planning on buying even more products of the cassette system. Both translifters and cassettes has been discussed. One of the products that has been discussed to buy is the Saferoll version of the transliifter. It would give them even more safe maneuverability on board the ship (Anonymous respondent 2, personal interview 7.5.2018).

6.1.2 Company B

The second company that was contacted is a Swedish based company that is active in the north of Europe in many countries around the Baltic Sea. They have been involved in the development of the cassette system from back in the 1980's. They developed the product together with some other companies for shipping different cargo, for example metal coils and paper rolls.

They are currently using both the cassette system and roll trailer system. They say that, since the roll trailer was developed first it is a product that most of the Ro/Ro companies are using for Ro/Ro operations. The reason that they use the cassette system is that they were a part of the development of it. In the beginning it was other manufacturers that built the cassettes for them. It was mainly Polish and East German manufacturers. Later in the 90's they switched manufacturers to other companies, including the mother company for the company that the thesis is written for. The mother company seemed to be the most successful of these and that is why their products are used today. Other reasons are their geographical position. This enables delivery on time which is highly valued by the company (Anonymous respondent 1, personal interview 22.05.2018).

The reason that they are using both the roll trailer and the cassette system is that they are suitable for different cargo. For example, when shipping one container of standard size of 20 feet up to two times 30 feet, or some loose cargo the roll trailer is perfect. Machinery is also suitable to ship on roll trailers. One reason might be the lower height and easier loading. Roll trailers exist in many sizes which can easily be matched to be the right depending on the size of the container. Cassettes on the other hand is suitable for other cases in their opinion. For example, if timber, paper or metal coils are shipped the special build cassettes are perfect, since the loading of them is easier and they are built to prevent movement of the coils. If a port has a large number of containers to be shipped cassettes are more suitable. The reason for this being the case is that they are more stable, and can be double stacked. If the ship has steep ramps the cassette system is more suitable, since the translifter has brakes that prevent any dangerous situations where the tractor and trailer would slip (Anonymous respondent 1, personal interview 22.05.2018).

The fact that the cassettes do not have wheels makes it safer to operate. They are stable throughout the whole loading process which increases safety. The company also feels that

the usage of cassettes is faster than the usage of roll trailers. There are many reasons that affect this. First, it is easier to drive in ramps, which makes it faster. This is because of the brakes that was mentioned. Secondly, cassettes are easier to maneuver both on board ships and in the container yards or warehouses. Finally, cassettes need less lashing which makes the process faster, especially when block stowed. Approximately 15% less space is needed according to their calculations. Mäkelä (2010) imply approximately the same space savings in the cassette system towards the roll trailers. The double stacking is also having an impact on the savings. Not many ports are allowing the double stacking on roll trailers due to safety risks. The containers can tip over on the roll trailer while on the cassettes they are more secure (Anonymous respondent 1, personal interview 22.05.2018).

The overall feeling that the company has of the products is that it has affected their business in a positive way. It has enabled them to ship more diverse cargo, since the two products has their own benefits. The decks are also spared on the ships which means less maintenance of them. This saves money and means that the ship can go more trips without having to stand in the docks while doing the maintenance. Also, the cargo that is shipped has had lower rates of damage claims. All of these reasons indicate cost savings and more income for the company (Anonymous respondent 1, personal interview 22.05.2018).

When the use of cassettes started, there were some problems that occurred. A few improvements were required before they could operate to their full potential. The reason for the problems were that, since the product had not been tested yet in practical use the design had not been proved yet to work properly. The weak points had to be detected of the product and once they were established and the improvements done they were happy with the result. Some of the problems that occurred for the transliifter in the beginning were that the lashing had to be developed and the clearance in height when driving under the cassette had to be improved, the cross-members needed to be protected from impact of the transliifter, and the sides had to be strengthened to avoid block stowing damages (Anonymous respondent 1, personal interview 22.05.2018).

The benefits of the cassette system towards the roll trailers are cost savings. This however requires a certain amount of movements to be done in order to make up for the cost of acquisition. The savings that the company noticed was that the manning requirement was not as high for the cassettes as for the roll trailer. Cutting down on the stevedores by five

to ten persons gives great amount of savings. Also the time in port while loading and unloading was reduced. If the cassettes are only concentrated on one deck then the reduction of stevedores are lower. Approximately two to four persons can be reduced if it is only on one deck. This creates many positive effects, since with shorter port time more ships can be taken into the port which generates more profit. The stevedoring time is also reduced which means that time for a movement can be reduced. In the interview they say that in Sweden, and the whole north of Europe, stevedoring costs can easily be over 500 SEK per hour which is up to 60\$. This means that if one hour is saved it is multiplied with the number of stevedores in order to have the actual cost savings. For the ships the reduction of time in ports does mean lower fuel consumption during its voyage, since lower sailing speed is possible. This does also save port fees where the ships are charged for port time. Utilization of the ship is also better which generates more income for the shipping company where customers are charged per container. Fewer units of the cassettes are needed compared to the roll trailers. This is because more cargo can be loaded onto one cassette than onto a roll trailer. Less maintenance and repair of the products is also needed (Anonymous respondent 1, personal interview 22.05.2018).

Before their initial investment in the cassettes they had plenty of discussion regarding them. They had been using the roll trailers for a while and it was proven to work already, but the cassettes functionality was not proved yet. They could not foresee the results that would come from the implementation of the cassettes. However, the company that they were developing the product with had some figures of the product that another company had been testing for some time. When they compared that with the usage of roll trailers they decided to go on with the development. The paper rolls that they were shipping were fragile and needed better solution for the surface of the trailer. The cassette proved to be better which resulted in fewer damages to the paper. During the interview the respondent pointed out that the shipping branch is fairly conservative, and new solutions are not easy to be accepted. However, the respondent thinks that the management was brave when they tested the new product that gave them new possibilities for shipping. The next step they had to do was to invest in ships that were built for the purpose. This made the scale of this whole investment very big (Anonymous respondent 1, personal interview 22.05.2018).

The transition from the previous ways of working was smooth considering that they had no experience of the product. The biggest obstacle was to train the stevedores to use the

product, and have them used to the height of the load. Safety had to be taught. Working around highly loaded cassettes can cause dangerous situations. Some investments in extra gadgets had to be made. These were a working platform that were on top of the load that they could work from, safety harness that prevents falling from over five meters, a special tool for tightening the lashings on the cassettes, safety construction to the transliifter, and support walls to the ships that prevent cargo from falling down in heavy weather (Anonymous respondent 1, personal interview 22.05.2018).

