CHALMERS

Evaluation of improvement areas in Freight Rail Transportation

- Case of Green Cargo

Master of Science Thesis

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Division of Logistics and Transportation
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2013
Master's Thesis E2013:019

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Cover:
Two Green Cargo engines. (Source: Green Cargo)

Name of the printers / Department of Technology Management and Economics
Gothenburg, Sweden 2013

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ABSTRACT

Rail freight transport represents a very important and environmental friendly way of shipping cargo. Nevertheless, several reasons make this mode of transport not to be efficient as it could be. The two main causes leading to this are the priority of passenger rail transport over freight rail transport and the fact that many railroads are close to reaching its maximum capacity limitations. Consequently, freight rail transport companies should try to find ways to improve and optimize their activities and processes.

This thesis was conducted as a case study at the railroad company Green Cargo, which is devoted to freight transport in Scandinavian countries. Apart from the information provided by Green Cargo, Trafikverket was also interviewed to bring the perspective of the whole rail industry.

This master thesis analyzes the improvement possibilities of those areas identified by Green Cargo as the most important ones to work with. The analyzed improvement areas focus in optimizing both capacity and staff requirements at Green Cargo. The Capacity utilization improvement areas comprises aspects such as the optimization of the maximum capacity of each train and the establishment of an even cargo flow with little variation both during the different hours of a day as well as during the days of the week. The possibility of optimizing staff requirements is investigated by analyzing the concepts such as “single-shunting” and “centralization of staff”. Those two concepts have been developed by Green Cargo.

The conclusion of this master thesis is that Green Cargo operations could be significantly optimized if the following suggestions were taken into consideration. When possible, the analyzed company should avoid driving in those railroads mainly occupied by passenger trains to avoid problems linked to the higher priority of passenger transport. Green Cargo should also establish a priority system intended to determine which customers are more profitable to work with, idea related with a Green Cargo own concept called “anchor blocks”. In addition, the further implementation of “single shunting” and “centralization of staff” would significantly benefit this company. In addition, Green Cargo should put efforts in solving some important communication problems among the different departments.

Keywords: Freight, cargo, rail capacity, rail transport, single-shunting, rail staff centralization, customer priority

Acknowledgements

This Master of Science in Engineering thesis was conducted as a case study at Green Cargo. The thesis was carried out during the spring semester of 2013 at the Logistics and Transport department at Chalmers University of Technology.

We would like to offer our gratitude to our supervisor at Chalmers, Violeta Roso whose support, help and encouragement has been very valuable throughout the work. We would also like to give gratitude to our supervisors at the Green Cargo office in Solna, Anders Lester and Marcin Tubylewicz for their guidance and support.

Furthermore we would like to thank Mats Tapper and Per Svensson at the Green Cargo's Gothenburg office for their assistance, support and helpfulness.

We would also like to thank everyone who has taken time for interviews to help us collect data during the thesis. Without all of them, this thesis would have been impossible to conduct.

Finally, we would like to thank our families and friends for their help and support during these years of study.

Gothenburg, May 2013

María de Nuria Calvo Mateo and Sofie Hagman.

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1 Introduction

This chapter starts by offering a general overview of the rail freight transportation industry and, later on, introduces the purpose and limitations of this master thesis. In addition, a description of the outline of this thesis is included.

1.1 Background

Freight transport represents an important sector in the global economy due to the existent close links between this and the industrial area. All sort of industrial companies need to receive their required rough materials in order to manufacture or produce those items which later will be transported to the final customers on the agreed times.

Statistics regarding European freight transport point out that road and rail transportation represent respectively the first and the second more important inland transport modes. Last decade trend indicates that rail transport market share has continuously decreased in contradiction to road transport, mode which has experienced a high growth. This trend can be explained by the flexibility offered by road transport mode, which allows freight shipping to any location presenting a road. On contrary, rail transport does not offer such a great variety or destinations, but it is considered to be a more sustainable transport mode due to its lower emission rates. (European Union, 2012)

European Union transport policies point out the need of optimizing current transport processes as well as turning transport into a more sustainable sector under economic, social and environmental points of view. (Commission of the European Communities, 2001) In order to achieve those objectives, an important approach would be the revitalization and optimization of freight rail transport sector.

The main existing problems regarding rail transport mode are shared all over the European countries, so that the following issues, representing the most important drawbacks in Sweden rail mode can be extrapolated to the rest of nations.

At present, Sweden railroad capacity is considered to be highly strained and utilized, aspect that many times ends up in a reduced quality of the offered train transport services. Some parts of the Swedish railroad system, such as Malmö, Göteborg or Stockholm, present capacity utilization rates close to 100% (Trafikverket, 2012b). Other aspect to consider is the high volume of rail companies interested in making use of those railroads. Only during 2010 a total of 47 Swedish rail road companies, both in the passenger and freight transport sectors, applied to the Swedish authority in charge of allocating railroad capacity, Trafikverket, for track capacity (Trafikverket, 2012b). All those aspects linked to the high congestion in Swedish railroads may lead to negative consequences such as train delays and the possible non fulfillment of those delivery times agreed with customers. In addition, Swedish train priority rules points out the priority of passenger transport over freight transport, being the last group forced to face unfavorable working conditions.

The most efficient solution to solve rail transport congestion problems would lie on the enlargement of the railroad system, especially in those areas presenting the high utilization rates. Nevertheless, considering that the enlargement of the railroad system is a long time horizon process that must be planned with more than 10 years in advance[10], the short time optimization of rail industry lies on a better utilization of the available track capacity (Trafikverket, 2012b). At Swedish level, both Trafikverket and rail companies are those implied factors in assuring the achievement of this objective.

The future horizon for rail freight transport companies in Sweden is expected to worsen within the next years due to the increase of the number of passenger companies in the rail market. All those new passengers transport activities will be prioritized over freight transport, what make even more necessary for freight transport companies to increase and optimize their internal processes and exploit as much as possible their available time slots. The optimization of the freight rail companies processes will also allow to offer more efficient and attractive services to industrial customer and hence, increase the possibilities of revitalizing this sector.

Considering the importance of optimizing rail freight transport activities and make it a more competitive transport mode for industry, this thesis analyzes how efficiency levels in freight rail transport companies can be improved. Particularly, the thesis is focused in analyzing how Green Cargo AB, a rail freight company owned by the Swedish government, could optimize its activities and processes in an internal way.

1.2 Purpose and problem analysis

The purpose of the thesis is to evaluate potentials to increase efficiency in freight rail transport. The objective of this master thesis is analyzing the feasibility and associated improvements related those areas considered to have the most potential to increase the internal efficiency levels of Green Cargo, a Swedish freight rail transportation firm.

The four improvement areas that will be presented can be divided into two different groups: the first one is related with the optimization of Green Cargo current capacity whereas the second one is focused in how to optimize the staff volume needed by the firm.

The first improvement area, focused in **capacity optimization**, analyzes three different main problems.

- Optimization of train capacity. The company wants to obtain full utilization of the forecasted and applied capacity, while considering the legal limitations. This category presents how the capacity level could be optimized in order to reach full capacity concerning the weight and length in trains.

- Peak reduction of the train traffic: at present most cargo trains are driven in nightly timetables, what is associated to increased expenses if compared with daily transport. This category analyzes the feasibility of reducing the current

[10] Håkan Lind, Short-time Planner, Green Cargo, Interview, 2013-02-19

nightly peak taking into consideration the most important constraints affecting this category.

- Uneven flow of cargo trains: This category presents the problems linked to the current uneven distribution of daily traffic during the different days of the week, and analyzes how this problem could be reduced.

The second improvement area is focused on **optimizing the staff requirements**, both for drivers and shunters. In this category it is analyzed how to achieve a more efficient and centralized transport network with a reduced number of important stations (later presented as main sites) and a higher number of lower importance locations linked to them. It is also investigated the possibility of removing completely the stationed staff in smaller locations and the consequences of this concept.

In addition, some other detected improvement areas not previously detected by Green Cargo will be presented and analyzed. Finally, a discussion presenting the feasibility and problems linked to the suggested improvements for each of the improvement areas.

1.3 Scope and limitations

This thesis is mainly focused in deeply analyze those improvement categories presented by Green Cargo as the most important aspects to consider: optimization of train capacity, peak reduction of the nightly traffic, uneven flow of cargo trains and optimization of staff volume. Other improvement areas not pointed out by Green Cargo have been identified and are briefly presented at the end of the thesis. Nevertheless, any deep analysis regarding them is not included.

Most of the data used to perform the analysis come from interviews with Green Cargo employees and Green Cargo internal documents, what points the possibility of those information may be biased and contain some subjective impressions differing from what reality shows. One of the thesis authors had previously worked as a Green Cargo employee, whereas the other thesis author had no relation with the analyzed firm. The combined background of the authors has made possible to assure the accuracy and veracity of the information presented in this thesis.

As Green Cargo, the freight company object of study, mainly operates in Sweden, the geographical limitation for this thesis is restricted to the mentioned country. In addition, instead of analyzing the improvement areas purposed by Green Cargo in specific regions, these improvement areas have been analyzed at a national and aggregated level following the directions of the company.

Although in an initial state this thesis was expected to carry out a quantitative analysis of the main improvement categories, due to confidentiality and sensitive data aspects and limitations, finally this analysis has been done under a qualitative view.

This thesis does not analyze any financial aspects, such as which of the considered improvement categories would bring Green Cargo the highest economic savings or would require the highest investments. Instead, it is presented a discussion of the

feasibility of each improvement alternative as well as the planning horizons needed to implement those improvements. Later on Green Cargo, considering the analysis included in this thesis as well as its confidential data will determine which of the presented improvement areas is more profitable and priority for them to implement.

The environmental aspects are only lightly considered, but no actual calculations of environmental benefits linked to the analyzed improvements are included in this thesis.

1.4 Outline

This Master Thesis is divided in four main parts: frame of reference, method, analysis of the possible improvements and discussion.

Firstly, the frame of reference presents a description regarding the current situation in the freight rail industry all over Europe and introduces the most important problems faced by this industry.

The method chapter focuses on explaining how data were taken and analyzed as well as describes the process followed to elaborate this Master Thesis.

The analysis block represents the most important section in this thesis, and it is divided in three groups: how to optimize capacity, how to optimize staff requirements, and other improvement areas.

- Analyses of how to optimize capacity and staff requirements study those improvement areas identified as Green Cargo as the most important ones to consider. These two chapters firstly introduce general concepts regarding capacity and staff, respectively. Later on, it is presented a detailed analysis related to the improvement possibilities identified in those groups.

- The third group: other improvement areas, identifies and discusses other possible areas which could be improved by Green Cargo.

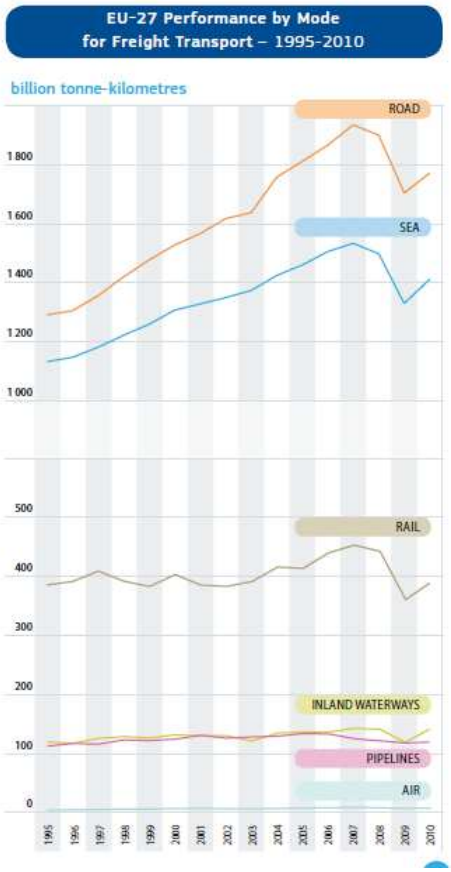
Finally, the discussion part analyzes all the presented results in this thesis and gives some final conclusions.

2 Frame of reference

This chapter provides general information regarding freight rail industry all over Europe, and particularly in Sweden. Some of the presented topics in this section refer to the main problems faced by this transport sector, how freight rail companies manage their activities and possible improvements intended to increase efficiency in rail transportation.

2.1 The development of freight transportation in Europe

An analysis of the historical distribution of the freight transport industry in the last two decades shows the three most important transport modes are road, sea and rail respectively. Figure 1 presents the overall performance by mode for Freight Transport in the EU-27 countries during the period 1995-2010. (European Union, 2011)



EU-27 PERFORMANCE BY MODE

FREIGHT TRANSPORT FOR INLAND MODES

thousand mio tonne-kilometres

	ROAD	RAIL	INLAND WATERWAYS	PIPELINES	TOTAL
1995	1289	386	122	115	1912
1996	1303	392	120	119	1934
1997	1352	410	128	118	2007
1998	1414	393	131	125	2063
1999	1470	384	129	124	2107
2000	1519	404	134	127	2183
2001	1556	386	133	133	2208
2002	1606	384	133	128	2251
2003	1625	392	124	130	2271
2004	1742	417	137	132	2427
2005	1794	413	139	136	2482
2006	1848	435	138	136	2556
2007	1914	448	145	130	2638
2008	1881	440	145	125	2590
2009	1690	361	130	119	2300
2010	1756	390	147	121	2413
1995-2010	36.2%	1.0%	20.8%	4.9%	26.2%
per year	2.1%	0.1%	1.3%	0.3%	1.6%
2000-2010	15.6%	-3.4%	10.1%	-4.8%	10.6%
per year	1.5%	-0.3%	1.0%	-0.5%	1.0%
2009-2010	3.9%	8.0%	13.6%	1.1%	4.9%

Figure 1: The overall performance by mode for freight transport in the EU-27 countries during the period 1995-2010 (European Union, 2012)

As it can be observed in Figure 1, from 1995 to 2009, freight transport sector experienced a continuous expansion process, mainly represented by the increasing importance for road and sea modes, which have taken an important share of the new market opportunities during that period. Within the years 2008-2009, and due to the economical crisis context, freight transport suffered a contraction process of 11,2% on its overall tonne-kilometres figures. After this period, it has been experienced an

increasing trend in the freight transport area, showing signs of recovery. (European Union, 2011)

In opposition to the average increasing tendency in freight transportation sector during the period 1995-2009, represented by a 1,6% yearly average expansion on the tonne-kilometers volume, rail freight sector only experienced an average 0,1% yearly increase regarding the same aspect. (European Union, 2012)

Within the last years, European Union has turned the promotion of freight rail transportation as one of its important priorities regarding transport policies guidelines. Policy documents such as the White Paper "European Policy for 2010: Time to decide", presented in 2001; and its Mid-Term review "Keep Europe moving – Sustainable mobility for our continent", published in 2006, include the main strategic EU plans intended to revitalize the freight railway industry. (Commission of the European Communities, 2001)

The three main key aspects pointed by the European Commission in order to achieve the railway revitalization lies on "integrating rail transport into internal markets", "making optimum use of infrastructures by opening-up the market" and "building a dedicated European rail freight network, as well as promoting the modernization of rail transport services". (Pricewaterhouse Coopers , 2008)

Nevertheless, more than ten years later after the publication of the White Paper, rail freight situation barely stands in the same situation, and those key objectives seem to be far to achieve, although some initiatives such as the creation of the European Rail Traffic Management System, ERTMS. This system is devoted to achieve the interoperability in the trans-European rail network by establishing common signaling standards, and it is being developed and introduced in the different European countries. (Abril et al, 2008)

Despite this fact, reality shows that there are still significant barriers within the European railway system and until those ones are not solved, rail freight area could not become competitive sector for international transports. Some of those main limitations are caused by the different infrastructure regulations in the European countries and the existence of own national freight companies. In order to create an effective European freight transport sector it would be necessary to solve issues such as (Wiegmans & Doners, 2007):

· The different national braking distances.

· The incompatibility on traction forms electrification.

· Different national train length limitations, implying the need of extra shunting operations to adequate trains to the legal requirements.

· Lengthy border checks, requiring in many cases the shifting of drivers in each border control.

2.2 The development of passengers and freight transportation in Sweden

In the 1990s, the rail freight train traffic in Sweden was quite constant and the prospect of developing further was not looking too bright. During the same time period the truck transports where increasing considerably as a result of the increased maximum weight for truckloads, increased maximum length for the trucks as well as the dropped additional taxes for driven kilometer. These new factors resulted in a major cost decrease for truck shipping. (Trafikverket, 2012b)

In 1997, The Swedish governmental department for communicational analysis did a forecast on the passengers and freight transports development until 2010 as a foundation for the future investment for society in rail traffic. The increase in passenger train transport was forecasted to increase steadily and flight and car transports were expected to increase significantly. When it came to the freight transports the conclusion was drawn that the increase in truck shipping would continue to increase significantly, while the rail freight traffic would only increase very slightly. (Trafikverket, 2012a)

In Figure 2 it is included a comparison the development of different freight transport modes between 1997 and 2010. It is clear that the forecasted increase in truck shipping was very inaccurate while the significant increase in rail traffic was not at all predicted. An explanation for the outcome could be the increase of container traffic, the increase of diesel costs and the increase of new operators with new freight transport solutions. (Trafikverket, 2012b)

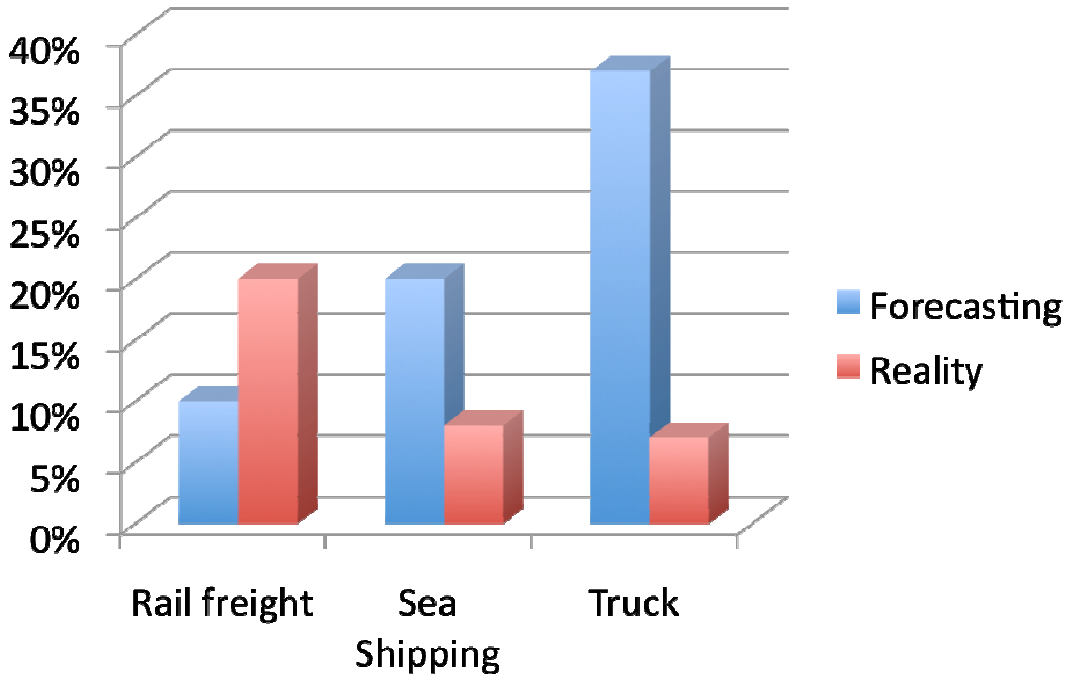


Figure 2: Forecast and real increase freight traffic between 1997 and 2010 measured in tonne-kilometers (Trafikverket, 2012b)

In Figure 3 the forecast for different passenger traffic transportations between 1997 and 2010 is presented. The forecast for passenger trains was set to be 26% but, in reality, it was more than twice a high increase of 58%. An explanation for the outcome could be the very incorrect forecast for flight transport, which even decreased from 1997 to 2010 instead of a major increase as predicted. The prediction of an increase in car traffic was also incorrect. The most major increase in the passenger rail traffic during the period has been in the local train lines reaching the major cities Stockholm, Göteborg and Malmö. (Trafikverket, 2012a)