The essential thing to remember according to the respondent is to know what kind of cargo is being shipped. Then make the decision whether the roll trailer or the cassette system is more suitable for the cargo to be shipped on. Another factor to keep in mind is the ships that are used for the cargo, and whether they are suitable for cassettes or roll trailer transportation. Since the cassettes require less space it means that more cargo can fit on board, but the width must be correct in order for the block stowing to be possible. The amount of units that is supposed to be moved on each call affects the decision also. High number of containers means that the cassettes are more efficient, while with a low number of containers the roll trailers are more suitable. Here also the cost of the products affect the decision. Fewer containers per call means lower income, and it means that more moves are needed in order to fill up for the investment. The number of terminals does also affect the decision, since each terminal needs at least two translifters where one is spare in case of problems. The previous experiences do also affect what the ports should invest in. If they have experience of one product and think that it is suitable for their business then that will have a great weight on the decision (Anonymous respondent 1, personal interview 22.05.2018).

Environmental and safety consideration is according to them the same thing as economic factors. They are all linked together and if either environmental or safety accidents happen it will affect the economical side. If one can load more units per call it will save the environment. Fewer ships are needed and they can drive slower if the port times are reduced. The fewer stevedores that are needed to stand around the operations, the safer the operations are. All these has to be taken into consideration when buying new products. Not just go for the cheapest solution in the hope that it will be the cheapest to operate (Anonymous respondent 1, personal interview 22.05.2018).

”If it’s not safe, you will not have any terminal willing to work that way. If it’s not environmentally friendly, you will not get permission to work that way.”(Anonymous respondent 1)

6.1.3 Company C

The third company that was contacted is a Finnish shipping company that is shipping cargo in Europe, mostly in the Baltic Sea. The company is using both roll trailer system and the cassette system. The respondent said that the reason they use the cassette system is economic. The shipping line must stand for the repair costs on the roll trailers while the port operator stands for the costs on the maintenance of cassettes (Anonymous respondent 3, personal interview 30.5.2018). These costs can rise high depending on the number of roll trailers that are shipped on the vessels.

The reason that they are using both roll trailers and cassettes is that all the ports do not have the infrastructure to receive both products. If this is the case they usually lack the translifters which makes it impossible to move the cassettes. This makes the roll trailers more flexible in ports all over the world (Anonymous respondent 3, personal interview 30.5.2018).

Business that only ships one sort of cargo should according to them more often use the cassette system. This would make the operations straighter forward, since there is only one sort of cassette and translifter. While there for roll trailers and goosenecks can be multiple different solutions that exist. The effects that this company has felt on their business was both positive and negative. The reasons why are unclear, but the fact that multiple products must be used will create problems and the two products must work seamlessly together. Calculations whether it has saved money has not been made, but they think that it should have been done (Anonymous respondent 3, personal interview 30.5.2018). These calculations will help companies develop their business even further and future investments are easier to do when they know how a certain product affects the profits.

The respondent has worked in the company for a long time, but the investment for these products has been made prior to his time in the company. Consequently, knowledge about

which calculations were made for the products are unknown (Anonymous respondent 3, personal interview 30.5.2018). Many different calculations can be carried out such as manning and service and running costs. The transition from the previous ways of working to the new ways, concerning mainly the cassette system, is unknown.

The essential things to consider when purchasing either the roll trailer or the cassette system, is according to anonymous respondent 3 (personal interview, 30.5.2018) the type of equipment the port operator has available now. The future investments should also be considered. These include all the investments that the port operator is planning to do. When asked how much weight they put on safety and environmental issues rather than just economic reasons, they say that all of the issues must be thought about (Anonymous respondent 3, personal interview 30.5.2018). In the end, they are all the same when making up costs plans. In case any accident would happen, no matter if it is an environmental or personal accident, it is extra costs for the company. That is why they should be taken into consideration.

7 Empirical research

Today, large quantities of products are shipped by sea from one port to another in containers. This has become a very popular way, since the cost of one container on the ship is relatively small compared to air cargo. This is because a ship can carry much more cargo than an airplane. Containers were developed, since cargo handling had to be more efficient than it was earlier. This part of the study covers the decision-making process that ports are dealing with in chapter 7.1. In chapter 7.2 a cost analysis will be described together with the help of the excel model that was developed for the study.

Port pricing will be taken into consideration, since it has a large impact on the calculation model predicting which product to use. If the price is higher it means that fewer movements are needed in order to pay back the investment. All the costs are same regarding the price, but the profit will increase.

7.1 Decision-making

The decision-making process is a long process that starts way before the actual offers are brought to the table. The process starts with acknowledging the problem that has occurred in a company. After that, the objectives need to be set. What do we have to do in the company to tackle these problems, if anything? If the decision is to tackle it somehow with new solutions, the company needs to know what different solutions there are on the market. When all the alternatives are identified, the decision from which ones are the best for this operation must be chosen. Then the optimal alternative is chosen. Until this point the process is called preparation of decision. When all of these steps are made the decision-making process enters the actual decision-making process. It starts with the management going through the alternative that was brought forward in the previous steps. Then some experimental tests can be conducted and finally the decision is made. The final and third stage is the realization of decision, where the product is in use and results from actual use are received (Navickas & Sujeta, 2012).

The process of making decisions is often long and the actual user's opinions in decision-making are of high value. This could in some situations mean that the company would

not change their way of working to a more efficient solution because the stevedores are afraid of losing their jobs. That is why they claim that the new and more efficient way is not good and would not benefit the company at all. Therefore more calculations regarding profits and revenues are needed to show companies the real value of changing the operation to a more efficient way. Changing to a more efficient way can in the long run have a much more positive impact on the business than the old and inefficient way has. The company that has requested this thesis has a product which is safer than the normal model that is used. The safety also brings more efficiency to the work. The product however was not met with enthusiasm from the stevedores, because they might have been afraid of using the product in fear of losing jobs. They had one stevedore from a port come to their production plant to try the product with a cassette and a container. When he had tried the product for a while he came out of the tractor claiming that the product was good. This shows that there are preconceptions towards many of the new and innovative ways of doing business.

Grönroos & Ojasalo (2004) says that in the service field, many organizations have low productivity. This is due to high costs and excess resources. They claim that the service provider could easily produce as much as earlier with lower costs, if the structure of resources were different. This could of course have the opposite effect also. If the customers are not happy with the new solutions, they would seek for better service at other places. This creates a dilemma in service processes. Even though internal productivity becomes better it might not lead to better economic results. Therefore, the processes are divided into internal and external efficiencies. The internal efficiency has to create external efficiency in order to lure customers to the company. When customers are happy with the service that is given they will continue to use the company, and attracting more customers is easier.

Sunk costs are cost that have already been paid. These should not have any weight on the decision-making process. If a port buys a certain product it should not affect the price for operations or the decision for future acquisitions of new products (Simon, 2001). If the acquisition of a product proves to be bad and the cost for it will rise enormous it should not be seen in the price. This will only lead to greater problems, since customers are not willing to pay much more than the actual market price at the moment. In the next chapter pricing is explained in more detail regarding port pricing. If two ports in an area has similar port operation systems and the service is similar, the cheaper will be chosen in

many cases. This is because companies want to maximize their profit. If an acquisition is unsuccessful it will affect the next decision when a company is buying new products.

7.2 Cost analysis

A calculation model, helping the author with mathematical problems has been developed for the thesis. This model will be used for calculating the costs that occur when using the two products presented in this thesis. The costs that occur are mainly, as earlier mentioned, manning costs, service costs and running costs. As the manning costs, different costs have been calculated to see the difference that can occur in different countries. The products are used all over the world and the wages differ from one country to another. That is why the cost calculation model is important, in order to see where the limit of different countries and whether they should buy one product or the other.

Anonymous respondent 1 (personal interview 5.4.2018) said that they had 60 movements per week in their company. It was not enough to give a return big enough compared to the investment on the cassette system. The amount of movement that is needed to cover costs will be calculated. If the number is very large, then only bigger ports could benefit from the cassette system which is not optimal. The cassette system is proven to be more efficient but the price difference in the cassette system and roll trailer is the crucial factor. In chapter 1.3 the hypothesis is laid out that at least 100 movements per week are needed to economically motivate the acquisition of the cassette system. By the help of the calculation model, the hypothesis will be evaluated.

The excel model is built with the help of the company that the thesis is written for and some basic information will be received from them. This basic information includes for example time and speed that certain tasks in the process takes. With the help of these, the whole time for the process of unloading and loading will be calculated. Costs will be taken from databases where a country's average salary is calculated. By adding these two with the number of roll trailers or cassettes per movement, total time and cost will be calculated for one movement. From these the total costs for the systems will be received and we are able to identify the most efficient system.

In the cost analysis, different income groups will be used. When using different income groups, the study will show the prices and break-even points for both developing countries and developed countries. The average salary of stevedores in different countries can have big differences. In some countries stevedores' salaries can rise to almost 100,000\$ per year. For example, in Finland is the average salary for stevedores is 4500€ per month, which is close to 5300\$ (Oikotie, 2018). This means a salary of almost 64,000\$ per year. While in cheaper countries, salaries for stevedores might be under 1000\$ per month. The salaries will affect the decision of which product to buy because the cost of products is the same, while labor costs vary.

Phillips (2005) writes about different approaches to pricing. There are three major approaches to pricing. These are cost-plus pricing, market based pricing and value based pricing. Cost-plus pricing means that the price of a service is calculated by the costs for a certain task, and then the margin is added to it giving the final price. Market based pricing depends on the market price. This means that the competitors' price must be reviewed and then the price of the service will be adjusted accordingly. Here it is usually smaller companies that has to follow the price of bigger companies and adjust their price after them. Market based pricing is not the best option for a company because then the competitors are setting other companies' prices. That again is better for the customers, since the price will be pushed down. Value based pricing again means that the price is set accordingly to how much the customer values the services that are sold. Here the prices can vary between companies. In table 1 the three pricing models are visible as well as the factors they are based on and what they ignore.

Approach	Based on	Ignores	Liked by
Cost-plus	Costs	Competition, customers	Finance
Market-based	Competition	Cost, customers	Sales
Value-based	Customers	Cost, competition	Marketing

Table 1: different cost models for port pricing (Source: Phillips, 2005)

The different teams tend to like different approaches, since there are different factors that they focus on. Finance teams tend to like the cost-plus model, since it gives them certain margins per sale. And if the margins are high enough it means that the company is economically managing their business. Sales team usually like the market-based, since it helps them compete with the competition. Furthermore, marketing teams like the value-

based, since they want the customers to gain a value out of the service or product that is sold (Phillips, 2005). The value-based pricing is directly linked to the competitive strategy which was presented in chapter four.

Port pricing can according to Meersman et al. (2014) not follow any of these models directly. Ports usually charge their services according to a linear pricing structure that depends on easily measured variables. The vessel size and tonnage/TEU are variables that determine the price for port operations. The list price that a port has are not followed and ship owners earn special prices that include different discounts and adjustments. This means that ship owners all have different costs for the port services (Phillips, 2005). If a ship owner often comes to the port this can lead to bigger discounts than for companies that rarely dock at the port. Thus, the pricing in ports is a mixture of all the approaches that was previously presented. Wijnolst and Wergeland (1996) write about the port fees in Rotterdam. The data is old, making it useless for the calculations, but they say that calculating the price for a ship is rather straightforward. Depending on the tonnage and if any port pilots or other assistance is needed will affect the price. Then a normal quay price is added to the calculations.

The TEU size of the vessel is making up a big part of the price. The bigger the TEU the bigger the price. However, larger TEUs can lead to bigger discounts. If a shipping company is using one port for their operations in an area on a regular basis they can receive greater discount than if they would only arrive a few times (Meersman et al., 2014). These will however not be calculated in the study, since the amount of discount is changing from one customer to another. A set price will be used in all the different cases.

In Finland, there are different costs that will make up the total cost of ships voyage and docking. These are pilotage, fairway dues, harbor due, sewage, garbage due, disposal of oil, mooring, unmooring, agency fee, possible overtime costs and phone and mail dues. All of these costs will be added together, upon that the profit that is wanted will be added which gives the selling price. The act on fairway dues (1122/2005) has set the price for fairway dues to offer the same price for everyone. It is paid to the government by the port operator company. The maximum cost of fairway due in Finnish waters is 53,875 euros (Finnish customs, 2018). The costs will vary in different countries and that is why several prices will be taken into consideration.