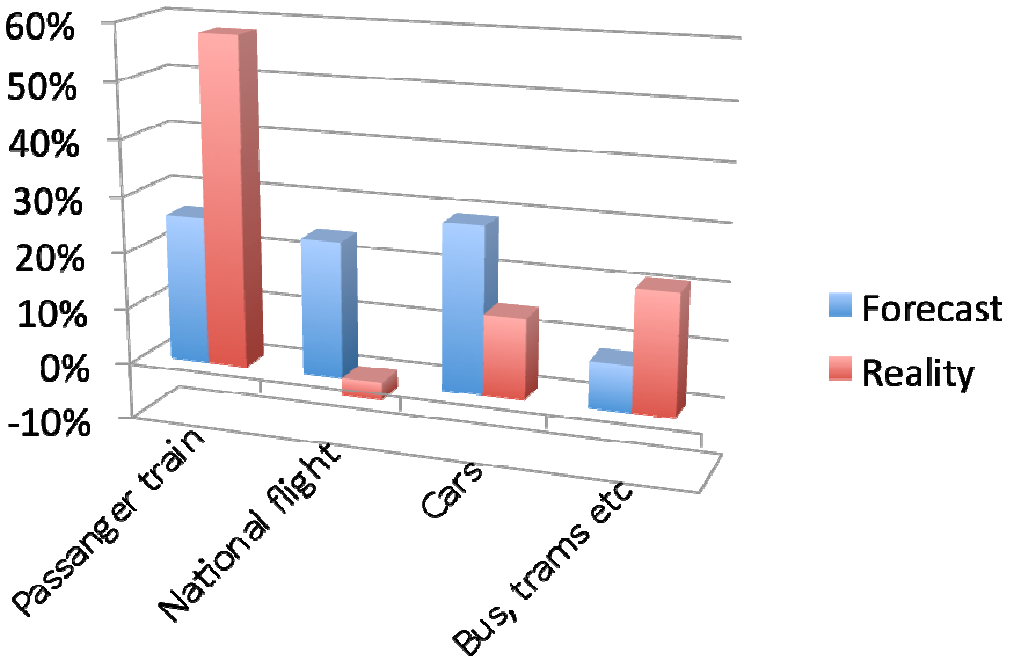


Figure 3: Forecast and real increase of passenger traffic between 1997 and 2010 measured in tonne-kilometers (Trafikverket, 2012a)

2.3 Rail freight transport VS road freight transport

A comparison between rail and road freight transport area, considered as its main competitor, allows point two main advantages linked to the first sector. One advantage is related to the environmental aspect: freight rail is a more sustainable and eco-friendly way of transport if compared to rail transport, mode which creates important air pollution levels as well as represents one of the main sources of carbon dioxide emissions in the planet. The second advantage of freight rail instead of road transport is related to its higher safeness level, presenting a more reduced accidentally rate. (Pricewaterhouse Coopers, 2008)

The environmental benefit of railroad shipping is evident when looking at the statistics over carbine dioxide pollution in Sweden. The electric freight railroad train has 0,11 grams of carbine dioxide emission per net ton-km, while in comparison a cargo truck would emit 57 grams. This results in the fact that the rail engines can drive 300 times as long as the trucks with the same amount of carbine dioxide emission. (Green Cargo, 2012)

With the environmental benefits of rail freight, a lot of companies want to use this more eco-friendly transport method instead of trucks. Unfortunately, the uncertainty about the capacity on the tracks makes it not as reliable as the rail companies wishes it to be. (Abrahamsson, 2010)

2.4 Passenger rail traffic VS Freight rail traffic

This section includes some of the possible mechanisms used to allocate rail capacity and later presents a common situation in the rail industry: the prioritization of passenger rail transport over freight rail transport.

2.4.1 Allocation of capacity in the rail industry

The allocation of the rail capacity among the train companies in all European countries is done by specialized agencies dependant of the national Governments, and three of the most important mechanisms used to determine the final allocation of the railroad capacity are:

Administered mechanisms: in this case, railroad capacity is allocated according to different train priority levels established by the national agencies in charge of doing this task. An administered mechanism can be "Commuter trains are the first to be prioritized". (Gibson, 2003)

Cost based mechanisms: this category tries to achieve an efficient allocation of the railway capacity, which many times results scarce for the interested rail firms, by setting different prices depending on which route and with time traffic band certain firm use. In addition, an extra fee is set for using those paths with high congestion levels. Train firms will apply for certain rail slots after considering their needs and the economic fees that would be faced in each situation. (Gibson, 2003)

Market-based mechanisms: in this type of allocation mechanism train companies apply for their desired time slots to their associated national allocation agency. Once all train companies have applied, the agency chooses that timetable which combines the different firms providing the maximum profit. (Gibson, 2003)

2.4.2 Freight and passenger allocation

In Sweden cargo traffic is dominating the railways if compared to other European countries where the passenger traffic really has thrived. (Vierth et al, 2012)

There are several limitations for optimizing the rail freight transports in Sweden as well as the traffic going from Sweden to Europe. Within Sweden one of the biggest limitations causing capacity and quality problems are those tracks trafficked by both cargo and passenger trains. At these routes there are also a lot of conflicts between the cargo and the passenger train, concerning the time slots given by Trafikverket, the Swedish authority in charge of allocating rail slots within rail companies in Sweden. (Vierth et al, 2012)

The current path allocation between freight and passenger trains in some countries, such as Sweden, shows that freight trains timetables are mainly allocated in basis on

the residual slots after planning passenger trains. In addition, in case of unplanned situations involving a conflictive situation between a passenger and freight train, the first group is often considered as prioritized. This situation may origin important freight train delays, which significantly affect the efficiency of this mean of transport. (Pricewaterhouse Coopers, 2008)

Green Cargo, Swedish company devoted to freight rail transportation, states that it is not really that many customers that have a realistic need for overnight transports. At least half of all these trains should without disadvantages for the customer be able to be shipped during the day. Unfortunately the capacity of the tracks would not be able to support this much extra day-time traffic as the lack of side tracks to let other trains pass by makes it impossible. (Vierth et al, 2012)

Green Cargo states that punctuality to customers is approximately around 95%. One of the most common reasons for a freight train to be delayed is the crowdedness/hustle on the tracks. The freight trains will have to leave room for the passenger trains. To be able to be reliable to the customers and keep the high rate of punctuality extra time has to be scheduled into the transportation time. Going on side tracks to let passenger trains pass is not only adding time to the transport time but also costing a lot in extra driver hours as well as required engine hours. (Abrahamsson, 2010)

Green Cargo states that all the time put together that their cargo trains are waiting on side tracks because of the prioritized passenger trains, costs them annually approximately 150 million SEK in increased production costs. (Green Cargo, 2011)

In order to revitalize the freight transport sector and make it more competitive against road transport industry, aspect which represents one of the goals of the European Union Commission, it would be interesting to change the current traffic management rules (Commission of the European Communities, 2001). A possibility would lie on establishing general priority levels according to the socio-economical value for each train, considering freight and passenger transportation at the same time. Another option suggests that trains on time, would remain on time. This means that in case of a rail traffic situation in which a freight train (traveling on time), and a passenger train (which has suffered a delay) were expected to meet anywhere in the network, the freight train would continue its route without giving priority to the passenger train. (Pricewaterhouse Coopers, 2008)

2.5 Rail freight companies management

Rail operations are complexly affected by the physical network constraints as well as by some policies such as train locomotive scheduling, empty wagons management, or car blocking. Problems linked to the interrelationship among those factors make the freight transport industry not to be as efficient as it could be in the theoretical way, and may explain the continuous decreasing of freight transport market share. (Abril et al, 2008)

Efficiency in freight rail transportation is intimately linked to how well **train operating** and **train scheduling** policies are managed to get to a common direction.

While operating plans are related to train routing or the wagons blocking strategies; train scheduling policies are linked to the temporal dimension, considering the constraints linked to the need of synchronize working timetables with other rail companies: both in freight and passenger transport. (Cordeau et al, 1998)

Operating policies comprise activities such as blocking, routing and makeup freight traffic, as well as manage the empty wagons flow. In the freight rail industry, the term "block" refers to certain group of wagons traveling in the same train and having a common destination. Blocking policies regulate which wagons should take part in each block as well as where those blocks should be created. Routing policies determine the departure and final destinations of the different blocks and finally, makeup policies establish the potential blocks that may travel in each train. (Cordeau et al, 1998)

Scheduling policies are in charge of managing the temporal dimension of the rail operations. Aspects such as rail network has to be shared between passenger and cargo trains, or some rail sections only has one line and two travel directions, cause the need of synchronizing the rail traffic, aspect that can be managed by using dispatching lists. (Cordeau et al, 1998)

It is custom in the rail systems around the world to follow a type of "go when full" policy. Even when schedules were introduced they were mostly used as guidelines and trains were still sent off schedule if it was full. But the very high volume of passenger trains in the system and the aspiration to decrease the total shipping time of freight has forced the European railroad companies to introduce more strict schedules for the cargo transports. The Swedish railways has already worked in accordance to this for quite some time and used a similar booking system for the freight transports as for the passenger ones. North America started using a concrete scheduled booking system as late as in the 90s, while the situation in Asia is still an overloaded system as the freight and passenger transportation heavily exceeds the capacity, forcing the companies into focusing more on managing the trains line operations and less on the actual scheduling. (Crainic, 1998)

Empty flow management is another aspect considered within the operating policies. Freight rail firms are both in charge of deliver empty freight cars to customers as well as transport the loaded wagons to the required destinations. Nevertheless, those tasks can be difficult to achieve because of several reasons, such as wagons location in far network stations or a temporary wagon shortage due to a high peak correspondent demand. (Narisetty et al, 2008) The optimization possibilities for the empty freight wagons are easier to achieve as the wagons are more flexible. A customer's loaded wagon with a set final destination has very limited options to reach its destination on a set time. When it comes to the empty wagons the demand is known at least one day ahead in Green Cargo particular case. When compared to European's large market, a smaller railway company like Green Cargo, the time period for which the demand for empty wagons are known until it has to be distributed is longer than most of the actual transportation times. In comparison with the loaded wagons the empty wagon flow gives much more possibilities to implement optimizations on the flow. (Joborn et al, 2004)

2.6 Capacity planning in freight rail transport companies

This section presents the three main planning levels used by freight rail companies all over Europe, and later explains the causes that make theoretical and practical capacity limits to be different.

2.6.1 The three levels methodology for capacity planning

Rail transportation capacity management and planning is done in base of three time horizon levels: strategic, tactical and operational, from a longer to a shorter time perspective respectively. The **strategic planning** determines the preliminary solutions required to cover future demands, for example, setting the acquisition of long-lasting resources such as locomotives or the building of new infrastructures or stations. The **tactical planning** refers to medium and short term aspects, for example the determination of the required rail slots to fulfill customer orders. Finally, the **operational planning** is linked to the daily control and management of freight rail firms activities, facing and solving last minute problems such as accidents in the railroad, or customer delays. (Abril et al, 2008)

2.6.2 Theoretical VS practical capacity

When analyzing train capacity, it is necessary to distinguish between theoretical and practical capacity. Theoretical capacity refers to the maximum weight that certain train is able to transport, whereas practical capacity considers the feasible and real transport possibilities after including operational and reliability aspects. For that reason, practical capacity is that one used when planning transport activities. (Abril et al, 2008)

Railway capacity is characterized for its dynamism and it's highly influenced by how it is used. Factors affecting theoretical capacity can be categorized within three main groups: infrastructural, operative, and traffic parameters, presented in Figure 4.

> **Infrastructure** parameters refer to aspects such as the existence of single or double tracks, fixed or moving block and signaling systems, disposable track structures, legal speed limits or bottleneck areas.
>
> **Operative** parameters comprise planned and unplanned track interruptions, for instance due to maintenance activities or accidents; maximum allowed trip times or network effects associated to interfering train lines.
>
> **Traffic** parameters consider those problems linked to train mix, such as different train speeds; peak traffic intervals or priority policies, which has been previously presented.

Nevertheless, practical capacity differs from theoretical one because of the service reliability, also known as robustness. It is necessary to consider that the scholastic nature associated to train operations may cause the appearance of non planned failures and other several disturbances which reduces the theoretical capacity levels. In other words, maximum train capacity and reliability levels represent an important trade off

for freight train companies, which are forced to set an optimal and economically feasible capacity level according to the desired reliability level. (Abril et al, 2008)

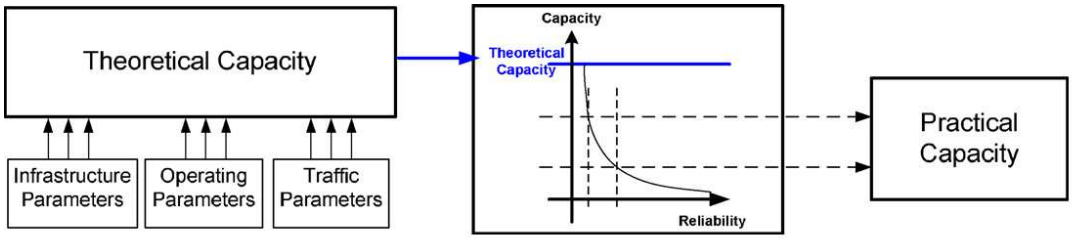


Figure 4: Factors affecting theoretical and practical capacity (Abril et al, 2008)

2.7 Different customers requirements

There are several types of traffic customer groups which can be identified in cargo transportation. Freight rail companies have to consider the fact that some customers are working with JIT or other time critical delivery approaches while other customers contemplate punctuality as a more important requirement. (Kwon et al, 1998) Customers' requirements need to be investigated in order to establish an acceptable classification of customer groups. (Crainic, 1998)

Another aspect to take into consideration is that some customers are willing to pay higher expenses to get extra services. Rail freight companies should take advantage of this situation as much as possible. (Kwon et al, 1998)

2.8 Traffic variation: weekly and daily

One of the current problems in trip planning is that wagons are simply booked into the earliest available train without any consideration to the train. When the train is full, overbooked wagons will have to be delayed until the next available train, which is typically 24 hours later.

There are two types of traffic variability; first there is seasonal or weekly traffic variability and then there is daily traffic variability. Seasonal traffic variation is a difficult aspect to modify, as it is dependent of customer or market demands, and causes that freight companies have to dimension their resources needs according to those periods which higher activity rates. The main advantage of this type of traffic variability is that it can usually be planned ahead, aspect allowing freight firms to plan their activities in a more efficient way. The weekly traffic variation is a more difficult concept to work with and control, as it varies depending on the daily production levels of the customers. It is not possible to deal with those problems linked to peaks in daily demand using predetermined blocking concepts, which do not vary with day of week or actual operating conditions. (Kwon et al, 1998)

The problem with having variation and peaks during some specific hours as well as days obviously limits the capacity on the whole rail system but it also affects the customer promises of punctuality and service to the customers during these periods. (Bowersox, 2000) If variation is detected, a manager may use the system to reschedule wagons to a later train. If this type of last minute adjustment is made after the trip has begun, this will alter the trip plan originally developed and given to the customer. (Kwon et al, 1998)

2.9 Utilization of the available track capacity

The Swedish National Road and Transport Research Institute, VTI, are currently in cooperation with Linköping's University of Technology researching the efficiency possibilities of using longer and heavier cargo trains. The study is expected to be finished by the summer of 2013. This study points out that driving longer and heavier trains makes possible a better utilization of the infrastructures and makes freight transport to be more energy efficient. (VTI, 2011)

Being able to transport more cargo in each transport would result in lower costs. This would also lead to fewer trains on the rails, which would open up the schedules to have a more flexible and fast railway system. The new capacity that would be created could be used either to take cargo traffic off the roads and to the railroad or just making the current timetables less sensitive. Making the railway system more efficient would make it a better competitor towards the truck transportation industry. (Vierth, 2012)

The capacity of shipping as much cargo as possible can be increased by using heavier and longer trains. This aspect would also result in utilizing the capacity of the infrastructure, as less trains are need to transport the same amount of cargo. At the moment Skogsindustrin, Trafikverket together with VTI are working on a project concerning longer and heavier trains. (Vierth et al, 2012)

Increasing the length of trains is often up for discussion as one of the most important factors when it comes to optimizing the capacity. The Trans-European Transport Network has decided that the TEN-T standard for train length will be 750 meters which makes the idea of increasing the length of the side tracks for meeting traffic a very relevant topic. (Vierth et al, 2012) At present, the general maximum train length in Sweden is fixed in 600 meters.

3 METHOD

This chapter aims to present the methodology used to answer and study the main purpose of this thesis: the evaluation of improvement areas in freight rail transportation. This section introduces the chosen method and analysis approaches and later presents the used data collection methods.

3.1 Method approach

Intention of this is to select the appropriate data collection, analysis and interpretation methods which will satisfy the primary purpose of the thesis.

3.1.1 Research method: case study

The master thesis is written on request from Green Cargo to investigate and evaluate its potential improvement possibilities. Evaluated from the purpose, requirements and situation, a case study approach is considered to be an appropriate method. A case study is defined as a description of an actual situation, commonly involving a decision, a challenge, an opportunity, a problem or an issues faced by an organization (Leenders et al, 2001).

A case study represents an appropriate research method depending on the purpose and research questions. The case study is an appropriate method when a question stated as a `how' or `why' is being asked about a current set of events that the investigator has little or no control over. The approach is especially practical to use when the wished outcome is a collection and presentation of more details and soft qualitative data. (Yin, 2003) This description reflects well the purpose of this thesis: analyze how to improve the efficiency of Green Cargo processes and operations, and the case study approach fits conveniently with the above-mentioned nature of this exploratory study.

Conducting a case study, considered to be the most flexible of all research designs, takes one or more selected examples of a social entity and offers the strengths of the experimental research within its natural settings (Hakim, 2000). The advantage of having a case investigated and studied in its real environment is that it makes it possible to obtain a well developed understanding and deep knowledge for the studied area. Another advantage is that a case study let the use of several strong data collection methods, such as interviews, observations and literature reviews. (Ejvegård, 2003) All those methods have been used in this thesis in order to gather data, and are presented in Section 3.3.

On contrary, the main disadvantage of using a case study as a research method is that it is difficult to make a general conclusion based on the result in the study as each study is unique and difficult to relate to reality. (Ejvegård, 2003)

3.1.2 Working process

An overview the working process followed to perform this Master Thesis is summarized in Figure 5. This working process is based on a case study methodology

work process, which states that a case study contains of four spheres of activity (Yin, 2003). The thesis initially started with 'Considering the theory', which was an initial step in designing a case study. This step involved a first literature review to get a clear picture of the theoretical proposition, which was the foundation for the proposed research. General data about the development of rail in Europe and in Sweden were analyzed, as well as different methods devoted to optimize and increase rail transport efficiency were studied.

After the general literature review, the thesis work continued to the second step, 'Define and design'. This stage involved mapping what exactly was doing to be the case and be investigated. This step also included the definition of how to gain all essential data and therefore, a data collection protocol was drafted to have a guideline for how, when and where necessary data that was going to have to be collected.