The costs that appear in the ports are divided into two sub sections. One of them are so called fixed costs, that do not change even though the production grows. The other type is variable costs which change depending on the size of production. Fixed costs are for example costs for leasing the soil, depreciation of the machinery, some of the salaries that are paid to the administrative personnel, and electricity. Variable costs are counted as fuel, stevedore's salaries and extra salary costs (Alhola & Lauslahti, 2000). If a port has many movements, it means that the stevedores have more work, giving them more salary. This creates a positive effect if the profit made per movement is greater than zero. It means that the port is making profit and the more movements there are the more profit it generates.

In the following table, the costs that occur are visible as well as who is pricing and who is paying. Not all costs not affecting the price of the calls are included

Activity	Who prices	Who pays?	Variables applied
Port dues <ul style="list-style-type: none"> • Tonnage dues • Mooring dues 	Port authority	Shipping line	Gross tonnage (ship) Load (ton)
Pilotage	Government and port authority	Shipping line	Draught, and distance Length of vessel
Towage	Towing company or port authority	Shipping line	Length of vessel and distance Gross tonnage and distance
Cargo handling on quay	Terminal operating company	Shipping line through its agents	Per weight or movements
Transport to/from storage	Terminal operating company. Other carrier if transported outside of port	Shipping line or receiver	Per weight or movements

Storage	Terminal operating company	Recipients of the cargo	Per unit of weight and time
Delivery	Terminal operating company	Recipients of the cargo	Per unit weight or TEU
Customs	Customs authority	Owner of cargo	Value of cargo and customs fees
Handling of empty boxes	Terminal operating company	Shipping line	Per box
Storing of empty boxes	Terminal operating company	Shipping line or leasing company if boxes not leased	Per box and time

Table 2: Port costs and who is pricing and who is paying (Source: Meersman et al., 2014)

The product pricing for the different products and services that are sold have some things in common. The supplier of the product or service wants to make a profit. The revenue is calculated from the selling price minus the total costs. Total costs of a product or service include fixed costs and variable costs. Fixed costs are costs that do not vary regardless of how much of a certain products or service is produced (Michel, 2002). In this case fixed costs will cover all the costs that the port has in rent of land, electricity, taxes, all the salaries, yearly depreciation of the products that are already owned and so on. Salaries could be calculated as variable costs, but this would require either firing of employees or that they would have hourly salary rate. The excel model will calculate on a yearly basis. Variable costs are fuel costs, since they will change depending on how much of a service is produced. From these the break-even will be calculated and it will show how much a port should produce of a service in order to have a profitable business.

7.3 Excel model

As previously mentioned an excel model was built to be used in the decision-making process for choosing the port operating system that can be used in daily business. The

data that is used in the system is from various sources. Sources will include the company that the thesis is written for and online sources for prices in shipping sea cargo, and databases over average salaries worldwide. The reason that the excel model is developed is to improve productivity and efficiency within the organization. This does not only apply for this certain company, but all companies that are existing. Information systems improve the efficiency by making the work processes easier (Hevner, 2004; Myers & Venable 2014). Hevner (2004) does also state that design science is a problem solving process. The excel model was built by design science which is a research method that addresses unsolved and important questions in innovative and new ways. The result with design science in information systems is an artifact that is purposefully built to address a certain problem in a company.

The excel model is used to calculate break-even points for how many movements are necessary to have the revenue higher than the initial investment and total running cost. The running costs include variable costs and fixed costs. Here for example salaries and maintenance costs are crucial factors that have much weight on the costs. The model consists of several sheets where different input data is set. After the input has been set for each port the calculations will be done automatically and the results are clearly visible in the model.

The model will consist of six different sheets where different calculations are done. The first page will include basic information of the operations in the port such as number of TEU and duration for different tasks. Here the time differences between cassette and roll trailer efficiency is filled in. The fact that ships with cassettes can fill more cargo must also be included in the calculations. This will affect the income more, rather than time.

The second sheet consists of the cost calculations for the process. Salaries and maintenance costs are the main factors in this part. The exact maintenance costs are impossible to know beforehand and that is why it will be an approximation of the maintenance costs that will be used in the model. Fuel consumption is also a crucial factor. Since the cassette system enables the port operator to use fewer products such as translifters and tractors, it leads to lower fuel consumption.

The third sheet includes productivity of the port. It calculates the total time for one movement where the total TEU and one containers movement is calculated together. The required productivity changes from one port to another, and from landside to vessel side,

but the average productivity requirement is around 100 containers per hour on both sides. Landside tends to have slightly higher than sea side. Productivity for the port operators is in this case calculated as the time it will take for them to unload and load one ship. This is a crucial factor that many ship owners want to know, since time in port is expensive and revenues is not generated when standing still.

The fourth sheet is calculating the cost per move. Here the manning costs are of high value as well as fuel costs. The time spent on a move has also a high value, since only one move is possible at time. One tractor can only pull one or two trailers or cassettes at time, which means that the efficiency needs to be high to be able to do as much movements in a short time as possible. The differences in cost per call comes from the fact that the roll trailer system needs more drivers in order to match the call times that the cassette system has. This means higher manning costs for the system per movement.

The fifth sheet includes calculations regarding needs. It will calculate the number of either translifters or goosenecks that are needed in order to fulfill the required productivity for each product. The required productivity can be changed according to meet each company's own requirements. For this part Pirhonen (2013) will be used to help make the calculations. When the required number of products is known, it will change into cost calculation and show how much it would cost to purchase the correct number of products.

The final sheet of the excel model is graphs and calculations from the study. Here the answers regarding which product is more efficient for the port will be shown. The break-even points will be visible for both of the products in order to show which product has a lower break-even point. Net present values will also be visible on the last sheet.

All the calculations are based on numbers that are gotten from the respondents, the employer of the study and online sources. The company selling the products has the knowledge of their own products and how long certain tasks take to do with their products. They also know the speed limits that are set, which will help calculating the duration of different tasks. Average salaries are used in the calculations from different countries. They will not be bound to any certain country, but it will show the approximation for how a certain salary affects the costs and the revenues. In order to do the calculations port fees are necessary. These are often classified contracts which companies do not share, therefore approximations will be used in this study.