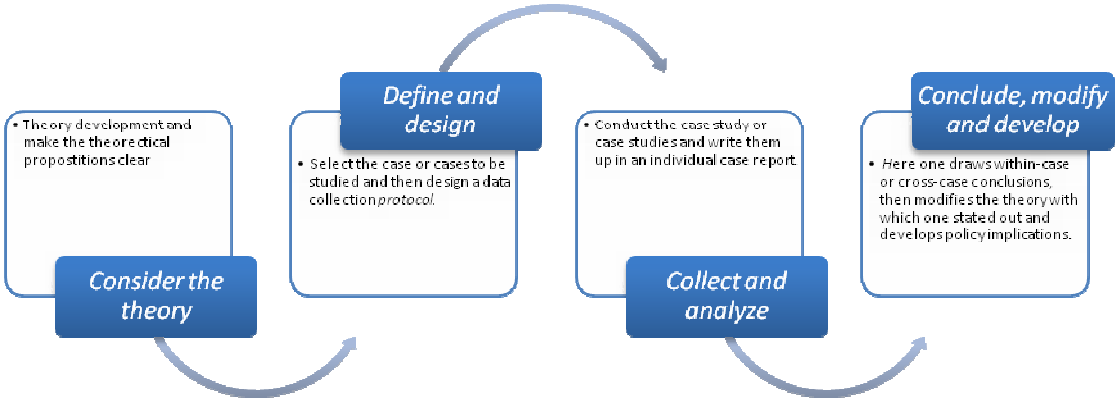


Figure 5: The case study work process containing four spheres of activity (Yin, 2003)

Having drafted out a data collection protocol it was time to 'Collect and analyze'. Interviews and observations were carried out at various locations in Sweden to get a deeper understanding of how the company organization was constructed, how the different planning levels of strategic, tactical, operational planning worked and were interlinked with each other, and also how the personnel planning and the day to day work was performed planned and executed. The interviews started essentially from the top management and then continued by interviewing key personnel from different levels down to the operators. While the interviews and observations were conducted, new areas and idea of importance were discovered, aspect which resulted in a new phase of continuous literature review as well. Analysis of the collected data was done continuously, to determine the different ways to continue evaluating the current problems in the purposed improvement scenarios.

Finally a 'Conclude, modify and develop' step process was taken into action once all the data collection was done and the analysis was in progress. A discussion and conclusion was placed for the different suggested improvement scenarios: both the optimization of train capacity and the staff requirement optimization. In addition, other detected improvement areas were also stated and discussed.

3.2 Analysis approach: qualitative method

Analysis presented in this master thesis has been carried out following a qualitative method as the main questions expected to answer are linked of "how Green Cargo can optimize its resources and capacity utilization" and "how staff requirements can be optimized". A quantitative research, representing the opposite approach to the qualitative one, is intended to analyze a certain case by using numerical and mathematical data (such as statistics), getting an unbiased result applicable for other similar cases. (Eliasson, 2010) This master thesis does not present a quantitative research for several reasons: first of all, due to confidentiality aspects numerical data have not been accessed. In addition, most of the data used to analyze Green Cargo's current situation is based on interviews with key people in the company, so the result of the interviews are data that are not possible to quantify. Secondly, although conclusions presented later on may be generalized for companies similar to Green Cargo, the main objective of the thesis is analyzing the single case of Green Cargo. These aspects make it very suitable to use the qualitative method for this specific study case.

It is important to choose a suitable analysis method depending on the purpose and research questions expected to be answered. The actual election of certain analysis method exemplifies a variety of beliefs regarding the disposition of knowledge and the methods through which that knowledge can be obtained. Depending on if the researcher intends to describe, explain or predict through observations, researcher should decide which sources of knowledge represent those that produce the best results for the given situation. *(*Klarner, 2010)

The qualitative method is based on a view and method where the researcher in question has to see a problem from the inside to be able to understand the actual situation. (Holme et al , 1997) The qualitative method is especially useful when the understanding of certain context is not immediately obvious, and this approach allows to make it clearer and uncovered as the research is performed. The qualitative method is also a very flexible approach, in the way that it is possible to suit and adapt it to the specific research needs and depending on how the research develops (Eliasson, 2010). All these reasons make a qualitative approach to be the best option to achieve the purpose of this master thesis, analyze how Green Cargo can optimize its efficiency levels. While the investigation and data collection process was done, new aspects not considered before were discovered. Thanks to the qualitative approach, it was possible to adequate the analysis presented in this thesis to the new information and data considered as relevant to include and analyze.

There are four principles to follow when a qualitative method is used in a research study. The first one is that there should be a physical closeness with which is being studied. Secondly, the written report which will be the result of the study has to describe the situation as objectively as possible. Thirdly, it is also important that the report includes descriptive descriptions of possible actions and activities. To conclude, if an object's own expression should be cited, an actual quote should be used to create better understanding for the studied area. (Holme et al , 1997) As it will be observed during the analysis presented later on, all those principles have been followed, being included detailed and objective descriptions of those aspects considered as relevant for the analysis.

The qualitative study creates validity within itself as the researcher is close to what is actually being studied. At the same time, the object being studied has a large influence to affect the situation and can control its participation. A disadvantages of the qualitative study, is that the researcher can misunderstand the objective's motive and situation. In addition, people can act differently at the presence of the researcher and indirect effect the outcome of the study (Holme et al , 1997). Considering that most of the data used to perform the analysis presented in this master thesis come from interviews with Green Cargo employees, some of the information gathered may contain certain subjective data. This fact was already presented in the limitations of this master thesis (see Section 1.3). Nevertheless, it is necessary to say that it should not be an important issue in this thesis, because data presented in internal Green Cargo documents as well as external information do not present contradictions with employees' testimony.

3.3 Data collection

There are four major methods for collecting data: questionnaires, observations, interviews and literature studies (Holme et al , 1997). The three latter ones have been used as methods to collect suitable data for this master thesis. Questionnaires were not used, as it is not a suitable way to collect data based on the nature and purpose of this thesis. The three selected methods are divided into primary and secondary data. Primary data includes observations and interviews, whereas secondary data is linked to literature studies.

It should be noted that the case study approach adopted in this study relies primarily on the data collected through interviews with subjects, rather than direct observation of the subjects during the performance of their daily communication tasks.

3.3.1 Primary data

Primary data are collected for the specific study a researcher is undertaking, in this case, analyzing how Green Cargo can optimize its efficiency levels. Qualitative data collection methods are usually divided into observations and interviews. When it comes to the observations, the observer can be more or less involved in participation. Interviews can be more or less structured depending on how the interviewer constructs the interview. All these aspects are presented in the next two sections.

3.3.1.1 Interviews

A qualitative interview represents conducting a conversation between an interviewer and interviewee with more or less prepared questions as a guideline. Depending on the purpose of the interview the outline can be unstructured, semi-structured or structured. Unstructured interviews represent just a basic conversation, and represent a good method if the interview outline is just one or two questions. A semi-structured interview is more guided than the previous group and has several prepared questions. In the same way that unstructured interviews, semi-unstructured ones allow the interviewer freedom to go deeper into chosen questions and new discussion areas that

may appear during the conversation. On contrary, a structured interview does not present high flexibility and rarely gives the possibility to go deeper into discussion concerning specific questions. In this type of interviews a very fixed question template is set and the interviews are quite easy to perform. Quantitative data collection often uses structured interviews. (Eliasson 2010)

The interview data has mainly been the foundation of the empirical data considered for this thesis. The choice of structure for the interviews in this thesis has mainly been semi-structured as this method had the best possibilities to obtain deep information and explore new areas not considered in the set list of questions. Most of the interviews have been conducted face-to-face, while the rest of them have been done by videoconference, which is an advantage as it is easier to get a deeper connection and better understanding with the interviewed person. In addition, in those cases body language can be accounted for.

The interview templates were prepared in advance and had different structures, lengths and approaches depending on the person being interviewed. The interviewees in this thesis are mainly employees at Green Cargo and span with their backgrounds from top management down to operators. The reason for the various backgrounds and positions of the interviewees was the need of getting a wide and deep understanding of the whole organization including both work methods as well as planning and strategic decision-making.

Interviews should be documented in some way either by recording or written notes to allow the future review of the gathered data during the analysis process (Eliasson 2010). In this master thesis, written notes have been the most common approach to document all the obtained information. In some particular cases, in addition to the written notes, interviews were also recorded for further and deeper analysis.

Below it is presented the list of interviewed people, their position and how and when those interviews were performed. After that, it is included a short explanation regarding which type information was provided for each of the interviewed persons.

1. Anders Lester (Company supervisor)
   Quality and Organisational Development Manager at Green Cargo, Solna
   Interview done face to face; Met at several occasions throughout the thesis

2. Marcin Tubylewicz (Company supervisor)
   Strategic Production Development Manager at Green Cargo, Solna
   Interview done face to face; Met at several occasions throughout the thesis

3. Inger Ericsson
   Head of Strategic Production Development at Green Cargo, Solna
   Interview done face to face; Date: 2013-02-04

4. Mats Tapper
   Strategic infrastructural Planner at Green Cargo, Gothenburg
   Interviews done face to face; Date: 2013-02-06; 2013-03-19

5. Tony Östlund
   Shunter coordinator at Sävenäs yard at Green Cargo, Sävenäs
   Interview done face to face; Date: 2013-02-06

6. Per Svensson
Group leader for shunters and drivers in Halland at Green Cargo Halmstad
Interviews done face to face, E-mail; Date: 2013-02-14, 2013-02-21

7. Lars-Åke Ingmarsson
Driver in Halland county at Green Cargo, Halmstad
Interview done face to face; Date: 2013-02-14

8. Ulf Wikström
Agreement Specialist at Green Cargo, Umeå
Interview done face to face; Date: 2013-02-19

9. Peter Ottoson
Driver, formerly Tactical Local Driver Planner at Green Cargo, Gothenburg
Interview done face to face; Date: 2013-02-19

10 Håkan Lind
Short-time Planner at Green Cargo, Gothenburg
Interview done face to face; Date: 2013-02-19

11. Tomas Gädda
Capacity Manager at Green Cargo, Solna
Interview done by videoconference; Date: 2013-02-21

12. Fredrik Andersen
Organizational Specialist in Planning at Green Cargo, Hallsberg
Interview done face to face; Date: 2013-03-04

13. Johan Gustafsson
Analyst of Trafikverket invoices at Green Cargo, Hallsberg
Interview done face to face, Date 2013-03-04

14. Bengt Palm
Capacity Distributer at Trafikverket, Gothenburg
Interview done face-to-face; Date: 2013-03-19

The Interviews with the company supervisors Marcin Tubylewicz and Anders Lester, both in the Strategic Development department at Green Cargo, gave the authors of this thesis a high general understanding of how the company works from a managerial point of view. They also provide us deeper information of the specific concepts that were expected to be investigated in this thesis and helped us to arrange interviews with other Green Cargo departments and personnel to help us gather necessary data to perform the required analysis.

Inger Ericsson, Head of Strategic Production Development, brought the authors of this thesis an overall understanding of the strategic planning on all different levels but also on the strategic decision making. She provided data and information about the current

capacity situation in Green Cargo and explained concepts such as anchor blocks and peak times.

Several interviews and meetings with Mats Tapper, who works as a Strategic infrastructural planner at Green Cargo, helped to bring essential and deeper understanding regarding the long term planning process linked to Trafikverket time plans, as well as the short time planning and last minute changes. Mats Tapper also provided information concerning categories planning and prioritization of trains, according to Trafikverkets guidelines. He also demonstrated how the software TrainPlan and Trafikverket reservation software worked. Understanding how the applying process of track time at Trafikverket was also provided by him.

Tony Östlund, shunter coordinator, provided general information on the work in a major shunting yard and also demonstrated how the software were used to help control the shunting yard in Göteborg Sävenäs.

Per Svensson, Group leader for shunters and drivers at Halmstad station provided deep information regarding driving and shunting during the several interviews that were performed with him. He provided essential information about the single shunting concept and the advantages and disadvantages this concept brought. He also informed about how shunters and drivers planning schedules are performed and allowed us to visit single shunting stations (Hylte and Brännegård).

Lars-Åke Ingmarsson and Peter Ottoson, driver and former driver respectively, provided very useful information concerning the engine driving processes, the legislation for drivers and shunters, and also data on the process of planning and scheduling drivers. Lars-Åke also offered important insight in the single shunting concept and gave his perspective concerning drivers shunting as well as information about safety and customer interaction.

An interview with Ulf Wikström, Agreement specialist at Green Cargo, provided useful information about personnel questions, allocation of personal and important legislations and other barriers limiting staff optimization. He explained the factors affecting the overall staff needed as well as gave deeper understanding to the main-site concept and the idea of centralizing staff.

Understanding and information about the software Platå and TrainPlan were provided by Håkan Lind, short-time planner at Green Cargo. He made us a demonstration of how engines allocation process is done according to the planned trips and explained how to manage minor and last minute changes in traffic and train requirements. The interview gave an overall idea of some of the different software used in Green Cargo as well as its correlation to each other.

Tomas Gädda, Capacity Planner at Green Cargo, provided information of how capacity needs are forecasted in the strategic perspective, including both the customer needs forecasting as well as the real capacity requests to Trafikverket. He also explained and provided information of the SAP software.

The Organizational specialist planner, Fredrik Anderssen, provided information and gave an overall understanding of the daily work performed in the customer service center in Hallsberg. He also explained how the adaptation between strategic production plan and weekly plan is done.

Johan Gustafsson, who works as an Analysis concerning Trafikverkets invoices, explained and provided information concerning the problems regarding Trafikverkets invoice system and the economic savings associated in solving them.

A meeting with Trafikverkts employee Bengt Palm, who works as a Capacity distributer, provided essential information concerning Trafikverkets general work and how it is interlinked with Green Cargo. He brought understanding to the competitive market in rail track time and explained the process of distributing the capacity of the rails among the rail companies in Sweden.

3.3.1.2 Observations

Observations represent another important source of primary data for this master thesis. During observations, the observer observes events in the environment and takes some kind of notes. It is important to do documentation of those observations to allow a further and later analysis of them. According to Gold's typology, it is possible to distinguish four different types of observers depending on the level of involvement: "the complete participant", "the participant as observer", "the observer as participant" and "the complete observer" (Gold, 1958).

In this thesis observations were done following "the observer as participant" approach. In this case, the observer does not represent a normal part of the observed environment and has a reduced involvement in the studied situation. This is the way in which the observations were performed, visiting the different places stated in the next lines and having a direct overview of the way of working in each of them.

Several Green Cargo offices in Sweden were visited in several occasions from January to April of 2013, specifically those located in Solna, Göteborg and Hallsberg. During those visits it was possible to get a general idea of how the different departments in each site were coordinated and communicated between them, as well as gaining a deeper understanding of the mission of each of those departments.

The Sävenäs control tower and Sävenäs rail yard were visited on 6th February 2013. This visit provided us general understanding about how the rail yard was controlled and how shunters work and perform their day to day tasks.

On 14th February 2013 the single shunting stations placed in Hylte and Brännegård were visited. This visit was very useful to get a deeper understanding of the single shunting process, especially after observing a shunting - driver performing this process in reality. In addition, it was possible to get better understanding regarding the environment inside the locomotive, the general feeling of working on the rail yard as well as a single shunting concept.

During 14th February 2013, it was also possible to visit the Stora Enso factory in Hylte, station working with the single shunting process. This visit allowed us to get an idea of how the interaction between the customer companies and the Green Cargo employees who work out on the rail yard takes place. In addition, Halmstad rail yard and the Halmstad harbor were briefly visited in this date.

3.3.2 Secondary data

In contrast to primary data, secondary data have been collected by someone else for some other purpose than the specific study of interest. (Klarner, 2010) The data collected is not always suitable and valid for other purposes than its original one. In this thesis the secondary data has been gathered from a literature review.

3.3.2.1 Literature review

In the same way as primary data did, the secondary data obtained thanks to the literature review has mainly provided qualitative data. As it is mentioned in Section 3.2.1, the literature review process started in the initial stages of the working process and was conducted continuously through all the process.

The focus of the literature review has been on the current situation of freight rail transport over Europe, the main problems faced by this type of transport, and how this sector is being developed worldwide in order to achieve higher efficiency levels. Literature studies have also been conducted to gather Green Cargo specific information, such as how the internal development, adjustment to the market and efficiency in this firm has progressed over time.

According to (Ejvegård, 2003), it is important to keep a critical approach to the literature and always question the data objectivity. The authors of this thesis have taken into consideration this aspect during the whole working process, assuring the objectivity of those texts evaluated in the literature review.

The secondary data used in this thesis includes several types of literatures, such as scientific articles, documents and consultancy reports from the European Union, documents available on Trafikverket's webpage, and internal Green Cargo documents. Those internal Green Cargo documents have been obtained from the 'Our document' Green Cargo database, the company's own annual report, and extra power point presentation material and documents were obtained during the interviews with Green Cargo employees.

4 Green Cargo

This chapter provides general background regarding the rail freight company Green Cargo, deeply analyzed in this master thesis. Some of the presented topics in this section are Green Cargo Key Performance Indicators and competitive advantages, its operating areas and its main limitations.

4.1 Green Cargo background and general aspects

Green Cargo is a government owned limited company which is administrated by the Swedish Finance Department since 1st of January in 2001. The company was created out of the logistics division of the formal Statens Järnvägar (The Swedish State Railways).

Green Cargo is one of the most important logistics companies in Scandinavia, focused in supply logistic solutions that meet customer requirements. The largest customers are those of the Swedish business world within areas such as steel, chemistry, vehicles, workshops, woods and retail. Green Cargo is in control of shipping more than half of Sweden's freight on rail and its network of partners reaches all of Europe. (Green Cargo, 2012)

Green Cargo offers transport and logistics solutions with environmentally certified rail and road-based freight transportation and third party logistics services. Green Cargo offers door-to-door service and can reach most destinations in all of Europe. To be able to offer complete logistics packages the company has third party logistics, which includes storage, collecting and distribution. (Green Cargo, 2012)

Green Cargo works actively and in a continuous way to analyze which ideas could be implemented in order to increase its efficiency levels. One of the main ambitions of this firm lies on being able to compete with other means of transport, such as trucking and shipping.

4.2 Key performance indicators (KPI) and competitive advantages

Other than the owner's profitability goals, Green Cargo's most important targets are aiming for safety and quality. These goals have their roots in the company motto: "With safety and quality we will reach profitability". These are the reason for the two most important KPI's, which are "Traffic safety index", related with a low accidentality rate; and "Punctuality to Customer" in the way of fulfilling customers promised delivery times.

Other non financial focused KPI's are "Coworker", "Environment" and "Society". "Coworker" is related with employees sick leave rate. Green Cargo sick leave rate represents a lower figure than the average office workers sick leave rate in Sweden despite of the high physical workload in activities such as shunting or driving. "Environment" is an indicator of the volume of consumed diesel per 1000 net ton km.

The last KPI is “Society”, which is a measure of the volunteering hours the company offers all their employees to do during their regular working hours. Figure 6 presents Green Cargo main KPI.

The monthly results of those five KPI’s are presented on screens across Green Cargo offices all across Sweden to keep all workers updated on the progress towards the goals.

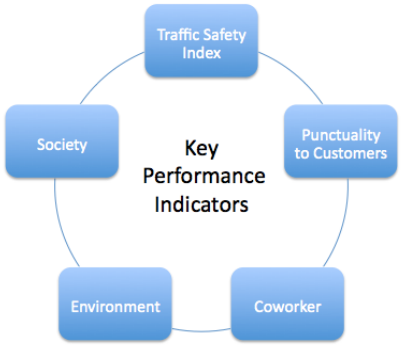


Figure 6: The key performance indicators for Green Cargo

Regarding Green Cargo competitive advantages, the most important one is identified with the high flexibility offered to customers[2]. Unlike other competitors, Green Cargo offers the possibility of reaching more than 300 stations all over Sweden as well as other European destinations in countries such as Norway, Denmark, Belgium and Germany. Green Cargo is a very customer focused firm, which prioritizes preferred customer delivery times over its most economic time slots to deliver.

4.3 Operating areas

Green Cargo management is comprised by two main operating sites: Hallsberg and Solna. Executive and Human Resources department as well as Strategic planning development division are placed in Solna, whereas Hallsberg can be defined as the neuralgic Green Cargo operations center. Hallsberg is in charge of establishing the Tactical and Operational plan based in the Strategic planning created in Solna, comprising activities such as network, staff and locomotive planning as well as customer service division.

Infrastructure planning as well as operational control is performed through 6 different areas presented in Figure 7: Northern Norrland, Sourthern Norrland, Middle, East, West and South[12].