In the excel model different values are used in order to make the correct calculations. For example in order for the roll trailer to be as efficient as the cassette system more manning is needed. This is due to differences in tasks times. Additional times for the roll trailer that the cassette system does not have are the times for lashing. The speed for both of the trailers are the same. That will in other means create no differences. The differences will come from a mixture of driving and loading times, since there are differences and the manning efficiency. The roll trailer would need more manning in order to keep the same efficiency as the cassette system.

Port performance is depending on various tasks that are done in the port in order to fill a vessel. The ratio between loaded and unloaded containers is affecting the performance in ports. Empty containers are not always counted into the data. The task that many port wants to reduce are the number of unproductive moves of containers. These will only take time and will not help with the actual process. Sometimes there might be other containers blocking the movement of one container and therefore it must be moved. However, this should be avoided as much as possible. The number of the gantry cranes will affect the productivity that ports have. In order to keep the gantry cranes moving all the time enough roll trailers or cassettes plus translifters are needed. Size and weight of the containers are also calculated into the port performance. Sizes of the containers are many and the knowledge of how many in a certain size can help develop the productivity (Forgeaud, 2000). The ship traffic will also affect the performance (Chen, Zhang, Ma, Wang, Li, Wu, & Pan, G, 2016). This number can also be measured in order to see the ports competitiveness against other ports in an area.

The fact that there are differences in the RTG and RMG ports productivity needs to be taken into consideration when making decisions regarding the products that are used. They have different loads per hour that are possible to do, which results in different equipment requirements such as roll trailers or cassettes. Pirhonen (2013) has made a study for the company that the thesis is written for where he compared the cassette system against shuttle carriers and trailers. This will be used as help when conducting the calculations. Pirhonen (2013) calculated both requirements of the products and costs. The cost comparison came from the required numbers of products when prices for the products are known. In this study only cassette and roll trailer will be compared and other products are left out of the calculations.

7.4 Calculations

With the help of the excel model calculations are done and in this part the results will be presented. The main calculations that matter for ports is the cost and productivity. These two are the same things, since high productivity means more traffic in the port, and that again means that more work has to be done which costs money. However, since the profit per call usually is positive, it does also mean more profit for the company.

If a port would be using the same amount of equipment, either cassettes and translifters or trailers to move the containers from one place to another there are some differences in productivity. The translifter takes less time to move, since there are fewer tasks that are involved in the process. The calculations made will be different to be able to see the differences.

To have the calculations correct a scenario where no previous fleet is existing is used. This makes the calculations easier, since each port has their own existing fleet and using an existing fleet would not be enough for the possible customer, since the calculations would most likely not match their numbers of products. To make the differences clearer double stacking is not an option on either of the systems. The cassette system would in some cases use double stacking that would enable even fewer products to be bought.

In the profitability calculations NPV and NPV rule are used. NPV stands for net present value and it means the difference of present value of cash inflows and outflows over a time. If the income for a project is greater than the costs over a certain time it will have a positive NPV. The NPV rule means that a project with a positive NPV is profitable and a negative NPV is not profitable. Thus, the only projects that should be invested in are the ones that have a positive NPV. Because two products are being compared they might both have a positive NPV the one with the bigger NPV should be considered.

7.4.1 Scenario one

Scenario one is a scenario where costs are calculated based on an expensive country's costs and salaries. The average salary in this case will be 50 dollars per hour. The number of employees in the team is 20. In this model the number of employees mean the number of stevedores. The rest of the employees' salaries and costs are calculated as extra costs of the port. This is a sum that is difficult to estimate without any background data. However for the sake of the study an estimation will be done. The estimated costs of the port upon the stevedore's costs are, five million dollars annually. These costs are including all the costs that are allocated under this system. Other costs that the port has but are allocated under other processes, are not included into these calculations. Fuel cost are kept at the price of 0.9 \$/liter, which is the tax-free price of fuel in Finland (Hankkija 2018). The maintenance costs for the products are also impossible to predict, since accidents that require extra maintenance can occur. However, an approximation will be used related to the running hours of using the products. The reason that the cassette has much lower costs is that metal is cheaper to use than the maintenance of the transliifter. The transliifter is expected to use one set of tires a year, which will be the main maintenance that is made.

For each call several cassettes or trailers must be moved. In this scenario the number of cassettes or trailers that must be moved is 100. The time during which all containers must be moved in is five hours. That means that the required hourly productivity is 20 moves for each of the products. The total time for the turnaround is in this case 3.8 hours with the cassette, and 3.3 hours for the trailers. The required number of equipment is calculated, which will help make the calculation for the turnaround time. This result is then used in the total time calculation. In this case, the required number of products is four for the cassette system, and five for the trailer system.

Total costs for the call will hereby be 16 534 dollars for the cassette. If the sales price for the call is 30 000 dollars it will leave a profit of 13 457 dollars. Here the extra that a port is having as well as the costs for the call, are costs taken into consideration. For the trailer system the total cost will be 17 074 dollars leaving a profit of 12 926 dollars. The break-even for the cassette system will in this case be five calls a week while the trailer system has a break-even of six. According to net present value (NPV) the cassette will have a

positive value of investment and the NPV-rule is profitable. The trailer system has a value of investment that is positive, thus making the NPV-rule also profitable.

The trailer system is not as profitable as the cassette system because of the excessive cost of investment for the product. If the port does not have any inventory of the trailer it must invest in 200 new ones. This is because the port needs to have enough for filling up one ship and have one set free for the next shipment. These will be loaded with cassettes when the vessel has left the port and while waiting for the next port call. The investment of 200 trailers is much higher than the investment of 200 cassettes. The price of one trailer is over twice as high as the price for the cassette. Even though the price of a transliifter is higher then for the gooseneck the total price will be lower for the cassette system than the trailer systems.

In this scenario the cassette system is a much better solution, since the NPV is much higher and the number of calls required is lower than for the break-even of the investment.

7.4.2 Scenario two

In scenario two, the costs will be calculated as a middle-priced country. The average salary for the stevedores will be calculated as 30 dollars per hour. The number of stevedores will be held the same as in the previous scenario, at 20. The load and the distance the cassettes are driven are the same. This is because the differences are more visible between different price classes when these are the same and only the costs are different. The sales price will be lower than in scenario one. The sales price will be at 20 000 dollars per movement. The fuel price will be held at the same 0.9 \$/l (Hankkija, 2018), but other costs that are calculated into the costs will be at 3 million dollars annually. The reason that these are lower is that the average salary in the country is lower and other costs will therefore be lower. This is the same as in the previous scenario, only the costs that are allocated into this system will be calculated. Other costs that are allocated into other parts of the business are not included.