[2] Marcin Tubylewicz, Strategic Production Development Manager, Green Cargo, Interview

[12] Fredrik Andersen, Organizational Specialist in Planning, Green Cargo, Interview, 2013-03-04

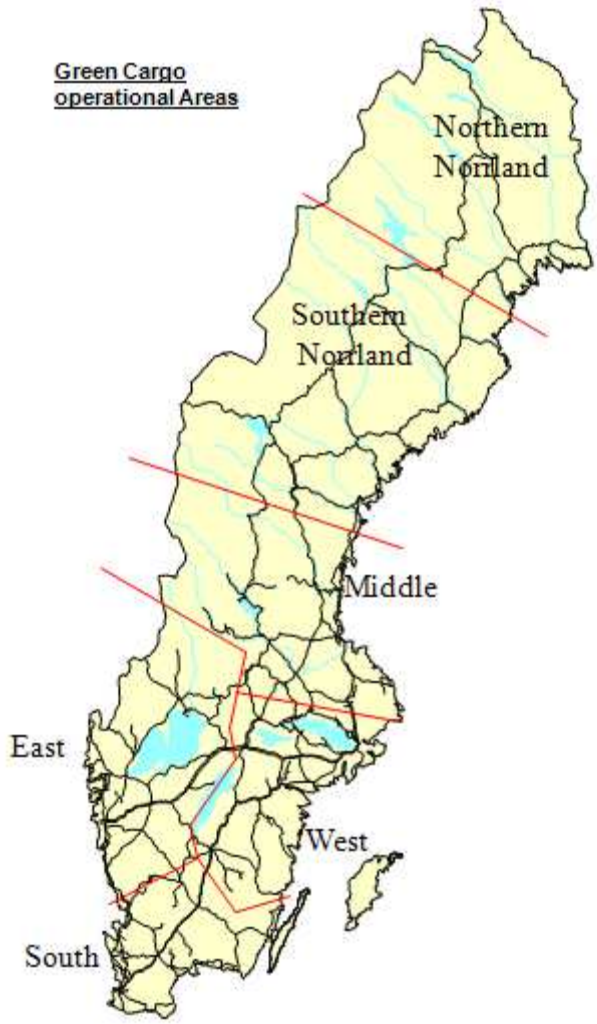


Figure 7: Map over Green Cargo's 6 operational areas (Green Cargo presentation material)

Apart from Green Cargo management locations, the firm disposes of 33 stations with permanent operators: both drivers and shunters, all over Sweden. From these 33 places, since now called "Main-Sites", Green Cargo offers the customers more than 300 possible destinations in Sweden. The biggest main site, with more than 350 shunters and drivers located there, is Malmö. The distribution and different main sites categories are further explained in Section 6.1.

The highest traffic volume for Green Cargo trains is situated in the surroundings of Hallsberg, Göteborg and Malmö. Hallsberg is an important location because it is placed at the junction of the connections of cities such as Göteborg, Stockholm, Malmö and the traffic northern Sweden. Göteborg high traffic volume can be explained because of the city harbor as well as the high number of industry set close to this location. Malmö, city with the biggest Green Cargo main site, represents a really important location because it connects Sweden with the rest of the European continent.

In Malmö, Green Cargo turns over its trains in DB Schenker Rail Scandinavia, what in many occasions imply a switch of engine to suit the European requirements and the adaptation to train length and weight to the established limitations in the next travelled countries.

4.4 Main limitations for Green Cargo

Green Cargo has to face and overcome important limitations during its planning processes as well as in its daily activities. This section presents the most important limitations for Green Cargo, which can be identified with Trafikverket, different European frameworks, speed and capacity limitations, customer contractual relations, external factors, weather conditions and legislation regarding working hours.

4.4.1 Trafikverket

Trafikverket is a transportation administration agency owned by the Swedish government. It holds the totality of the state-owned railroads and roads all over Sweden, being responsible for keeping them as well as establishing the long-term infrastructure planning for the different ways of transport. (Trafikverket, 2013)

4.4.1.1 Allocation of rail timetables

Regarding rail transportation, Trafikverket schedules maintenance activities, plans and builds new infrastructures to adapt to future capacity needs, plans rails schedules between freight and passenger transportation companies and controls the daily train traffic. (Trafikverket, 2013)

Trafikverket is in charge of allocating rail timetables in Sweden among the different interested companies, both for passengers and freight transport, according to its own administered mechanisms (Cordeau et al, 1998). Trafikverket manages the planning for the timetable schedules for approximately 20 passenger train companies and for approximately 40 freight train companies, trying its best to grant everybody their wishes and demands. For the next years, it is expected an increase in the volume of passenger transport firms in the Swedish railroad.[14]

Every year in the beginning of April, interested rail firms apply to Trafikverket for those time slots they would like to own and run during the next year. In addition, in this application companies also need to specify the priority level of the trains expected to run in those time slots according to Trafikverket classification categories. (Trafikverket, 2013)

After studying the different applications submitted in April from all interested rail companies, in September Trafikverket publishes their decision regarding the rail allocation for the upcoming year. Once this resolution is publicly presented, rail companies have a complaining period. (Trafikverket, 2013)

Figure 8 shows an example of the documents elaborated by Trafikverket to communicate the final train allocation for every Swedish railroad track for each hour during the following year. The horizontal axis makes reference to the considered time slot for certain date, in this case 11th February 2013 from 06:00 to 12:00; whereas the vertical axis indicates the locations included in the presented railroad track. Each one of the sloped lines, both green and red, represents a train and it is possible to expect in which location (presented in the vertical axis of the graph) this train will be in certain moment of certain date (presented in the horizontal axis of the graph).

[14] Bengt Palm, Capacity Distributer, Trafikverket, Interview, Date: 2013-03-19

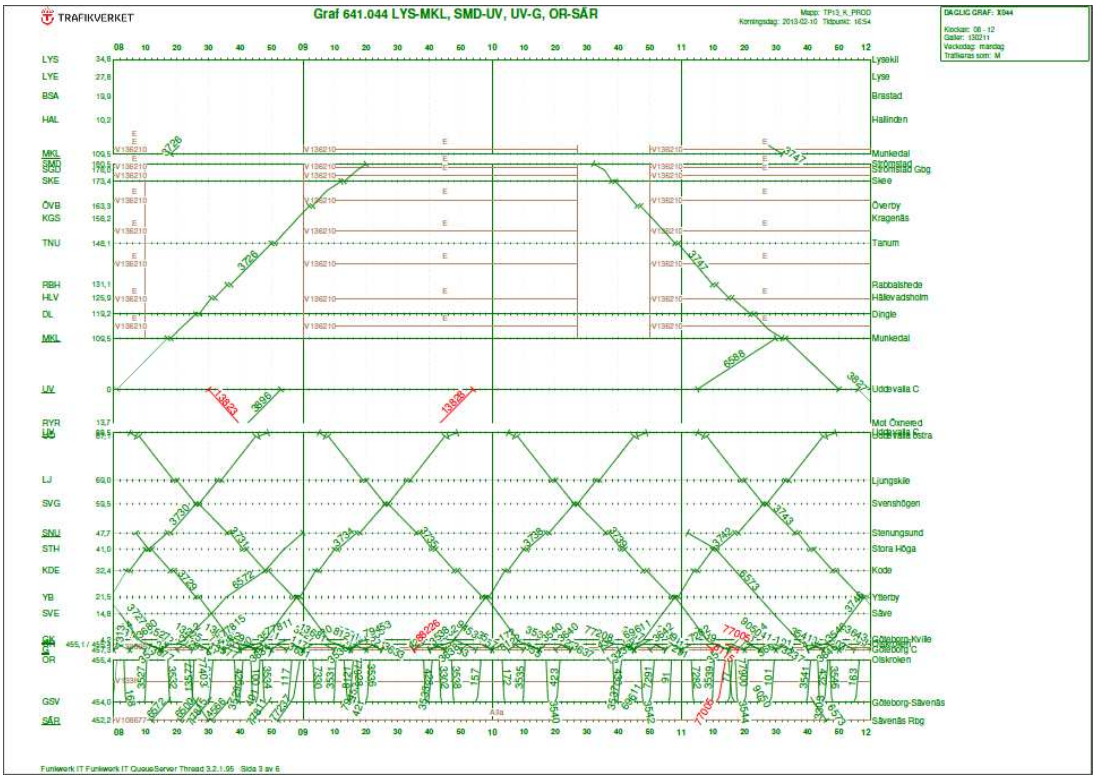


Figure 8: Overview of specific rail road route and ever train scheduled within the route for a specific day (Trafikverket, 2013)

Traditionally, rail passenger transport has presented a fixed yearly schedule which does not require to be readjusted as the companies print and present a yearly travel schedule for their passenger customers. Nevertheless, in the most recent few years passenger rail companies have started to slightly adjust their yearly planning considering aspects such as cancellations because of lack of travelers, broken vehicles, or maintenance activities.[14]

On the other hand, final and real freight transport timetables may differ considerably from the originally applied ones because of the customer changing needs. Trafikverket receives approximately 100.000 yearly changes regarding those established timetables and schedules for the 40 rail freight companies operating in Sweden.[14]

For companies such as Green Cargo, it is very difficult to predict one year in advance which will be its required exact time schedules. Because of that, it is possible for the companies to cancel or modify a rail slot in case it is not finally needed, provided that this information is communicated to Trafikverket before scheduled departure time. In that case, companies would not have to pay for those time slots previously booked.

Nevertheless, it is important to consider that if a company (eg. Green Cargo) applies for a train slot which finally will not be used, if the next year another competitor is also interested in that rail schedule, they will probably get that slot rather than Green Cargo. For that reason, it is not recommended to apply for as many slots as possible, although later can be cancelled. Also if a company is not using the time slots as applies Trafikverket has the right to demand that there is a change in the upcoming

[14] Bengt Palm, Capacity Distributer, Trafikverket, Interview, Date: 2013-03-19

weeks or the company will lose the applied time slots.[4] Nevertheless, it is necessary for Green Cargo to consider that within a close future horizon Trafikverket is planning to introduce a fee linked to each booked time slot. This fee will not be refunded if later the rail company does not make use of the reserved slot. This fact is further explained in Section 5.2.4.

A clear difference can be seen between large and smaller freight companies, where the smaller ones make a lot more changes, compared to traffic volume driven, during a year then the larger ones like Green Cargo. This is one of the advantages for the small companies, being able to be more flexible and adjusting faster and better to the market and customer demands.[14]

Another possibility offered by Trafikverket, allowing to increase the flexibility of rail transport firms, is related with the possibility of applying to the disposable free time slots within a shorter time period to be able to adapt to new customer needs. Normally, only minor changes takes place within this context, because the best time slots have already been previously allocated, and rail transport firms need several time to modify their planned activities. For Green Cargo particular case, three months would represent the minimum time period in advance to acquire new rail slots and include them automatically in the planning process. Green Cargo capacity planning process presented in detail in Section 5.1.1, involves many different departments and software and represents a very time requiring activity.

4.4.1.2 Trafikverket categories prioritization

Trafikverket disposes of two independent priority categorizations for both passenger and freight transportation. Both of them are based on the society value represented by each type of train as well as the amount of high sensitive travelers.

When a freight rail company such as Green Cargo applies to Trafikverket for capacity for the upcoming year, that firm has to categorize the different customers which will fill each time slot into the branches and priority groups established by Trafikverket. Those categories are based on the transported goods and as well as customer types, being food, mail, and transportation for companies like Volvo on the top priority list. Once freight companies apply for a certain category train, this cannot be changed later on. (Trafikverket, 2013) Green Cargo does not dispose of any established guideline to decide what priority certain customer/train really has, and this categorization is done mainly in base of capacity planners own judgment, personal knowledge and experience.

An analysis of Trafikverket final allocation decisions suggests that in those situations in which a passenger and a freight train companies apply for the same rail slot, the passenger train will be consider more priority than the freight train whatever the importance categories of each of them are, only with the exception of the dedicated post trains.[4] This idea can be observed in the distribution of passenger and freight trains: whereas passenger trains are almost totally scheduled during the daily slots, freight rail transport is mainly planned during night hours in the remaining time slots.

[4] Mats Tapper, Strategic Infrastructural Planner, Green Cargo, Interview, 2013-02-06; 2013-03-19

[14] Bengt Palm, Capacity Distributer, Trafikverket, Interview, Date: 2013-03-19

The priority categorizing between passengers and freight trains can result misleading in several situations. Passenger trains often have high priority both during commuting hours and during the rest of the day. Unfortunately, Trafikverket priority system does not have different time periods in its system, what causes that if a commuting train is considered to have high priority during commuting hours, it will maintain this priority over other trains around the clock.[14]

When two freight companies apply for the same time slot for the incoming year, maybe intended to serve the same customer, Trafikverket is placed in the very unfortunate position of deciding which firm will get that track time. Consideration will be put into the possible fact that one of the companies has had the same track time previously. Consideration is not taken whether the company is planning on using diesel engines or the more environmentally friendly electrical engines. Even though the electrical engines cost the rail companies money to use and therefore is financially beneficial for Trafikverket.[14]

Even though it has been put an important effort to develop and improve the train prioritizing criteria between freight and passenger transportation, the Näringslivets Transportråd (Swedish Shippers' Council) states that there are still flaws to the system. They state that the freight transporting value to society is very under appreciated. The increasing number of rail companies in Swedish rail industry makes the prioritizing system to be used more frequently in order to solve conflictive situations. (Trafikverket, 2012b)

4.4.1.3 Trafikverket fees

Trafikverket fees faced by rail transport companies are related to many different services. Trafikverket has three different pricing categories dependent on the importance of the rails in which trains run: red, yellow and green. Red and Green categories represent respectively the most and least important and expensive rails in Sweden. Trafikverket rail pricing categories are further explained in Section 5.3.4.

Those rails connecting Malmö - Stockholm - Göteborg represent the most expensive ones due to high volume of traffic. In addition, Trafikverket also charge an extra fee when trains arriving to one of the major Swedish cities, because of the high traffic volume and limited capacity. (Trafikverket, 2013)

When train routes are planned, it is needed to consider those fees linked to shunting operations. In some stations such as Göteborg's Sävenäs, Green Cargo can perform shunting activities without paying any tax, because the yard is owned and controlled by this firm. Other shunting yards such as Hallsberg station, which is controlled by Trafikverket, requires companies to pay a fee for operating there. This type of yards can be used by several rail companies.

The fees for using the railroad will be increased in the upcoming years as a decision done by the government. For each next 5 years the fees will almost be doubled which will mean increased costs for the rail companies. These costs will result in higher prices for the end customer, which can affect the demand for using rail as a preferred transport method. (Trafikverket, 2012b)

[14] Bengt Palm, Capacity Distributer, Trafikverket, Interview, Date: 2013-03-19

4.4.2 Different European frameworks

Trafikverket is working actively in improving Swedish infrastructures to keep up with the European standards and therefore ease the international connections for freight and passenger traffic.

Trains and wagons from other parts of Europe are prepared to operate within different braking distance limits and different signals system. In the particular Swedish case, regulated braking distance is shorter than in other European countries, aspect which prevents the same trains with same loads to drive as fast as it would be possible in different countries. In case the Swedish Government decided to lengthen the current braking distances and the location of the signal signs were to be placed further apart, the trains speed could be considerably increased. Unfortunately, Trafikverket is not currently working on this, as it would mean a lot of work to change all the signs and systems all over the country. Something to consider would be to do the changes just for some routes and locations to increase the speed in capacity limited areas.[14]

When talking about international freight transportation, there is a list of constraints which difficult the transport between different European countries. Apart from the braking distances, there are differences in aspects such as the catenary systems, the signaling systems or tracks width. This makes that a lot of engines are approved in several different countries, which is a big and well-known problem and is definitely one of the limitations to develop and optimize the international train traffic. (Vierth et al, 2012) If those problems were solved, European freight transport industry could be significantly increased, thereby favoring companies such as Green Cargo (Wiegmans & Doners, 2007).

Currently there is a TEN-T standard set by the Trans-European Transport Network to increase the length of the trains to 750 meters, and consequently increase the train capacity for the trains traveling within Europe. (Vierth et al, 2012)

750 meters is a standard train measure far away from being met in Sweden as the standard is currently 614 meters. To able to operate with longer trains, those side rail tracks planned to meet and pass other trains need to be increased from the current 614 meters. There is one location in Northern Sweden trafficked by Green Cargo with a route over to Norway that does have a side track of 715 meters allowing almost 100 meter longer trains then the rest of Sweden to travel on those tracks.[14]

4.4.3 Speed and capacity limitations

The standard speed used for cargo transport in Sweden is 100 km/h. Trains can theoretically reach this speed on most rails, nevertheless in some areas it is necessary to lower down the speed because of infrastructural factors such as tilting or curving.

The sharing of same railroads between cargo transport and passenger trains, travelling at speeds close to 200 km/h, results very unfavorable for the first group. In those conflicting situations in which a passenger and a cargo train meet in the railroad, freight trains are bound to go on side tracks and let the passenger trains pass them to keep their schedule and be able to continue travelling in their higher speed. This represents an important obstacle for cargo trains and something that significantly

[14] Bengt Palm, Capacity Distributer, Trafikverket, Interview, Date: 2013-03-19

delays the freight transport travel time. (Pricewaterhouse Coopers, 2008) Only during 2011, side track waiting time caused an increase of 150 million of SEK in Green Cargo production costs. (Green Cargo, 2011)

Green Cargo activities are also constrained by those capacity limitations linked to geographical conditions. The unfavorable land geography northern than the Swedish locality of Ånge limits the maximum transported weight for Green Cargo trains. Trains running northern than Ånge only can transport 1100 tons, whereas in those railroads southern than this location the maximum weight limitation is 1600 tons. The consequences of these different weight capacity constraints are amply analyzed in Section 5.2.1.

4.4.4 Customer contractual relations

At present, Green Cargo disposes of a three different contractual relations with customers: single wagons, fixed delivery and dedicated trains, presented in the next lines.

- Single wagons: in this case, customers apply for a determined amount of wagons which will be delivered to them according to Green Cargo delivery time policy. According to this, wagons will reach the customers in within a 60 hours period since an order is made.
- Fixed delivery: customers and Green Cargo agree on the delivery of certain number of wagons on a fixed time and on certain scheduled week days. With this time of contract, customers are required to pay all the whole contracted services although they are not used.
- Dedicated trains: with this contractual relation, customers work with a whole train and pay for it, not sharing it with any other companies. As in the fixed delivery contract, Green Cargo and customers agree on a scheduled delivery requirements.

Customers presenting both fixed delivery and dedicated trains contractual relations with Green Cargo specifies at which time orders should be delivered or picked up. In many occasions those agreed times requires nightly cargo transportation, resulting in higher expenses and worse economical consequences for Green Cargo.[4] This idea represents an important constraint for Green Cargo, being obliged to please the requirements of this type of customers in order to avoid a relation rescission between both parties.

On contrary, single wagons contractual relations provide Green Cargo extra flexibility to plan those transports when consider as the best option. Green Cargo works with a booking policy represented as the first customer to book will be the first customer to be delivered customer.

[4] Mats Tapper, Strategic Infrastructural Planner, Green Cargo, Interview, 2013-02-06; 2013-03-19

4.4.5 External factors affecting Green Cargo operations

Green Cargo is influenced by several external factors which may affect the overall flow for Green Cargo freight traffic as well as modify the already planned activities. Those aspects are difficult to control and predict, and consequently Green Cargo needs to consider them when planning their future activities

One of these external factors affecting Green Cargo operations is customer unreliability, problem which can significantly affect and change the planned transports within a very short period of time in advance. This category includes aspects such as the possible arrival of new customers, the unexpected contract rescission with old customers, last minute order cancelations or very irregular bookings.

For the even bigger picture the whole market can change. Situations such as depression or flourishing economy will majorly change the market needs and the whole company forecast, as well as the even flow of traffic.

4.4.6 Weather conditions

Weather conditions can become an important restrictive factor in rail transportation that needs to be taken into consideration. Some of the most affecting natural phenomena are snow, rain and leaves fall in autumn, aspects affecting both maximum feasible speeds as well as maximum train loads.

Another consequence of adverse weather conditions is identified with train delays or cancellations, affecting the promised delivery times to customers and decreasing the punctuality rates.

4.4.7 Legislation regarding working hours

Green Cargo policies regarding working hours are affected by three different constraints: European legislation, Swedish legislation and Green Cargo legislation. The correlation between the EU, Sweden and Green Cargo legislations is presented in Figure 9. As it can be observed, European regulations represent the real constraint both for Sweden and Green Cargo policies, being impossible to break those rules set at European level. On contrary, it is possible for Green Cargo to set any aspects out of the Swedish law limitations if agreed with the company Union.[8]

[8] Ulf Wikström, Agreement Specialist, Green Cargo, Interview, 2013-02-19

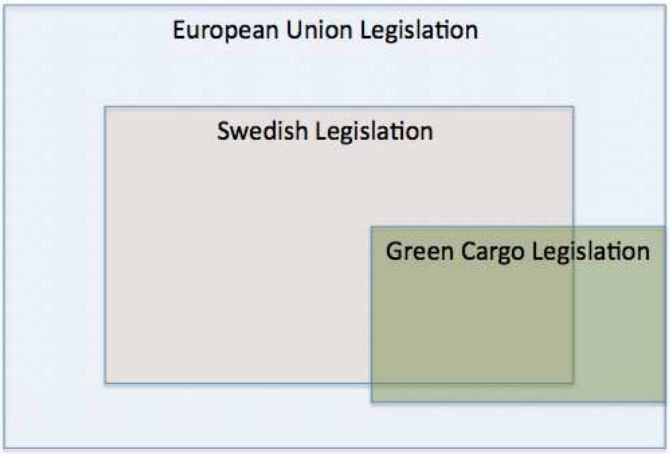


Figure 9: The interrelationship between the regulations of EU, Sweden and Green Cargo

One example of this fact is related with the night work schedule: in general, Swedish government does not allow works performed after 23 pm, nevertheless Green Cargo management and union reached some agreements letting those nightly activities after 23 pm. Those activities performed during the nightly period are rewarded with extra economic compensations as well as better working conditions. Nightly working policies are further explained and analyzed in Section 6.2.2.

5 Capacity optimization areas: current situation and analysis of the possible improvements

This Chapter analyzes the improvement possibilities related to those capacity areas identified by Green Cargo as the most important ones. Green Cargo capacity optimization improvements are divided into three main groups: "Optimization of train capacity"; "Reduction of the uneven flow of cargo trains" and "Peak reduction of the train traffic". This section begins with the presentation of general capacity aspects, and later on presents a separate analysis of each of the three mentioned categories. These analyses are intended to identify the main problems faced by each category and suggest possible improvements.

5.1 General capacity aspects

Capacity planning represents a very requiring and important aspect for Green Cargo. The company begins to estimate its future and rough capacity needs with a 2 years planning horizon, which is continuously translated into more concrete and short term requirements until reaching the daily operations management. Green Cargo works with a three step planning horizon for its activities: strategic, tactical and operational; from a longer to a shorter horizon time respectively. This planning strategy is shared all around Europe. (Cordeau et al, 1998) The management of all these planning activities for the different planning horizons is done with a considerably large amount of software, which will be briefly presented next in this section.

In addition, prior to analyzing how capacity aspects could be optimized, it is necessary to introduce two important: blocking and "anchor blocks".

5.1.1 How capacity is planned: strategic and tactical planning

The process of planning future capacity requirements represents one of the core aspects for Green Cargo. As Figure 10 presents, the planning process begins with the estimation of the future capacity requirements with two years in advance, since now called "year (n+2)".

Future capacity requirements for year (n+2) are determined in cooperation between the Market and the Production departments by combining historical data and forecasting estimations. At present, salesmen at the Marketing department yearly estimates each own customer branches requirements for year (n+2) and put them into an approximate forecasting plan. The Market division also takes into consideration aspects such as currency and prices changes or new customer requirements.[11]

[11] Tomas Gädda, Capacity Manager, Green Cargo, Interview, 2013-02-21

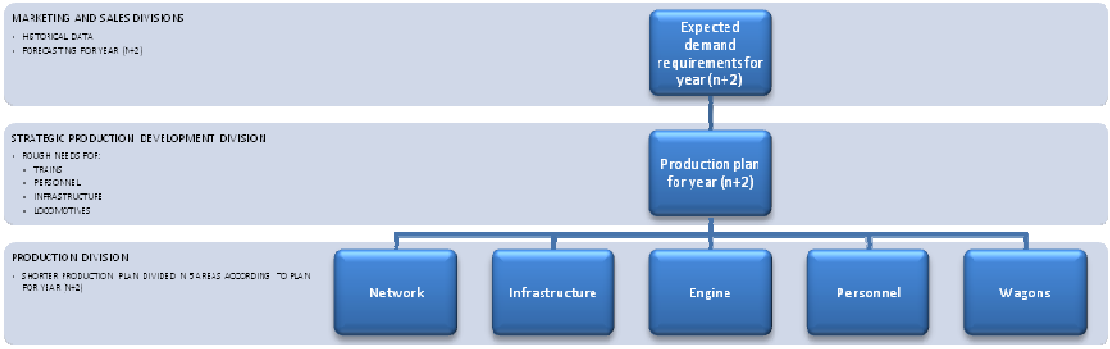


Figure 10: Overview of the strategic and tactical planning divided into the different divisions

Taking as an input the expected capacity requirements estimated for year (n+2), the Strategic Production development division is in charge of analyzing possible solutions to satisfy those requirements. In addition, this department elaborates a general production planning for year (n+2) including rough estimations of the future trains, locomotives or staff needs taking into consideration aspects such as speed in the different points of the network, new routes or infrastructure problems.[3]

Once the two years ahead strategic planning is established, this is translated into shorter time specific capacity requirements regarding five different planning divisions: network, infrastructure, locomotives, personnel and wagons.[12]

The first division, **network planning**, is planned in collaboration between the divisions of Strategic Production Development and Production, and determines the main "skeleton" of the required routes and railroad connections for year (n+2). After that, the second division, called **infrastructure planning,** is in charge of deciding which specific railroads and timeslots would be necessary for Green Cargo to own in order to fulfill the network planning requirements, considering future infrastructure modifications. This division is in charge of applying to Trafikverket for those desired time slots for the next year before April (for example, in April 2013 infrastructure planning division applied to Trafikverket for its demanded time slots and routes for year 2014). About five months later, in September, Trafikverket communicates its final decision regarding railroad allocation for the year (n+1). It may happen that Green Cargo does not get the totality of its request to Trafikverket, so that it would be needed to plan alternative routes.[4]

Once Green Cargo disposes of the information regarding its owned railroads and timeslots, the next division called **engine planning** plans the engines allocation for the next months which covers the capacity requirements all over Sweden. This task requires taking into consideration aspects such as not all the drivers are able to drive the whole variety or locomotives.

[3] Inger Ericsson, Head of Strategic Production Development, Green Cargo, Interview, 2013-02-04
[12] Fredrik Andersen, Organizational Specialist in Planning, Green Cargo, Interview, 2013-03-04
[4] Mats Tapper, Strategic Infrastructural Planner, Green Cargo, Interview, 2013-02-06; 2013-03-19

After engines allocation is done, the **personnel planning** division establishes the daily schedules for both drivers and shunters in the whole country. This schedules need to be given to the employees with one month in advance.[6]

Finally, the **wagons division** is in charge of managing the empty wagons flow as well as ensuring that wagons are placed in the proper locations in order to fulfill capacity requirements.[12]

As it can be observed, the capacity planning is a continuous process, which translates the strategic planning into shorter and more tactical capacity requirements adapted to real needs. Nevertheless, Green Cargo faces a large amount of changes in the short term which makes necessary to change the already established capacity plan.

5.1.2 Operational planning: need to adapt to real and changing requirements

Capacity planning is not preferred to be changed, nevertheless during 2011 it was necessary for Green Cargo to make more than 30.000 manually unplanned changes regarding the established plan. This situation makes operational planning to be very difficult, affecting the originally established long term planning and complicating the forecast process. Flexibility of being able to do last minute changes can be seen as a way to adapt to unforeseen events, nevertheless last minute changes are not desired from Green Cargo point of view.

5.1.3 Green Cargo software and information flow

This section presents the main booking and pricing policies operated by Green Cargo, and later on provides a general overview of the complex software system used by this company.

5.1.3.1 Booking and pricing system

The process of placing transport orders is done directly by the customers. The software gives the customer the first and best available slot in the system with no regard to anything else such as time, demand, weight, etc. The system is very customer focused and always tries to give the customer the very best transport solution and as fast delivery time as possible. If there is any type of change, the original delivery plan is changed and the transport is considered delayed from the promised delivery time given to the customer. This is fact can be misleading and high amounts of money can be lost when a transport is considered delayed to customer even though the delivery time still is within the 60 hours of delivery as it states in the customer agreements.

The pricing system for the ordered transport services is done by following an old and not very accurate criteria, mainly considering the amount, weight and transport itself.

[6] Per Svensson, Group leader, Green Cargo, Interview, 2013-02-14, 2013-02-21

[12] Fredrik Andersen, Organizational Specialist in Planning, Green Cargo, Interview, 2013-03-04

Having a great network of many stations and a large grid of customers is very beneficial as it results in an immense transport network. This network intertwines with itself so that the same transport routes can carry several of the customers, resulting in customers coming together on the same routes and support the cost of the cost of the overall transport. However this outlook is not taken into consideration when pricing.

5.1.3.2 General software

A flow of some of the most used software's in the different planning horizons can be seen in Figure 11. The original plan was to use MultiRail as a foundation for all the other software and it should be used by system and capacity planners within production. This software makes possible to build scenarios and it supports integrated production planning such as flows routes, train capacity and local planning but, unfortunately, Green Cargo does not use it to its full potential. The strategic production development department uses last years planning together with the traffic data from MultiRail, complemented with forecasting changes, empty wagon flow and potential new businesses to create a suitable production solution. All of the data is compiled to create a production plan including everything from trains, engines, personnel and maintenance to shunting and sorting. The production plan can later on be optimized before it is correlated and adapted to the budget together with the market division.[3]

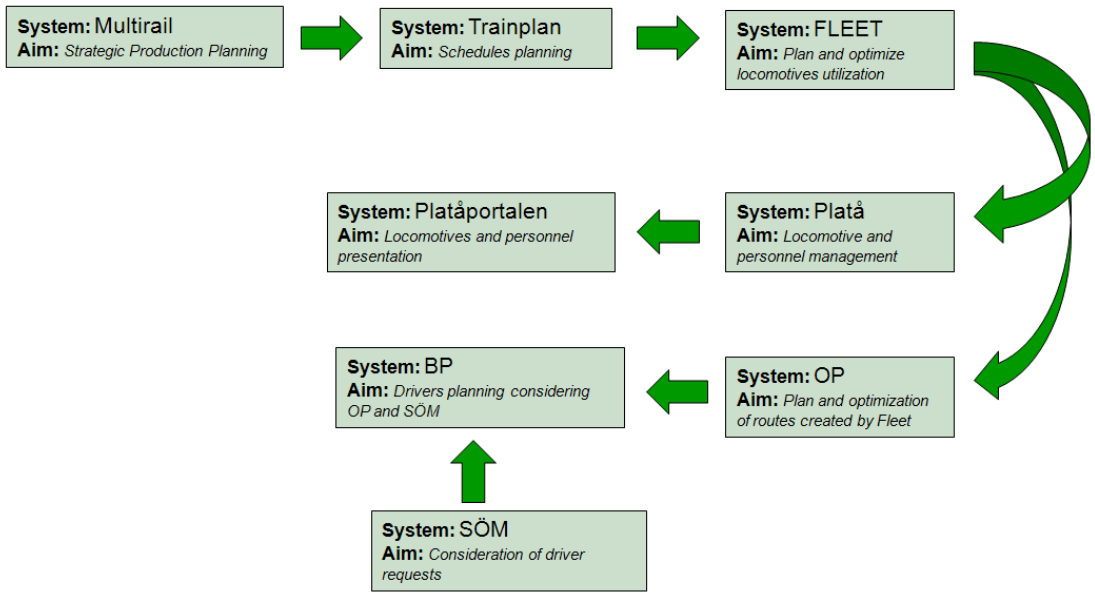


Figure 11: Overview of a few of Green Cargo's software in the different planning horizons

TrainPlan is software for planning and allocation of timetables. It is used in collaboration with Trafikverket to perform the timetable application process as well as used continuously internally within the production planning. The monthly tactical planning involves planning the actual cargo, drivers and engines. Information is gathered from TrainPlan every month and sent to the software FLEET for the engine planning. In FLEET the information is used to strategically and tactically plan the

[3] Inger Ericsson, Head of Strategic Production Development, Green Cargo, Interview, 2013-02-04

engines routes. It can be used both long-term as well as tactical planning based on the timetable. The program calculates routes with optimization algorithms to get the most cost efficient solution for the given data.[10]

The information in FLEET is linked and transported to PLATÅ and OP, which are both basically schedule planning software. PLATÅ supports operational engine and personnel planning and is the software used mainly for resource planning. It submits information concerning the train plan mission, vehicle shortage and routes. OP is used to plan the operator's schedules. It includes an optimizing function and bases the efficiently planned schedules on given data such as legislations, time tables and engines routes. BP supports the creation of the individual schedules. It collects information from both OP and SÖM. In SÖM the operators can put in wishes concerning their schedules such as vacation and the timetable.[10]

An additional software used in a daily basis is the freight transport planning program GTPL, which holds all information concerning cargo trains and the wagons, their allocations, timetables and the shunting times. The GTPL software is used to do the strategic planning, which is done yearly and involves planning of the flows and actual trains. Schedule and capacity for all trains for the upcoming year is set. All timetables are set based on the time slots given by Trafikverket.[10]

There are over 80 software used within the company, all used to a different degree. Most are not interconnected with each other and a lot of manual work putting in the necessary data from one software to another. Reasons for not using all software to its full potential and utilization are lack of resources, complexity, outdated and double work.

In addition, Green Cargo is a member of X-Rail, which is a production collaboration program between 7 European rail companies to ease the process of shipping cargo within Europe. (Green Cargo, 2012)

5.1.4 Blocking policies and "anchor block" concept

The term blocking makes reference to the concept of placing together several wagons which share the same destination. Once blocks are created, several blocks with different final destinations but a certain shared route, can be temporarily grouped together to conform a more capacity optimized train. After this train arrives to the intermediate and common yard station, this process could be repeated, creating again a new and more optimized trains with different blocks travelling to new locations.

Another possibility is that train blocks coming from different locations but sharing a common end destination are stored in a yard station until a whole train can be sent to this specific location. This method is related with the hub and spoke system concept, which presents the idea of a yard station that could be considered as a temporary storage location (hub station) before cargo is delivered to its required destination, the spoke station. Several blocks could be stationed in this hub location until the reception of new blocks needed to create a determined train. (Racunica & Wynter, 2005)

[10] Håkan Lind, Short-time Planner, Green Cargo, Interview, 2013-02-19

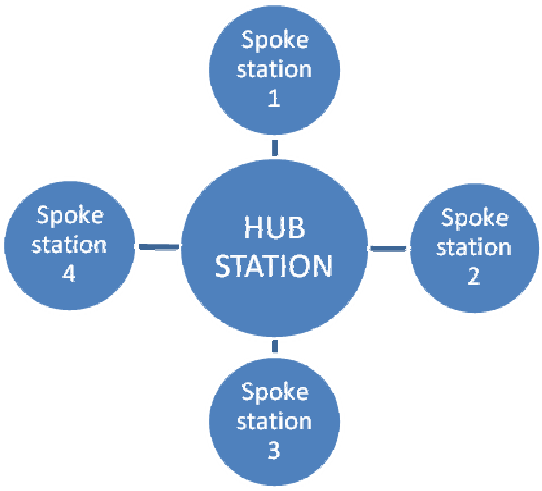


Figure 12: Hub and Spoke station concept (Racunica & Wynter, 2005)

Another important aspect that needs to be explained is "anchor block". The "anchor block" concept makes reference to the fact that one or several customers require enough transportation volume to make a cargo train profitable to run. In those cases in which anchor blocks companies do not require the whole capacity train, Green Cargo can offer its remaining capacity to some other firms within the train route, getting the possibility of creating a more capacity optimized train.

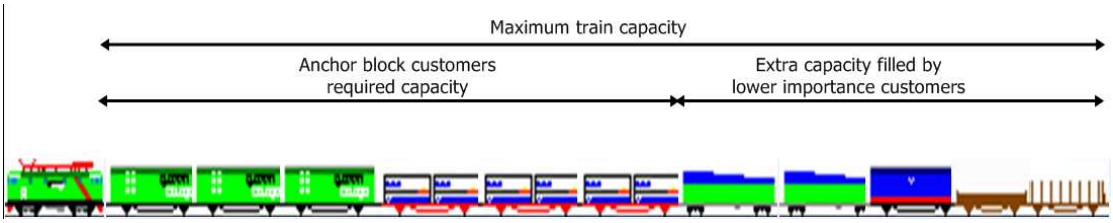


Figure 13: Illustration of the use of the anchor block concept to maximize train capacity

5.2 Capacity optimization area 1: Optimization of train capacity

The first improvement area is related to the optimization of train capacity. In order to analyze this concept it is necessary to consider several aspects. The maximum allowed load per train is constrained by train length and weight, both of them limited by legislation. In addition, maximum weight is also dependant on geographical and infrastructural conditions as well as engine power.

Another restriction, already presented before, is related to the fact that Green Cargo applies for rail capacity to Trafikverket with one year in advance, which will result in the forecast done a year earlier not to fit perfectly with the final demanded capacity. Green Cargo is interested in determining the possibilities of improving these issues with the objective of utilizing the resources as much as possible.

This chapter analyzes the different factors related with the final used train capacity. Aspects such as how capacity utilization is calculated, how forecasting of rail capacity

is made or current weight limitations are presented below and based on that, possible improvement suggestions regarding these areas are analyzed.

5.2.1 Weight and length limitations

Two of the main physical constraints affecting the maximum train capacity are identified as weight and length limitations. According to legislation, maximum allowed train length corresponds with 600 meters whereas there are two different weight limitations are dependant for the geographical situation of the railroads as it can be observed in Figure 14.[1,2] Ånge represents the key point regarding this aspect: trains driver along railroads places farther north than this city are limited to a weight of 1100 tons, whilst the maximum permitted weight for railroads places further south than Ånge is 1600 tons. This fact is also connected to Green Cargo locomotives power specifications, which needs to reduce its maximum transported weight as more unfavorable geographical conditions occur.