The average maintenance costs will be the same as in the first scenario. This is because the spare parts are the same price, since they are sold from the same country regardless of which country the buyer is in. Total times for the process will be unchanged. The

tractors can drive at the same speed as in the first case. Speed with load is 10km/h and without load the speed is 35km/h.

Operational costs will be reduced dramatically, since the stevedore's salaries and other costs are reduced. Double stacking is not possible in this case either to make it possible to compare it better to the other cases. The costs have been reduced excessively, however, since the selling price has been lowered also the profits per move are still at the same level as in the previous example. The total cost per call for the cassette system is approximately 10 155 dollars and for the trailer system 10 600 dollars. This leaves a profit approximately of 9 845 dollars for the cassette system and 9 400 dollars for the trailer system.

The number of required trailers has not changed, since the input data of cargo load and time restraints are the same. This means that four translifters and tractors are needed, as well as seven goosenecks and tractors.

The break-even point for both systems in this scenario is five. That means that there are no differences in the number of calls in which one system is more efficient than the other. However, the break-even amount of dollars per week differs. The break-even for the cassette system has a lower amount of income that is required.

Both decisions would be profitable in this scenario. However, the cassette system has a higher NPV along with the lower break-even which makes it more profitable. The cassette system does also have a lower cost which makes it a more profitable solution in this scenario as well.

7.4.3 Scenario three

In scenario three, the stevedore's average salary is at 10 dollars per hour. The distance and number of movements has not changed. The sales price is lowered to 10 000 dollars per call. Other costs that are allocated to the products are lowered to one million dollars. The maintenance costs are kept at the same level, since the spare parts are sold from Finland to all the countries. As previously mentioned, the service cost is counted as an hourly fee. The cost is known by the company that is selling the products, since they have data over the usage and how much cost the maintenance is on average.

In this scenario when the price of the stevedore's salaries and other port fees are changed but the other costs are kept at same level such as maintenance and fuel the differences in profitability will be clearly visible. In the third and final scenario the cassette system will be more profitable. This is because the yearly fixed costs such as maintenance and salaries are high. The maintenance will require much more money for the trailer solution than for the cassette solution. The cost of buying the products is also higher for the trailer system, based on the calculations.

Total cost of the call for the cassette system is in this scenario 3768 dollars. The sales price was at 10 000 dollars and will therefore leave a profit of 6232 dollars. For the trailer system the cost of the call is 4127 dollars leaving a profit of 5873 dollars.

The break-even point for the cassette system is in this scenario four calls, while the trailer system has a break-even of five calls. This does also result in a higher NPV for the cassette system compared to the trailer system.

7.5 Summary of the calculations

The cassette system was in all the cases the superior solution. This is affected by the high costs that the maintenance requires for the trailer system along with the high acquisition cost. All costs can of course not be foreseen, since accidents may occur leading to higher costs that will change the outcome of the calculations. The number of total calls per year to have the correct cost per move is counted as 365, meaning one call per day. This is because a number that is higher than the break-even was used. This would keep the extra cost of the port in a good range which will be as close to the real number, since ports want to go over the break-even to make profit.

Many of the costs are the same regardless of the solution that is chosen. These are for example the cost of salaries and extra costs that are calculated for the systems. The extra costs are not the same in each port, since it depends on which costs are allocated into the systems. If the port has other business too, it might lower them and if the Ro/Ro operations is the only business, all the costs must be covered by it. The times for the calls are lower in both scenarios one and three, since they are using one more trailer, compared to the translifter case.

Type of country	Average salary	Cost of call		Profit	
		Cassette	Trailer	Cassette	Trailer
Rich	50	16 534	17 074	13 457	12 926
Average	30	10 155	10 600	9 845	9 400
Poor	10	3768	4127	6232	5873

Table 3: The cost and profit of the different solutions

In table 3 the different costs and profits are visible. As the table shows the costs are lower in all the scenarios for the cassette system. This due to the previously mentioned manning costs that are lower for the cassette system than the trailer system.

8 Final discussion

This thesis has discussed two diverse products that port operators can use in their day-to-day business. There are multiple more products that have the same purpose. However, in Ro/Ro terminals these are the more common products, while others are used in container terminals. In the thesis, the acquisition of either of the two products was compared and the conclusion of the calculations and the interviews will be presented in this chapter, as well as future studies regarding the topic.

8.1 Conclusion

The study was made in collaboration with a Finnish-based company that is selling the cassette system and trailer systems to ports around the globe. The products have been presented previously in the study as well as the different areas where they can be used.

The dynamic competition depicted by game theory is a crucial factor in today's port business regardless of people thinking of it daily, or even recognizing it as such. It steers the competing or collaborating companies in both their short- and long-term decisions. If one party makes a crucial decision to change their way of operating the port, it can affect more players taking part in the business. It can change the way or route that cargo must be shipped from one place to another. This will change prices that occur for shipments which again affects the profits of companies. Thus, the decision-making in port operations affects businesses globally.

The interviews were conducted by interviewing some companies using either of the products or both. In general, the respondents were happier with the cassette system. The cassette system has helped them make their operations more efficient and therefore save money. However, automation was also mentioned as an important factor. Some respondents think that ports might be more automated soon, which will affect the way the products are used. Today, there are automated cranes, but in the future the trailers or cassette systems might also be automated. Autonomous trailers and cassette systems would save manning costs, which are reported to be the biggest costs. The investment cost for a trailer or transliifter is insignificant compared to the manning costs.

All the scenarios that were envisioned showed that the cassette system is more cost efficient. Double stacking was not taken into consideration and it could change the result even more. The fact that the trailer system is an old system, makes it more inefficient. This study shows that ports should in all cases consider that cassette system. However, game theory presents that companies want to differentiate themselves from their competitor. Since the trailer system was economically profitable in all the cases, it is not a bad solution to use if it is required by the shipping lines. There are more aspects to take into consideration than just the theoretical profit that is received according to these calculations.

The hypothesis was not fulfilled, since it varied from one scenario to the other. The number of movements that were needed in each scenario was higher than the hypothesis that was made. The actual number of moves per week that was needed was around 500.