Although Ånge represents the theoretical weight limitation location for Green Cargo, its practical weight limitation point for this company is placed in Borlänge, city placed more than 300 km further south than Ånge. At present, all activities related to shunting, sorting and building new trains in order to adapt them to the different weight limitations is done in Borlänge because its rail yard is considered to be more suitable than the Ånge one to perform those activities.[8]

This aspect represents an important constraint for optimizing the capacity of Green Cargo trains. Apart from presenting the theoretical weight capacity limitations, Figure 14, shows the daily freight traffic volume in the different Swedish railroads during year 2010 (Trafikverket, 2013). The higher the thickness of the line is, the higher traffic volume it indicates. As it can be observed, the rail route between Ånge and Borlänge represents a main stretch in the connection between the Northern and Southern part of Sweden, presenting a traffic volume with more than 40 daily freight trains and. Considering that Green Cargo drives approximately 500 daily trains over Sweden, the connection Ånge-Borlänge represents an 8% over the total transport. (Green Cargo, 2012)

[1] Anders Lester, Quality and Organisational Development Manager, Green Cargo, Interview
[2] Marcin Tubylewicz, Strategic Production Development Manager, Green Cargo, Interview
[8] Ulf Wikström, Agreement Specialist, Green Cargo, Interview, 2013-02-19

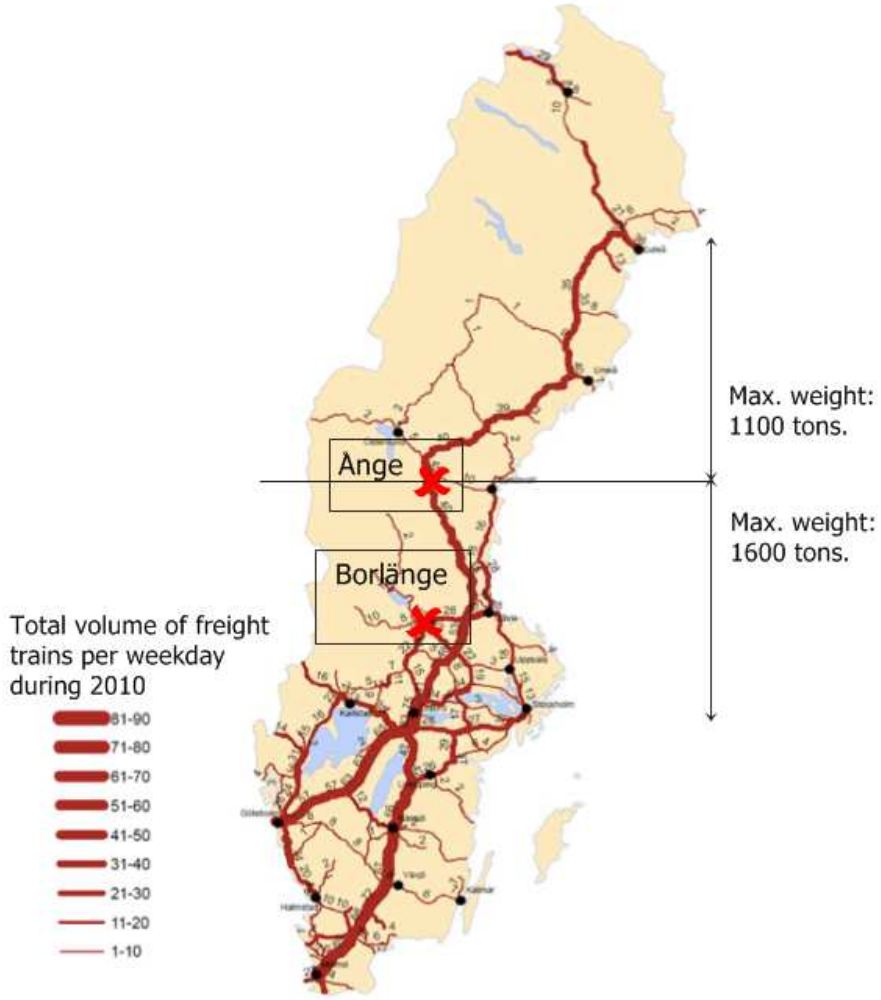


Figure 14: View of the total volumes of freight trains per weekday during 2010 (Trafikverket)

A possible suggestion which would significantly allow to optimize train capacity lies on establishing Ånge instead of Borlänge as the practical weight limit location, hence avoiding the current unnecessary weight limitation between these two cities and allowing to increase on 500 tons the transported weight of those trains travelling this route.

5.2.1.1 Calculation of weight and length capacity values

At present, Green Cargo only traces and analyzes capacity values regarding length and weight limitations for long-distance trains[12]. Figure 15 presents the average monthly capacity for the long-distance trains transported in Sweden from February 2012 to January 2013, in relation to with weight and length train target values.

[12] Fredrik Andersen, Organizational Specialist in Planning, Green Cargo, Interview, 2013-03-04

Figure 15: The average monthly capacity for the long-distance trains transported in Sweden from February 2012 to January 2013 (Green Cargo presentation material)

Capacity values regarding train length optimization are calculated considering the final length of each sent train in comparison with its maximum possible value, 600 meters. The average figure of train length capacity optimization during the mentioned period presented a value of 65,58%.

Capacity values related to train weight optimization are calculated establishing a weight target of 1300 tons, which approximately represents the average value between weight limitations in those rails further north and further south than Ånge, with 1100 and 1600 tons respectively. The average weight capacity values from February 2012 to January 2013 regarding versus the 1300 tons target level reached a value of 68,28%.[12]

Nevertheless, several reasons let us consider that 1300 tons does not represent a realistic overall target value in order to calculate train utilization of weight capacity. This figure represents an average value of the two allowed weight limits all over Sweden, but the reality shows that train volume further north than Ånge is far from representing the 50% of the overall transported cargo figures. Because of that, monthly weight capacity values present higher values than those would be obtained in case of using a most accurate target value. It would be interesting for Green Cargo to calculate weight optimization values for each train according to their real weight limitations in order to have a more precise and realistic view of their current situation.

Train capacity figures are calculated for each train covering a long-distance route after its real length and weight values are reported to the system. However, although those data are available they are not analyzed in a daily basis. At present, operational departments are in charge of making sure not to exceed length and weight train limitations before a train is allowed to leave, and real train capacity figures are

[12] Fredrik Andersen, Organizational Specialist in Planning, Green Cargo, Interview, 2013-03-04

calculated once the train has been sent[1]. Because of this reason, and according to Green Cargo top management, it is not necessary to analyze those daily data because the company does not enough resources to accomplish this task. In addition, daily capacity analyses would not provide them any significant advantage, because there is no possibility for them to carry out short-term modifications to solve possible undesired values.[2]

As it has been mentioned, Green Cargo only analyzes capacity train fill rates for those considered as long distance trains. It is suggested for Green Cargo to consider and try to increase capacity fill rates in those trains covering short and medium distances, aspect that can result easier to control than in long distance trains.

5.2.1.2 Target levels weight and length capacity fill rate

Green Cargo goals regarding weight and length capacity optimization presents a 75-75% relation target for both categories, versus the current 65-68% length-weight, seen in Figure 15 in Section 5.2.1.1, capacity optimization values obtained during the period February 2012-January 2013. Green Cargo is aware that practical train capacity may differ significantly from theoretical train capacity depending on the required degree of reliability. There is a trade-off between the reliability level of the offered services and the final and practical reached capacity (Abril et al, 2008). For this reason Green Cargo does not consider feasible to attempt to reach higher capacity values, because it might cause significant problems for the firm.

As it has been previously presented, customers can order certain wagons or a train until two days prior departure time whereas overall capacity planning is prepared with a much longer time horizon. Because of that, if during the planning process this firm would decide to work with figures of train length and weight capacity optimization closer than 100% and the final ordered volume by customers was higher than expected, Green Cargo may face important problems. In this situation, the firm would need to outsource those non predicted extra transport needs to certain truck companies, what would considerably make the planning process more complicated than it is already.

It is considered that those capacity optimization values seem to be achievable to reach and reasonable according to the current Green Cargo constraints. However, as it has been previously purposed, it would be interesting for the firm to calculating the weight capacity optimization values according to the real weight limitations of each route in order to avoid overestimations of the current values.

5.2.2 Allocation of final and real capacity needs

Final train fill rate capacity values are dependent on the whole planning process. At present, the overall capacity needs for the next year are planned according to historic data as well as yearly forecasting estimations made by the Market division. In base to

[1] Anders Lester, Quality and Organisational Development Manager, Green Cargo, Interview
[2] Marcin Tubylewicz, Strategic Production Development Manager, Green Cargo, Interview

those capacity estimations and Trafikverket decisions about how to allocate capacity, Green Cargo gets certain time slots around September of the previous planned year. Since that moment Green Cargo begins a complex process intended to create train routes, manage the empty wagons flow or allocating locomotive and operator resources for the next months, which finishes six weeks before certain planned week.

Before this six weeks period prior to train departure, it is possible to adapt automatically (not in a manual way), the planned activities in the software according to changing customer requirements. Nevertheless, after this time fence all required adaptations and modifications in the planned activities need to be done manually, which meant more than 30000 during 2012 and involved the full time work of several employees.[10]

The last step affecting the final train capacity values is related to the departments in charge of daily coordination of the real train traffic. Some of the problems faced by these "short-term" departments can be related with customer delays when preparing the goods to transport, changing orders or last minute cancellations. All this complex process is represented in Figure 16.

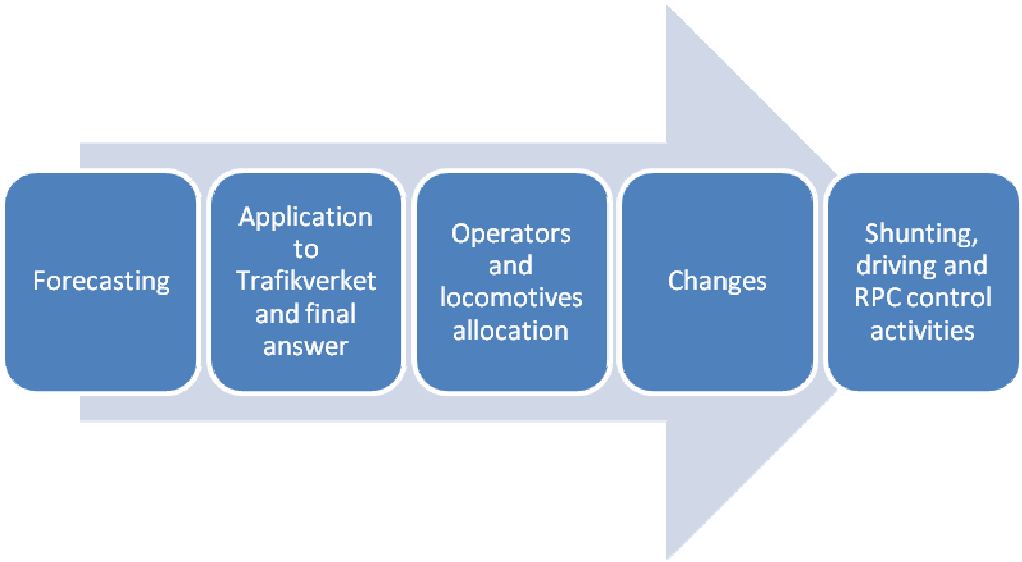


Figure 16: Process over how to reach final train capacity values

An analysis of the whole planning process let us identify several ideas destined to improve Green Cargo current situation regarding each of the presented planning steps, as well as for the general problems faced by the company.

5.2.2.1 Forecasting

As it is explained in Section 5.1.1, strategic planning for two years ahead is made considering historical data as well as yearly forecasting estimations regarding market changes. Since 2011, Green Cargo is under a continuous improvement process regarding forecasting of future capacity needs[11]. In that year it was adopted software

[10] Håkan Lind, Short-time Planner, Green Cargo, Interview, 2013-02-19

[11] Tomas Gädda, Capacity Manager, Green Cargo, Interview, 2013-02-21

in which Marketing department can upload their estimations for future needs as well as checking historic demand values. Within the future objectives it highlights the setting of 3 yearly forecasting processes, aspect which will optimize the future capacity needs estimations and will provide the planning departments more time in order to adapt and modify the existing production plans to the real capacity requirements.

At present, when Trafikverket allocates a time slot for the next year to a certain rail company, this firm has the possibility of cancelling that slot provided free of charge before planned train departure time. This situation causes some rail firms to book certain time slots in case they might need them because it does not cost anything for them. Nevertheless, situations like this represent an important problem for Trafikverket planning process and since next 2014 this company is going to implement a new booking system to solve this aspect. In the future, once a company receives the allocation of certain time slot, it will be necessary for them to pay a fee in order to book it. In that way, if a rail company later would want to cancel certain planned train, it would not be possible for it to get back the paid fee.[14]

As companies as Green Cargo will not anymore dispose of the flexibility of free train cancellation, it is considered that Green Cargo current implementation process of quarterly forecasting processes will help the firm to reduce significant amounts of money. A more accurate estimation regarding company future will allow Green Cargo to only apply for those required time slots, avoiding losing money related to the new Trafikverket fee.

5.2.2.2 General weekly planning and manual changes

Green Cargo operates with a large number of software programs in order to plan and control their activities. An analysis of the current situation indicates that this company does not explore all the possibilities offered by those software, and the communication between them is not very efficient in some occasions. This aspect is deeply analyzed in Section 7.2.1.

Those modifications on the already established train planning performed after 6 weeks in advance of the expected date represent an important and really time requiring problem for Green Cargo. Every time that a planned train needs to be changed, it is necessary to manually find an available locomotive, wagons, a suitable railroad route and as well as a required time slot to rearrange those trains and serve the customer within the promised delivery time[10]. Another possible modification lies on the cancellation of an already planned train. In that case would be necessary to consider, among other aspects, whether the engine or the transported wagons would be required in the final destination for future trips or whether it would be feasible to cancel planned drivers trips or modify shunters timetables.[12] Once these aspects have been analyzed, Green Cargo takes the decision of contacting Trafikverket to cancel a train, or on contrary, send the train although it only presents the locomotive and the driver.

As it can be observed, modifying or analyzing the possible cancellation of a planned train require to consider a large list of aspects which managed by several Green Cargo

[14] Bengt Palm, Capacity Distributer, Trafikverket, Interview, Date: 2013-03-19

[10] Håkan Lind, Short-time Planner, Green Cargo, Interview, 2013-02-19

[12] Fredrik Andersen, Organizational Specialist in Planning, Green Cargo, Interview, 2013-03-04

departments placed on different locations. In addition, it is necessary to add that each of those departments work with distinct and non-interconnected software, what makes even more difficult the communication between them and causes a long and requiring process until a final decision can be reached.

Green Cargo should actively work in the possibility of coordinating its software programs used by the different departments in order to facilitate and shorten the decision process and avoid forget considering any aspect considered as influencing for this. This suggestion would significantly improve the day-to-day management and coordination, because only during last year 2012 Green Cargo performed more than 30.000 "last-minute" changes, meaning a really considerable amount of working hours analyzing those aspects.

5.2.2.3 Operational planning and control

Operational planning and control departments are in charge of directing shunting operations as well as determining the final wagons allocation for each train. An analysis of the current situation of Green Cargo shows that those departments in charge of controlling shunting activities and train loading processes do not seem to be aware about some important company policies regarding train cancellation. In opinion of those operational control divisions, if possible, it is better to group into a single train those wagons travelling towards the same direction although those groups received the order of sending those wagons into several different trains. According to their own criteria, in this way train capacity is optimized and Green Cargo performance is improved, but they do not considered the problems linked to a modification in the already established train planning in the last moments. In those situations in which operational departments decide to cancel or modify an established train under their own criteria, Green Cargo central site in Hallsberg is obliged to solve the inconvenient associated to that situation in the best possible way, trying to maintain customer promised delivery times.[12]

Green Cargo needs to be aware of those undesirable situations, which show an important lack of communication between the different company departments. Although there are many disposable documents included in Green Cargo intranet informing about the most important policies and information of the company, it is clear that this communication way does not seem to be efficient enough. One suggestion in order to diminish this problem would lie on establishing periodical short courses and meetings in the different company departments intended to inform about the new company policies, the main problems faced by Green Cargo or solve employee doubts. Nevertheless, it is important to consider that many employees have already worked in the company for a very long period and it could be difficult to change their way of thinking.

[12] Fredrik Andersen, Organizational Specialist in Planning, Green Cargo, Interview, 2013-03-04

5.2.3 Green Cargo current blocking policy and new planned blocking policies

This section starts with a presentation of the different contractual relations offered by Green Cargo to its customers at present. Then, it is introduced a new possible blocking idea in which Green Cargo is currently working. This new policy idea will be analyzed, and several important limitations linked to it will be presented.

5.2.3.1 Current situation: contractual relations with customers and anchor blocks

At present, Green Cargo disposes of a three different contract types to offer to customers: single wagons, fixed delivery and dedicated trains. All those were presented in Section 4.4.4. Whereas single wagon and fixed delivery contracts give Green Cargo the possibility of transport in the same train cargo from different companies, those trains categorized as dedicated only transport cargo from a single customer.

The "anchor block" concept is also considered a very useful approach to optimize train capacity in those cases in which a train is shared by various customers. The remaining train capacity after considering anchor block customer demands (See Section 5.1.4 for a further explanation of anchor block concept) can be completed by other customers contracting "single wagons". Green Cargo already works actively with this concept[3], and it is suggested to continue developing this idea in order to create more capacity optimized trains, and hence increase the efficiency in the transport activities.

5.2.3.2 Presentation of the new planned blocking policy and its limitations

Green Cargo strategic management is working on a drastic modification on the current booking system, substituting the three contract types for a single option in which customers buy certain amount of capacity[3]. This new booking system is linked to a new wagons blocking policy which is characterized for the cancellation of dedicated trains. Figure 17 represents a comparison between the current Green Cargo blocking system and the new purposed one.

The three first pictures indicate how the blocking policy is made at present. The first picture corresponds to a "single wagon" contract, in which wagons from different customers are transported in the same train. The second train corresponds to "dedicated trains", in which all transported wagons in each train belong to the same customer. The third train corresponds to an intermodal train, transporting cargo containers between different ways of transport.

[3] Inger Ericsson, Head of Strategic Production Development, Green Cargo, Interview, 2013-02-04

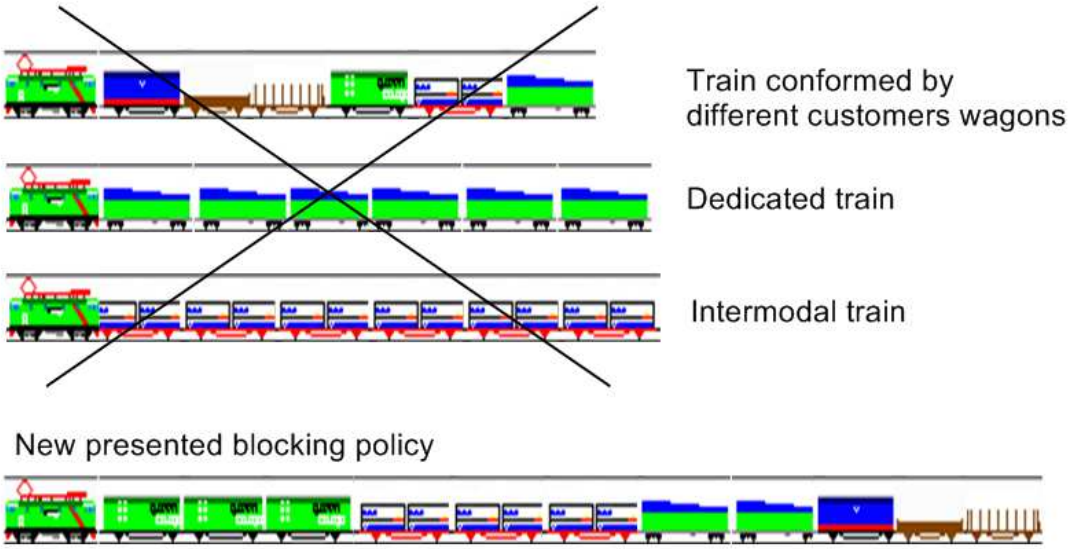


Figure 17: Comparison between the current Green Cargo blocking system and the new purposed one (Green Cargo presentation material)

The fourth picture presents the new blocking policy idea, which main advantage lies on the possibility of creating more optimized trains from a capacity perspective and hence, reducing Green Cargo current expenses per travelled ton-km . In this situation, each customer would apply for certain capacity and Green Cargo would be in charge of combining the different customer requests creating a more optimized train, both for weight and length.[3] One possibility to achieve this would be mixing light and heavy cargo from different branches. The new blocking policy would also offer customers the option of getting a fixed delivery time and priority over other customers by paying an extra fee.

This new blocking policy system is only an idea and it is not introduced yet in Green Cargo operations. The implementation of the new booking and blocking policies would require the adaptation of the software system as well as a deep restructuration in the current customer contractual relations. But, previous to modifying the current blocking policy, it is considered that Green Cargo should take into account some aspects that could make this concept not to be as successful and profitable as desired.

At present, some high importance customers operating with dedicated trains, such as SSAB, are not disposed to share their trains with other customers, although this possibility would provide them economic advantages.[2] Those customers prefer to pay the whole train although they do not use it totally to avoid problems such as delivery delays caused by other customers. On contrary, other customers working with dedicated trains accept sharing part of their spare train capacity with other firms to reduce their total costs.

It seem to be very difficult to change the mind of those customers not willing to share their dedicated trains, making them send several wagons in different trains instead of a whole own dedicated train. Green Cargo could try to convince those customers about the advantages of a mixed blocking system offering them interesting fares for their services. Nevertheless, Green Cargo must consider the possibility that any of its

[2] Marcin Tubylewicz, Strategic Production Development Manager, Green Cargo, Interview

competitors offer those firms the possibility of working with own "dedicated trains" even at cheaper prices.

Green Cargo current main competitive advantage is the great variety of offered destinations in Sweden, unlike rail freight competitors, which currently work in a reduced number of stations[3]. Nevertheless, if any of those competitor firms could reach all the required destinations for a big company such as SSAB and offering low fares "dedicated trains", it would be a high possibility for Green Cargo to lose that customer.

If eventually that customer, i.e.: SSAB, decided to terminate its contractual relation with Green Cargo, apart from the direct loss of money linked to the completion of the transport services the company would face another expenses. Green Cargo owns special wagons dedicated to high importance customer services that cannot be used for other purposes[4]. In case of losing the customer linked to those wagons, Green Cargo would have to face some storing expenses for them although they were not used anymore, or on contrary Green Cargo could sell those wagons to the competitor firm which would need them.

Other disadvantages from the "mixed blocking policy" compared to the current Green Cargo blocking policy lies of the extra difficulty of determining which the contribution of each customer to the total company profit is, or the possible delays when operating with many different customers within the same train.

Although the idea of establishing a "mixed blocking system" theoretically represents an interesting option for optimizing train capacity, Green Cargo needs to consider all the potential problems linked to this new way of thinking. Especially, Green Cargo must contemplate the possibility of losing important customers which represent a high profit source if they would not accept those new booking and blocking policies. In addition, the introduction of this new blocking policy would require a deep restructuration in Green Cargo way of working which does not seem to be feasible in a short time period. Considering that this company does not have enough resources to exploit its software[12], the new blocking policy seems to be far too resource demanding to be implemented. Green Cargo should preferably focus its efforts in optimizing the utilization of its software and get as much profit as possible from them before trying to establish the new blocking policies.

5.2.4 Future implementation and limitations of the "layer on layer" concept

Green Cargo is working on a new concept called "Layer on Layer", not yet in practice, intended to increase the firm flexibility relating demand changes and to create more capacity optimized trains. This concept is meant to be used to adapt to customers demand changes in a well established and controlled way. It is also considered to be very useful and beneficial to adapt to lower or higher economic activity rates, either nationally or internationally[3].

[3] Inger Ericsson, Head of Strategic Production Development, Green Cargo, Interview, 2013-02-04

[4] Mats Tapper, Strategic Infrastructural Planner, Green Cargo, Interview, 2013-02-06; 2013-03-19

[12] Fredrik Andersen, Organizational Specialist in Planning, Green Cargo, Interview, 2013-03-04

[3] Inger Ericsson, Head of Strategic Production Development, Green Cargo, Interview, 2013-02-04

"Layer on Layer" presents the introduction of an additional layer (or even more than one), of trains on top of the original schedule plan in those situations when there is enough volume to support a new train to travel between two train building yards without having the need to stop at the passing yards[3]. For example if the original train is scheduled to departure from Station B through station C and arrive down to Station F, as can be seen in Figure 18, if enough bookings are ordered an additional direct train can be added going directly from Station C down to Station F.

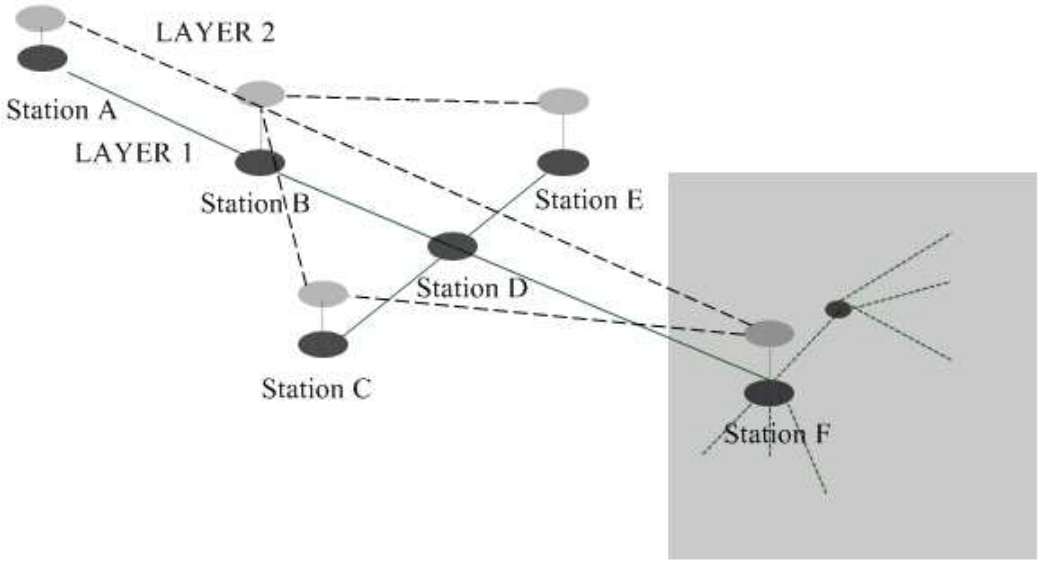


Figure 18: Illustration of the layer on layer concept

The time slots for all planned layers of trains need to be applied to Trafikverket during the previous year than the expected departure date. When the departure date was closer, Green Cargo could estimate whether there is enough cargo volume to transport and maintain that secondary layer (direct train) or, on contrary, it should be cancelled to Trafikverket before its departing time. It is always the direct train that is being lifted and canceled in case of a change in demand, as there could be possible transport plans to the one of several stations in-between. The express train is therefore only used when the volume of transports require it and the express trains delivery time can consequently not be promised to the customers.[3] Nevertheless, Green Cargo need to consider some important limitations that would significantly reduce the potential economic savings linked to this technique.

At present, Green Cargo and any other rail company in Sweden can cancel their assigned time slots if not required provided free of charge before expected departure time. However, as it has been mentioned in previous sections, in the near future Trafikverket is going to introduce a booking fee which could not be refunded in case of not using the assigned time slot. This situation would significantly affect "Layer on Layer" concept theoretical profit. Depending on how expensive the booking fee was, Green Cargo may not consider worthy paying for some train slots that might not be used later. This fact would make really necessary to adequate the forecasting estimations to avoid book and hence pay for a time slot that will not finally be needed. Green Cargo is already working on improving the forecasting process, establishing

[3] Inger Ericsson, Head of Strategic Production Development, Green Cargo, Interview, 2013-02-04

quarterly demand estimations instead of yearly ones, fact which significantly would allow to adequate the future needs estimations. It is strongly suggested for Green Cargo to continue working on this idea and optimize its forecasting estimations.

Another aspect to consider is that when certain rail company applies for a timetable to Trafikverket and finally decides to cancel it, it is very likely this rail company will not receive this specific time slot in future allocation processes if another firm is also interested in it[14]. This is another reason for which it is really important to adequate forecasting estimations.

Another downside of this concept is linked to Green Cargo booking policies (1st booked 1st delivered). With this idea, those customers booking their transport needs firstly would be allocated in the regular first layer, while last bookers would get the shortcut second layer transport. If "layer on layer" is implemented, instead of rewarding those customers booking their needs on advance, "last minute" bookers would receive the best routes (second layer). Nevertheless, it is considered that Green Cargo should preferably award those customers booking with more time in advance, and hence allowing the company to plan and allocate trains in the most efficient way, with the best train routes.

5.3 Capacity optimization area 2: peak reduction of the nightly train traffic

In the rail industry all over the world, daily hours are most covered by passenger trains whereas freight transport mainly runs during night time. This fact creates important economic disadvantages for Green Cargo, having to face higher drivers nightly salaries or lower allowed working hours per day. Nevertheless, possible improvements in this category are restricted by two main actors: Trafikverket and customer demands.

At present, Green Cargo operates certain routes because of the existence of individual anchor block companies in specific area. This concept means that one or several customers require enough transportation to make a train profitable to run, using the remaining train capacity to serve other firms. Because of the changing economic situation, it would be needed to determine if the current customers considered as anchor companies still represent this role. If not, Green Cargo could decide to avoid operating these routes, or make those customers adapt to receive cargo during hour days in order to reduce nightly peak times.

Another aspect related to peak train distribution is the local planning of train routes, which allows to create different connections between certain locations, avoiding those congested railroads mainly used by passenger trains and representing higher utilization fees. This chapter analyzes all those mentioned aspects and investigate the possibilities to decrease the nightly cargo transport peak taking into consideration the existing and future limitations.

[14] Bengt Palm, Capacity Distributer, Trafikverket, Interview, Date: 2013-03-19

5.3.1 Peak time distribution in cargo trains

In Sweden, following the same trend than other European countries cargo train transportation mainly takes place during night hours (Pricewaterhouse Coopers, 2008). Figure 19 presents the Green Cargo current situation regarding the number of moving locomotives for the different hours and days of the week. As it can be observed freight cargo transport is mostly performed during week days, especially from Monday to Thursday; whereas during Friday, Saturday and Sunday the volume of moving locomotives is much more reduced. This situation is caused by the intimate relation between Green Cargo transportation services and industry, which normally operates during weekdays and reduces its activity levels during the weekend[1,2]. An observation of the Figure 19 indicates that the highest locomotive activity rates, colored in green, happen during the time slot from 22:00- 02:00 since Sunday night until Friday morning. At present most cargo trains runs during the night, which causes that companies such as Green Cargo need to dimension their capacity needs in base to those nightly peak requirements, establishing idle capacity during the rest of the day. During those peak service hours around 120 locomotives are driven at the same time, whereas in the intervals between 06:00 - 12:00 from Monday to Friday, only about 70 locomotives are driven. During weekends freight cargo transportation presents its lowest activity rates, existing a minimum number of driven locomotives on Saturday from 00:00 - 10:00 am.

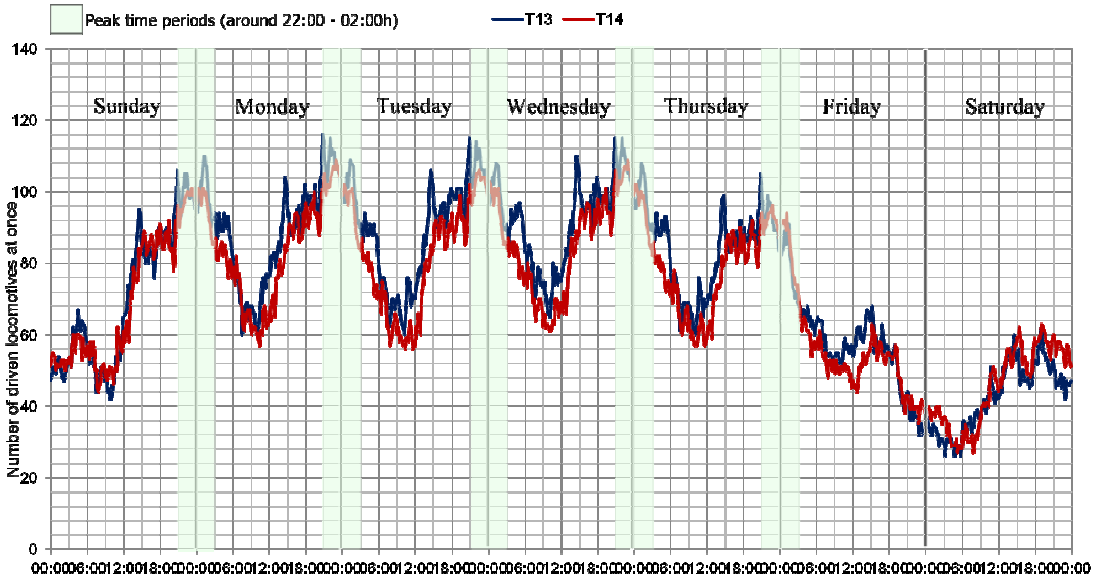


Figure 19: Weekly and hourly locomotives utilization during 2013 and 2014 (expected). Peak time periods marked in green

The highest nightly freight transport activity rate, called “peak times” from here in advance, is caused by several aspects. Train passenger traffic in the whole Europe mainly takes place during day times, displacing rail freight to the night time slots not used by passengers. In addition, customers usually request to have their cargo orders

[1] Anders Lester, Quality and Organisational Development Manager, Green Cargo, Interview
[2] Marcin Tubylewicz, Strategic Production Development Manager, Green Cargo, Interview

delivered in the morning, what makes Green Cargo operate during night hours to satisfy its customer requirements.

"Peak times" represent an important problem for Green Cargo, making this firm own a higher resources volume than required in case of a more even flow during the day, and generating extra expenses because of the nightly working regulations.

5.3.1.1 Problems associated to nightly regulations legislation

Nightly "peak times" make Green Cargo to dispose of a locomotives volume enough to satisfy those highest activity rates, but they also imply the need of nightly drivers working, presenting special regulations and higher operator fares than those faced during diurnal working hours.

As it was explained in Section 4.4.7. both Swedish and Green Cargo legislations are regulated by European limitations, without any non-fulfillment possibility to those. On the other hand, Green Cargo policies are limited by Swedish legislation but, nevertheless, if agreed with the union, Green Cargo can establish some policies out from Swedish legislation but respecting European limitations.

Swedish legislation sets weekly working times limited to 40 hours in which employees cannot work over 23:00. Green Cargo transportation services are mainly carried out during nightly hours, which create the need of special nightly regulations for this firm. Agreements between union and top management have established a maximum weekly workday of 36 hours in those cases of nightly activities, also rewarded when higher salaries than during diurnal hours.[8]

Green Cargo is very concerned in the reduction of nightly "peak times" because its associated employee nightly regulations implies this firm of disposing a higher number of drivers than required in case of daily hours due to the shorter weekly workday limitations. In addition, nightly drivers' services are also more expensive. All these aspects would make very interesting for Green Cargo to distribute their cargo transport services all over the day, reducing the nightly peak hours and hence obtaining better economic conditions. Nevertheless, there are some factors limiting the possibilities of reducing the nightly "peak times" such as Trafikverket limitations or the future of the rail industry sector.

5.3.2 Trafikverket and rail industry: main causes of nightly peak times

As it has been previously presented in Section 4.4.1, Green Cargo is importantly constrained by Trafikverket. This organization determines the railroad allocations between passengers and freight transport, hence significantly influencing the future expansion possibilities of Green Cargo.

The current railroad situation shows an industry dominated by train passenger transport, group disposing of the daily time slots and considered as priority over freight trains. In those conflictive situations in which both a passenger train and a cargo train require the same railroad, the cargo train will have to stop on the rail side

[8] Ulf Wikström, Agreement Specialist, Green Cargo, Interview, 2013-02-19

to give preference to the passenger train. Time invested by cargo trains in the rail side represent an important contribution along the year. During 2011, waiting times on the side track involved an increase of 150 million SEK of Green Cargo total production costs.

According to Trafikverket, this priority system is explained because of higher passenger trains speed, what makes more feasible for cargo trains to give preference. In addition, possible passenger complaints because of late train departures or arrivals are other cause justifying this priority rules.[14] At a European level, passenger trains priority over cargo transportation is also the common approach. (Pricewaterhouse Coopers, 2008)

One of the European Union objectives lies in revitalizing the freight train transport sector, considered more eco-friendly that truck transportation, its main competitor area. In the last years, freight train transport has continuously lost importance while, on the opposite way, truck sector is becoming a more powerful area. In order to make freight rail transportation a competitive alternative versus trucks, some important modifications in the train industry would be required, especially those linked to establishing a higher priority of cargo over passenger trains. Results associated to this hypothetical situation characterized by an increased freight priority are presented in the European Unions study, Preparatory study for an impact assessment for a rail network giving priority to freight. (Pricewaterhouse Coopers, 2008) This purposed priority system would significantly advance Green Cargo, allowing reducing its nightly peak times.

Nevertheless, the evolution of the current rail transport sector neglects this possibility, expecting a continuous increase in the passenger transportation both at national and European levels. According to Trafikverket, in the next years Swedish rail industry will welcome a great number of passenger companies (at present all passenger transport in Sweden is controlled by a single company, SJ)[14]. As it happens now, those new companies will have priority over cargo transportation, what will make even more difficult for companies such as Green Cargo to get time slots during diurnal hours, especially in the commuting hours (Monday to Friday from 06:00 – 11:00).

Apart from these constraints for rail cargo transport linked to Trafikverket and the rail passenger transportation, it is necessary to consider the traditional schedules in cargo transportation. According to tradition, industry is used to receiving its orders and materials at first time in the morning and sending its finished products at the end of the workday, what makes Green Cargo travel during the night to satisfy customer requirements. Nevertheless, Green Cargo believes that companies could change this traditional delivery times, and adapt to a more daily freight services, especially if lower fares were associated to this idea.[2]

All the previous aspects make us think that it would not be possible to face a significant change in the current rail allocation. However, next sections introduce several improvement areas which could be relatively easily implemented and would significantly help Green Cargo to reduce the current peak times and optimizing its capacity levels.

[14] Bengt Palm, Capacity Distributer, Trafikverket, Interview, Date: 2013-03-19

[2] Marcin Tubylewicz, Strategic Production Development Manager, Green Cargo, Interview

5.3.3 Anchor blocks: relation with peak time distribution

Another cause of the current nightly peak times is related with the "anchor block" concept. A Green Cargo customer is considered to be as an anchor block when it requires enough transportation volume in order to make a train profitable to travel. In some occasions, anchor block-customer demands represent a whole train, whereas in other situations the remaining free capacity is offered to other firms operating in the same route, creating in that way more capacity optimized trains.

Green Cargo and its anchor block companies are joined by contractual relations of the type "fixed delivery" or "dedicated trains" (see Section 4.4.1), in which delivery times are scheduled according to customer requirements. In many of the situations, those companies require Green Cargo the traditional industrial schedule, characterized by the reception of the finished orders at the end of certain day and their orders delivery before the beginning of the next working day. In order to satisfy those customer requirements Green Cargo is forced to drive their trains during nightly hours although this represents higher costs than diurnal work, causing the appearance of nightly peak times.

According to Green Cargo's top management anchor blocks time requirements are mainly influenced by industry traditions, and some of those companies would not have any important inconvenient in adapting their delivery times to more diurnal timetables.[2] This aspect would significantly help Green Cargo to reduce its expenses linked to nightly services.

The changing economic situation suffered by Sweden in the last years causes Green Cargo not to be certain if the customers formerly categorized as anchor blocks still represent this role for the company. In those situations in which Green Cargo is not aware about whether a certain customer is an anchor block or not anymore, it is necessary to analyze if that customer still creates profit to Green Cargo.

Green Cargo is not interested in operating with those customers that do not represent profit for the company, and that is why this firm is considering a new approach to achieve this objective. The strategic planning department has determined the need of carrying out a detailed analysis intended to determine if those considered as anchor block-customers still represent this role for the firm. In addition, all the current anchor block firms will be phoned to present them the possibility of modifying and adapting their time requirements to more diurnal ones[2]. Once this information has been gathered and studied, Green Cargo will be able to establish a clearer image of their current situation as well as its improvement possibilities. Thanks to this, it will be possible to avoid operating with those firms not representing profits for the company and restructure Green Cargo routes in basis to the new anchor block-customer map as well as the expected more diurnal transport requirements.

In order to make the idea of moving scheduled timetables to more diurnal hours, anchor block customers could be offered economic advantages linked to that idea, in the same way that Green Cargo would be benefited of avoiding operating after 23.00.

Those customers presenting "single wagon" contractual relations with Green Cargo, which are allocated in many occasion in the remaining capacity train after serving "anchor block" customers represent another possibility for reducing the nightly peak times. The 60 hours delivery time provide Green Cargo flexibility to plan those

[2] Marcin Tubylewicz, Strategic Production Development Manager, Green Cargo, Interview

wagons transportation out from the peak night hours, when possible. A lengthening in the current maximum agreed delivery period for "single wagons" would offer Green Cargo extra flexibility to determine when those "single wagons" could be transported. Often punctuality is more important than speed for customers.[8] This statement allow us to think that those "single wagons" customers would not have any important problem in adapting to longer delivery times always that Green Cargo informs them and fulfills its planned arrival time. This measure would provide this company higher flexibility levels to avoid the transportation of those wagons during peak time timetables.

5.3.4 Local planning: relation with peak time distribution

Swedish railroads can be divided in three pricing categories: red, yellow and green, representing respectively the most and least expensive railroads. (Trafikverket, 2013) Figure 20 presents the Swedish rail system in function of these three groups. Red color is linked to the most important railroads providing direct and fast connections between Swedish big cities. Yellow and green categories represent respectively medium and lowest price railroads categories in Sweden.