8.2 Future studies regarding Ro/Ro ports and the products

For the future research, this topic will be a good starting point. A study of the two products in actual use would be beneficial both for the ports and the companies selling the products. This would enable the gathering of more data of all the costs and incomes from the products after they have been in use for a while. This will ensure that all the calculations are more precise instead of using approximations of diverse costs and incomes. Since this study was made from an artifact building perspective, a study from the ports' perspective would either complement this study or generate new information. All the costs are impossible to prophesy, but after a few years of use the costs are known which will help analyze the two products from an economic perspective.

Swedish Summary

En jämförelse av hamntransportprodukter och orsaker som påverkar uppköpet av dem

1. Introduktion

Denna avhandling är skriven i samarbete med ett finskt företag som tillverkar och säljer produkter för hamnverksamhet. Företaget blev för cirka ett och ett halvt år sedan uppköpta av sin konkurrent som sålde en konkurrerande produkt. Detta har lett till att företaget har flera produkter i sitt urval som kan användas i olika typer av hamnar. Företaget ville att jag skulle jämföra rolltrailers och kassettsystemet i så kallade roll-on-roll-off hamnar.

En stor del av dagens varutransport länder emellan sker till sjöss. Detta är det säkraste sättet att transportera varor eftersom vädret påverkar flyg till en stor grad. Dessutom har flyg inte samma kapacitet att ta ombord varor. Då man började transportera varor till sjöss länder emellan så lastades allting löst på däck, vilket resulterade i att lastningarna vid hamnarna tog lång tid. Hamnarna ville försnabba denna process så de skapade en produkt som kallas rolltrailer. Med hjälp av denna transporterades varorna ombord på båten där varorna sedan lastades av från trailern. I nästa hamn gjordes processen omvänt. Även detta var tidskrävande så transportföretagen började ta ombord trailrar. Även detta visade sig vara en dålig lösning eftersom varorna då låg löst på trailern. Detta resulterade i att containrar började tillverkas. Containrar kunde lastas fulla med varor som sedan lyftes upp på en trailer med hjälp av en lyftkran. Detta möjliggjorde att mera varor kunde börja transporteras på en trailer. Under ett tiotal år användes endast rolltrailers. Rolltrailers började användas på 1960-talet och först i slutet av 1980-talet började planeringen av en ny konkurrerande produkt. Denna produkt är den andra produkten som undersöks, i denna avhandling och den kallas för kassettsystemet. Kassettsystemet fungerar genom att en translifter hela tiden är fastspänd i en hamntraktor. Transliftern körs under en kassett och med hjälp av hydraulik lyfts transliftern vilket även lyfter kassetten (Anonym 1 personlig intervju, 5.4.2018).

Vid hamnar räknas hamnverksamhetens storlek med hjälp av TEU, en förkortning av engelskans *twenty foot equivalent unit*. En TEU är alltså en container som är 20 fot lång.

Nuförtiden finns det flera olika storlekar av containrar och de minsta är 20 fot och de längsta är över 50 fot. Storleken på containrarna kommer inte att tas i beaktande i avhandlingen eftersom alla kalkyler kommer att basera sig på hur många rolltrailers eller kassetter som ska lastas in eller ut ur båten istället för TEU.

En hamns största kostnader är manskapskostnader. Syftet med denna avhandling var att vid sidan om själva avhandlingen utveckla en produktivitetskalkyl för att kunna beräkna de olika kostnader en hamn har. Övriga kostnader som en hamn har är underhållskostnader samt kostnader för olyckor. Underhåll och olyckskostnader går inte att förutspå i samma grad som manskapskostnader men togs i beaktande eftersom de påverkar de kostnader som hamnen har. Att kunna minska på manskap minskar även risken för olyckskostnader tack vare att färre människor rör sig i farozoner i hamnen.

Många hamnar använder än idag rolltrailers även om kassettsystemet kunde vara ett lönsammare alternativ att använda. Denna avhandling undersöker när det är lönsammare att använda sig av rolltrailers och när det är lönsammare att använda sig av kassettsystemet.

2. De två produkterna och deras användningsområden

Som tidigare nämnt fokuserar denna avhandling endast på de två produkter, rolltrailers och kassettsystemet, som finns i samarbetsföretagets produktsortiment. Det finns dock flera produkter som konkurrerar med dessa två produkter på en del av deras användningsområden men de beaktas inte i denna avhandling. Härnäst presenteras de två produkterna samt deras användningsområden noggrannare.

Kassettsystemet är, som tidigare nämnts, det nyare systemet av företagets två produkter. Det har även mera högteknologiska egenskaper än vad rolltrailern har. Kassettsystemet fungerar genom att en translifter lyfter upp kassetten från marken, vilket möjliggör flyttande av kassetten. Transliftern, som har sensorer, assisterar chauffören med att köra transliftern under kassetten så att skador kan undvikas på transliftern och kassetten. Sensorerna försnabbar även processen. Hjulen på transliftern kan vända på sig vilket gör att chauffören endast behöver komma under kassetten från ena ändan och därefter backa långsamt och därefter sköts resten av processen automatiserat. En translifter kan lyfta

olika mängd vikt beroende på hur många axlar den har. Vid hamnar används oftast en translifter vars lyftkapacitet är 90 ton. En negativ sida med kassettsystemet är att den kräver mera rum för att kunna användas. Detta kan vara problematiskt ombord på fartyg då den kan skapa trånga situationer eftersom kassettsystemet kräver 19 meter utrymme för att kunna lämna av en kasset. Därtill behövs två transliftrar ifall en translifter skulle gå sönder, vilket betyder att anskaffningskostnaden är stor.

Rolltrailern är inte lika utvecklad som kassettsystemet och den består av endast en platta som har hjul under sig. Det finns alltså inte så mycket som kan gå sönder på en rolltrailer och därför är den ett säkrare alternativ än kassettsystemet men produktiviteten är dock inte lika hög. När en rolltrailer körs ombord på ett fartyg måste den bindas fast i fartyget eftersom hjulen kan börja röra på sig ifall det är sjögång. Rolltrailern körs lika som transliftern, med en hamntraktor, men istället för en translifter används en gooseneck. En gooseneck är tillverkad av endast metall vilket gör att priset på den är låg.

Vid beräkning av anskaffningskostnader jämförs transliftern med goosenecken och kassetten med rolltrailern. Goosenecken har en mycket liten anskaffningskostnad jämfört med transliftern, men rolltrailern är lite dyrare än kassetten. Detta gör beräkningen viktig eftersom de totala kostnaderna avgör vilken produkt som är det bättre alternativet.

Användningsområdena för dessa produkter är, som tidigare nämnts olika hamnar. Kassettsystemet lämpar sig dock även ypperligt för industriområden, i första hand pappers- och metallindustrin där tunga rullar av papper och metall ska flyttas. Till dessa användningsområden har skapats speciella kassetter som lämpar sig för sådan verksamhet samt minskar på faror som kan uppstå. Denna avhandling har dock att avgränsas endast till hamnar eftersom det skulle bli för brett att ta med alla användningsområden, och beräkningarna görs olika.

3. Metod

Kvantitativa metod baserar sig på stora mängder av data medan kvalitativa metoder försöker undersöka beteende, erfarenheter och känslor hos de olika svarspersoner (Parasuraman, 1991; Malhotra & Birks, 2006). Kvalitativa metoder valdes som metod för denna avhandling. Detta eftersom kunder som redan använder sig av de två produkterna

fanns tillgängliga och skribenten hade möjlighet att fråga deras åsikter om produkterna med hjälp av intervjuer. En annan metod som användes var artefaktskapande metod. I samband med denna avhandling skapades en Excelmodell, en produktivitetskalkyl, som hjälpt skribenten med kalkyler i syfte att beräkna lönsamhet och produktivitet för de två produkterna. Järvinen (2004) beskriver fyra viktiga saker som man ska komma ihåg då man gör ett informationssystem. Dessa är: *always analysis; dynamic requirements negotiations; incomplete, usefully ambiguous specifications* och *continuous redevelopment*.

För att genomföra studien intervjuades tre företag som använder sig av någondera av de två produkterna. Dessa svar, tillsammans med kalkylerna, kom att ge resultaten.

4. Den empiriska forskningen

Kalkylmodellen gjordes till en del i samarbete med företaget som beställt avhandlingen. Företaget gick igenom kalkylmodellen och påpekade beräkningar som ska göras på ett annat sätt och berättade vad de önskade av modellen. Denna modell kan sedan visas för framtida kunder och därmed får kunden veta vilken av produkterna som är lönsammare att använda. Beslutsprocesserna inom företag är långa och enligt Anonym 1 (personlig intervju, 5.4.2018) är branschen konservativ och inte öppen för nya alternativ. De tre stegen som Navickas och Sujeta (2012) har lagt fram vid beslutsfattande är att ledningen går igenom olika alternativ, sedan testas de i praktiken, och till sist fattas beslutet. Innan dessa steg kan genomföras måste dock försäljaren vara känd för kunden så att de kan vara ett möjligt alternativ.

Kalkylmodellen användes för att räkna ut lönsamheten för tre olika kundgrupper. Den första gruppen är rika länder, där kostnaderna är höga. Löner och diverse bikostnader i sådana länder antas vara höga. Den andra gruppen är medeldyra länder där kostnaderna är mindre än i första gruppen, men större än i den tredje gruppen, som är fattiga länder. Kostnaderna för olika länder hittades online och intervjuobjekten hade även sina åsikter om olika kostnader.

Den första kalkylen gjordes, som tidigare nämnt, för ett land där kostnaderna är höga. Här valdes en kostnad för hamnarbetarna till 50 \$ per timme. Utöver kostnader som uppstår

vid lastningsprocessen beräknades även andra fasta kostnader som uppstår i hamnar och som hamnarna vill beräkna under dessa system. Kostnader som kanske finns men täcks på andra vis tas inte i beaktande. Här visade sig kassettsystemet vara det bättre alternativet. Anskaffningskostnaderna som krävdes för trailer systemet var för höga vilket minskade vinsten. I den andra kalkylen användes en kostnad på 30 \$ per timme för arbetarna. Sidokostnaderna minskade även lite eftersom de olika kostnaderna i hamnen förväntas minska då landet har lägre prisnivå. Här visade sig även att kassettsystemet vara bättre än trailersystemet. Skillnaden i lönsamheten var dock mindre än i den första kalkylen. I den sista kalkylen minskades igen alla kostnader och arbetarnas kostnader minskades till 10 \$ per timme. Här visade sig igen skillnaden vara större än i den andra kalkylen till kassettsystemets fördel.

5. Sammanfattning

Denna avhandling gjordes i samarbete med ett finskt företag som säljer de två produkterna, rolltrailers och kassettsystem, som presenterats i avhandlingen. För att genomföra studien gjordes intervjuer med tre kunder som använder sig av åtminstone den ena av produkterna. Utöver intervjuerna skapades en kalkylmodell som möjliggjorde beräkningar för att se vilken av produkterna som är lönsammare i olika situationer. Kassettsystemet visade sig vara mer lönsamt i alla situationer även om det fanns skillnader i de tre kalkylerna som gjordes. Orsaken till att kassettsystemet är lönsammare är att det har lägre anskaffningskostnad även om en translifter är dyrare att anskaffa än en gooseneck. Rolltrailern är dyrare än kassetten och eftersom de ska skaffas i så pass stora mängder utgör de största delen av priset. I kalkylerna beaktades inte produkter som redan existerar i hamnarna. De redan existerade produkterna kommer att påverka resultatet när försäljaren gör nya kalkyler åt möjliga kunder.

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Attachments

Attachment 1: Research questionnaire

1. Which of the logistics systems are you using? Roll trailers or cassette system, or both?
2. If you are using the cassette system, why did you choose to consider the products that NT Liftec Oy is providing?
3. Why use both cassette system and roll trailers, if so?
4. Have you felt that using the cassettes instead of roll trailers, or other systems, has affected your work in the ports? How?
5. Has the change to this product affected your business in a positive or negative way?
6. Have you been satisfied with the products you are using?
7. Has it saved you money? Where has the biggest savings been seen?
8. Did you calculate the running costs for each product? Manning requirements, maintenance and other costs that might arise from the system? How did it affect your decision in acquiring the system?
9. How was the transition from your previous ways of working? Did any big challenges come up, or was it a smooth implementation of this new product?
10. What do you think is an essential thing to think of when considering buying either the roll trailer or cassette system?
11. How much weight do you put on environmental, and safety reason when considering the products instead of just the cost?
12. Other facts that you think of regarding these products?
13. How big is your business, in average monthly TEU?