Passenger transportation mainly takes place in red-categorized railroads, presenting its highest activity rates from Monday to Friday at commuting hours (06:00 – 11:00). The rest of the day passenger and cargo transport shares these red railroads, always considering priority of the first group over freight transport. This situation creates important loses for companies such as Green Cargo, which besides of having paid for using a fast (red) railroad are forced to wait in the side track in case of conflicting situation with passenger trains. Nightly transportation represents for cargo transport firms the only non problematic timetable for using red-categorized railroads because of the absence of passenger trains.

Yellow and green-categorized railroads are mainly used by freight transportation trains. Those railroads run through less important municipalities than red ones, allowing companies such as Green Cargo arriving to those customers placed out of high size cities. One example of this customer is Stora Enso placed in Hyltebruk, a small town located near Halmstad. This location will be further analyzed in Section 6.

According to this information, it could lead to think that the best option for Green Cargo would lie on establishing all their train routes through yellow and green-categorized railroads, thus benefitting from aspects such as lower railroad fares and more independence from passenger trains, avoiding side track waiting times. Some authors defends that a possibility to increase freight trains market share is creating sub-networks of railroads in which freight transport is priority. Those "sub-networks" would identify with yellow and green railroad groups. Nevertheless, there are several practical limitations reducing the applicability of planning Green Cargo activities by mostly using yellow and green railroads, idea since now called "local planning". (Racunica & Wynter, 2005)

[8] Ulf Wikström, Agreement Specialist, Green Cargo, Interview, 2013-02-19

Figure 20: View of the Swedish railroad network and its track prices high, medium and basic. Trafikverket, 2013)

In order to satisfy its customer requirements, Green Cargo offers more than 300 possible destinations since which orders can be picked or delivered. Those destinations are operated by the 33 stations all over Sweden with located shunters and drivers, called "Main Sites" in the rest of this project. All those locations present a wide variety of sizes, making each of them only be reachable by a specific railroad category: red, yellow or green.

Those aspects, in addition to Green Cargo delivery time policies, which establish a delivery time up to 60 hours since an order is made wherever the required service is located, makes necessary for this firm to operate by using fast and red-categorized railroads. Although freight cargo transport mainly takes place during nightly hours

part of the Green Cargo transportation is made during day hours, needing to share red-categorized railroads with passenger trains, what may occasion those problems already presented.

Green Cargo infrastructural planners are aware of these problems and shows that although there are many disadvantages when sharing the railroad with passenger trains, it is still necessary for the firm to do it. Without using red railroads during day hours this company could not fulfill its time delivery policies, aspect that would cause negative consequences in the relation with its customers.[4]

Moreover, some of the main sites are placed under red-categorized zones. Green Cargo could decide to avoid travelling to those locations by using an alternative route one planned only over yellow and green railroads, and avoiding in that way side track delays and high fares. Nevertheless, this idea would require the daily transportation of the employees belonging to certain main site until those new routes, resulting in high expenses and a non-efficient way of working. This particular situation represents an economic trade-off for Green Cargo, which is normally solved by operating through the red-categorized rails.

Considering the forecasting regarding rail industry, establishing an even more important passenger transport sector than at present, it is highly suggested for Green Cargo to continue developing and working on its "Local planning" idea. In that way it could be possible to avoid problems linked to the higher priority of passenger transport, and using less expensive routes; but unfortunately it would bring associated longer delivery times. It seems clear than a future expansion of the "local planning" concept should be linked to an enlargement of the delivery times, which could be more easily adapted in those contracting situations of "single wagons". In case of establishing a new blocking system, as it is explained in Section 5.4.2, this idea could adopted since the beginning, giving the company more flexibility to plan alternative routes avoiding as much as feasible those red-categorized railroads.

5.3.5 Possible improvement: expansion of nightly peak time periods

After the previous analysis regarding the influencing factors in the current nightly peak time activities in Green Cargo, it can be concluded that the most feasible improvement possibility would lie on expanding the current peak time period. Figure 21 shows a graphical representation of this idea. At present, peak time interval corresponds from 22:00-02:00, showing a maximum value of 115 driven locomotives at the same time on Monday night.

According to the presented restrictions imposed by passenger transportation, it would not be possible for Green Cargo to increase its volume of driven trains during commuting hours (06:00-11:00 from Monday to Friday). As it can be observed in Figure 21, those time slots from 15:00 to 21:00 from Monday to Friday present an important cargo traffic volume, although not comparable with the peak time values. This time period before 23:00, is controlled by general and diurnal driver regulations and not by the special economical nightly conditions. After Green Cargo expected interviews with its anchor block-customers (see Section 5.3.3), hopefully some of

[4] Mats Tapper, Strategic Infrastructural Planner, Green Cargo, Interview, 2013-02-06; 2013-03-19

those would accept a change in their delivery times, making possible an expansion in the current peak time period.

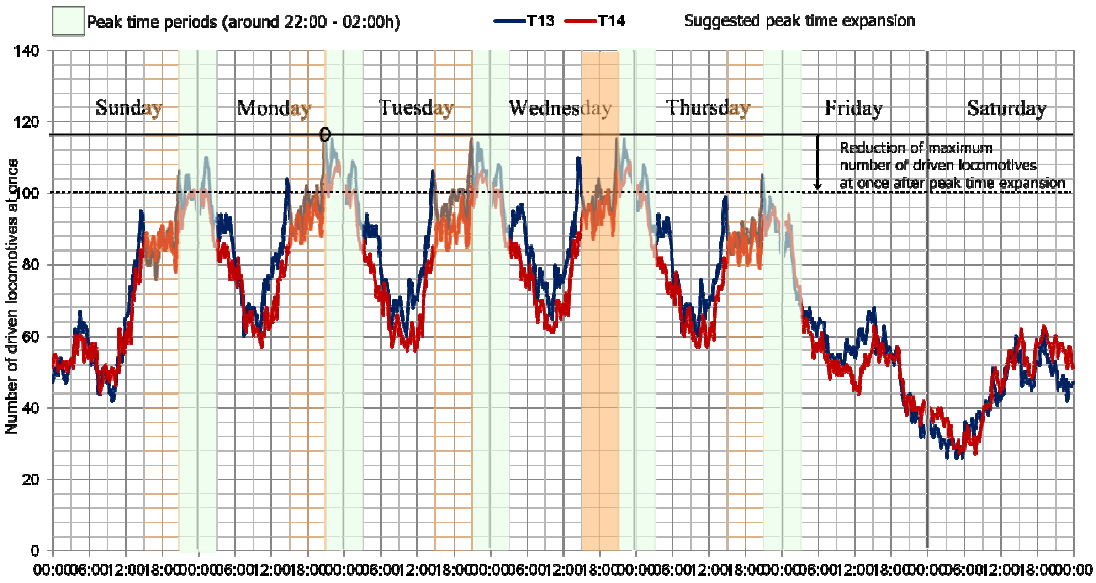


Figure 21: Weekly and hourly locomotives utilization during 2013 and 2014 (expected). Suggested peak time expansion marked in orange and green

With a wider peak time period (colors orange + green), in which it was established an even use of the locomotive resources it would be possible to reduce the maximum amount of needed locomotives at the same time. This would give Green Cargo the possibility of selling or renting those extra locomotives to other companies, or not having to purchase more in case of an expansion in its business. In addition, a reduction of the number of locomotives driven at night would bring Green Cargo an important driver related costs saving, linked to the avoiding of those unfavorable economic conditions for the firm during nightly timetables.

The expansion in the current peak time period would neither affect the maintenance activity services, at present performed during morning hours in which cargo transportation presents its lowest activity levels.

5.4 Capacity optimization area 3: Reduction of the uneven flow of cargo trains

Another problem faced by Green Cargo is the uneven cargo transportation demand during weekdays, from Monday to Friday. This situation creates a uneven resources utilization, and makes Green Cargo dimension its resource volume according to those days with highest activity rates.

The objective of achieving a more even daily transport flow seems to be difficult, because this aspect is slightly linked with customer demands, and therefore difficult to control. This section presents two ideas intended to obtain a more even flow of cargo trains: the importance of reducing the variety of locomotives and the introduction of a new customer prioritization system.

5.4.1 Weekly variation of cargo transport

Cargo transportation is intimately related to industrial activities, which present the highest production rates mainly during weekdays (Monday to Friday). (Kwon et al, 1998) This fact is clearly represented in Figure 22, in which it can be observed that freight traffic volume is much higher from Sunday to Friday afternoons than during weekend time.

In addition to the uneven cargo traffic between weekdays and weekend days, it is also important to consider the uneven cargo flow during weekdays. Traditionally, Tuesday and Thursday have represented those days with higher freight train flow.[12] In the last years Green Cargo has done important efforts to balance out the uneven cargo flow during the weekdays. One of the adopted measures was to manually allocate new customer bookings to Monday and Friday, days presenting less cargo traffic. Improvements like this have allowed Green Cargo to achieve less traffic variation during the weekdays, as can be seen in the Figure 22. Nevertheless, Green Cargo still wishes to smooth even more the uneven weekly cargo flow.

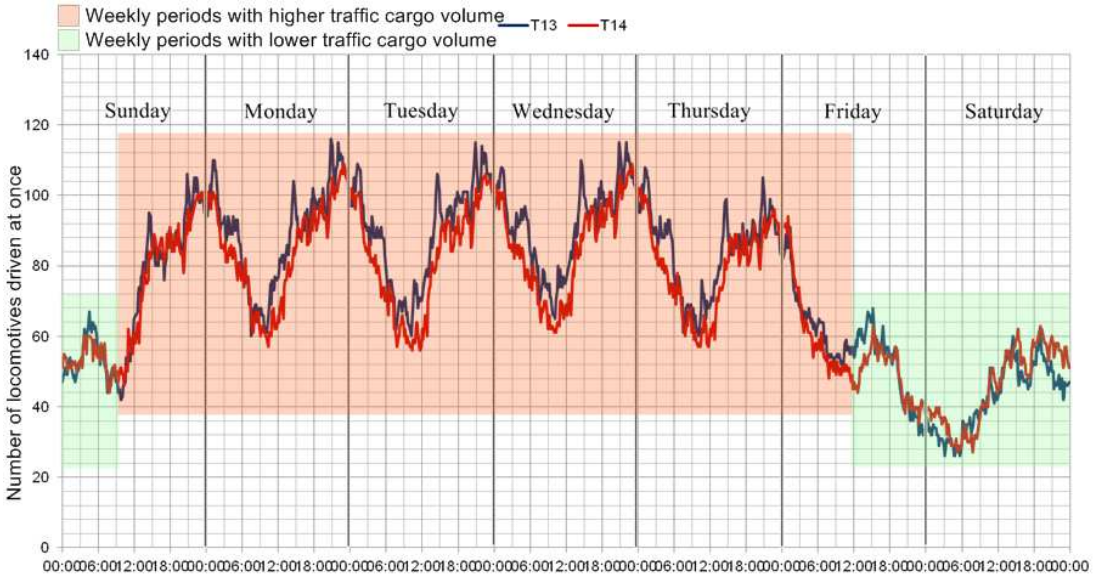


Figure 22: Average utilization of locomotives during week days in 2013 and 2014 (expected)

Apart from trying to establish contracts with new customers mainly during those days with less traffic volume, Green Cargo should analyze its current customer needs and demands. It is very likely that certain old customers accept some modifications on their agreed delivery days, providing Green Cargo the possibility of establishing a more even weekly cargo flow.

Some of the benefits linked to the reduction in the weekly traffic variation are the establishment of better planning processes, the achievement of increased punctually precision and the resources optimization. An even traffic volume would allow to dimension both engines and personnel requirements according to the highest activity rates, which are supposed to be quite similar during the different weekdays.

[12] Fredrik Andersen, Organizational Specialist in Planning, Green Cargo, Interview, 2013-03-04

5.4.2 Advantages linked to the reduction of the number of engine types

Green Cargo has a total of 18 types of engines. They can be categorized as diesel engines and electrical ones. The diesel engines are more used in shunting, because electricity is not always available in the totality of shunting yards. The newer electrical engines are used for longer distances threw Sweden. (Green Cargo, 2012) If looking more closely on the different engines there are other differences between the types as well, making the variation and final number of distinct engines even higher[12]. Different training is needed for many of the engines.

Only a driver or shunter with training and knowledge of a specific type of engine is able to use it, making matching engine with a suitable driver an important part of planning the schedules. This irregularity makes it tricky to keep a even flow on the traffic as there always has to a specific engine with specifically trained personal at the correct location to provide the transport service.

If a reduction in different types of locomotives would be achieved, there would be fewer problems in locomotives and drivers allocation process. In addition, equipment and education for drivers as well as shunters could be majorly standardized, providing more flexibility to adapt employees to the different locomotive resources.

Despite of the possible advantages linked to the standardization of the locomotives park, unfortunately Green Cargo is working in the complete opposite direction as new and different types of locomotives are bought, increasing this problem even more.

5.4.3 New suggested blocking policy and introduction of a categorization system

The current Green Cargo booking system stands that the first customer in booking some services will get the first available slot. This policy only is applied with those customers having contractual relations of the type “single wagons” (See Section 4.4.4), because the other customers, included in the groups “fixed delivery times” or “dedicated trains”, dispose of established and fixed delivery times.

The policy first booked first served can be considered to be as one of the causes of the uneven transportation flow during the weekdays. This booking system does not consider any priority category, resulting in negative consequences for Green Cargo. For example, in certain occasions, some orders not considered to be really profitable from the economic point of view are accepted whereas other orders considered to be much more worthy to work with cannot be accepted because they have been order later. Green Cargo should take notice to the different several types of customers to take notice to, as they are fairly easy to separate and investigate if they should be prioritized.

If Green Cargo adopted a new priority categorization system, at the same time it also would be possible to introduce some modifications related to the current customer booking system. Those changes in the booking system were expected to stimulate

[12] Fredrik Andersen, Organizational Specialist in Planning, Green Cargo, Interview, 2013-03-04

customers to book their orders with more time in advance and plan their wagon requirements in a more accurate way. In order to achieve this objective, customers could be benefited with certain advantages and discounts if they could schedule their needs further in advance than other companies. If customers made their orders with a longer period in advance, this fact would provide Green Cargo more flexibility to allocate orders to the different scheduled trains. Consequently, a more even transportation flow during the weekdays could be created.

According to our new purposed priority system for Green Cargo, the customer prioritization process should take into consideration several aspects, which are presented in Figure 23.

Green Cargo priority system should be determined by establishing suitable balance among the economic profit linked to each specific order, the actual agreement between each customer and Green Cargo, and the customer priority level. It is important to remark that this idea could be adopted in the current booking system when working with "single wagons" customers, as well as in the expected and purposed future blocking system presented in Section 5.2.3.

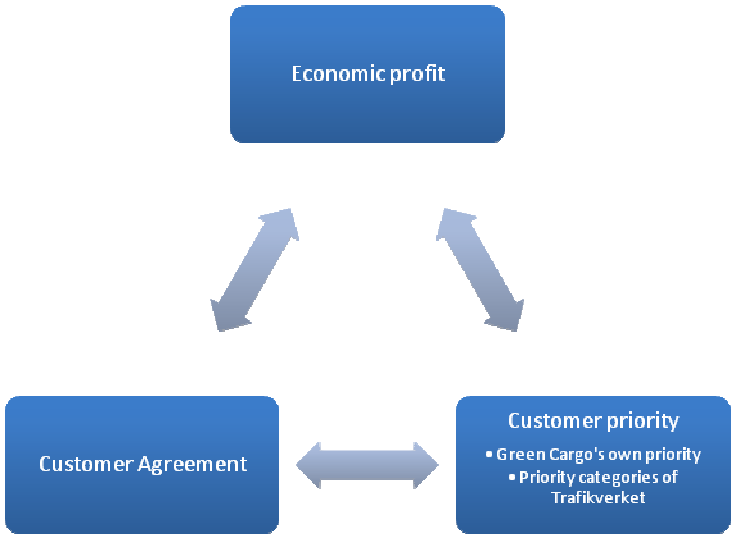


Figure 23: Demonstration of factors that should be taken into consideration in the customer prioritization process

5.4.3.1 Economic profit

At present, the economic profit associated to certain order does not represent a main guideline or criteria to decide which transports should be prioritized. It would be definitely suggested to determine the actual profit linked to each customer transport activities. In this way, it would be possible to weight those profits against each other and determine which customer would be more profitable to prioritize from an economic point of view.

Currently Green Cargo does not dispose of any software or system able to do these complex calculations, but it is strongly suggested to prioritize the introduction of a pricing system. An advance pricing system would help Green Cargo to analyze the profits associated to each of the services provided to customers and would provide

accurate data in which base decisions. Thanks to the information provided from this system, Green Cargo would be able to avoid those activities not considered to be profitable for the firm, hence increasing the company profit.

It is important to point out that, at present, Green Cargo is so customer satisfaction oriented that until certain deal is not signed with the customer, it is not possible to confirm whether that agreement will be profitable or not for the company. Green Cargo should solve this problem and make sure of operating only with those customers providing any type of economic advantage.

5.4.3.2 Customer agreements

The general customer agreement policy states that Green Cargo has 60 hours period to deliver a booked order to its required customer. Normally, those 60 hours are not completely required and deliveries are done way ahead of the deadline, aspect considered as positive both from a customer satisfaction point of view and market competitive point of view.

A great possibility for optimizing train capacity, establishing less expensive routes and creating a more even transport flow lies on making the most of the 60 hours delivery time period. The transportation of those non-priority cargo could be spread on time to even out the weekly traffic volume, provided that 60 delivery hours are respected. The full exploitation of the maximum delivery period would also allow the further implementation of the local planning concept (Section 5.3.4). Cargo could be transported on of yellow and green categorized rails, characterized by lower utilization fees than red rails. Nevertheless, those cheaper rails provide slower connections between important locations in Sweden.

Unfortunately, the 60 hours stated in the customer agreement policy has become a vague indication for customers, as they often consider that orders can be ordered with only one day in advance. As a result, customers feel unsatisfied with Green Cargo when delivery times are close to 60 hours, even though this delivery time respects the general customer agreement policy.

Green Cargo would definitely investigate why and how the customer agreement policy has become so vague to the customers. One possible reason is that new customers have misunderstood the agreement signed with Green Cargo. Another possible cause could be associated to the existence of certain old customers accustomed to the faster delivery system performed by Green Cargo some years in advance.

The first possible cause of misunderstandings could be easy to prevent if new customers received more clear and specific information regarding the signed contract. This information should clearly state that those customers have agreed a maximum delivery period of 60 hours. Misunderstandings linked to previous delivery policies could be avoided if Green Cargo held formal meetings to explain those old customers the differences between the previous and the current delivery policies.

In the new purposed priority system, if certain customer wanted to assure a shorter delivery time than the 60 hours stated in the general customer agreement policy, that customer would have to pay an extra fee for those additional services.

5.4.3.3 Customer priority

Green Cargo needs to establish a customer categorization hierarchy as well as determine clear guidelines intended to decide which customers it would be more profitable to work with. It is suggested that this categorization system includes the same categories as Trafikverket priority system does (see Section 4.4.1.2). In that way, it would be easier for Green Cargo infrastructure planners to determine the right priority level of each customer when applying for time slots to Trafikverket.

The suggested customer priority system should also consider customer loyalty levels. Customers can be categorized in two main categories: regular and non-regular. Regular or loyal customers present very constant and regular bookings, whereas non-regular customers order wagons in an irregular pattern. Approximately, regular customers order the same amount of wagons following a smooth pattern, aspect that helps Green Cargo to plan its activities with more time in advance, allowing establishing a more even traffic flow.

At present, in a situation in which a regular and a non-regular customer are interested in transporting wagons in the same train, the first customer in order will be the first customer to be served. As it can be observed, the actual Green Cargo policy 1st booked, 1st served does not take into consideration the customer loyalty levels. It is suggested for Green Cargo to modify this aspect and reward those regular customers over non-regular ones. According to the new suggested prioritization system, Green Cargo should modify this aspect and reward those regular customers over non-regular ones.

Next lines present an example regarding how the policy 1st booked 1st served works at present. Later on some possible improvements related to this example will be presented. Figure 24 shows a scenario in which a regular Customer A, which normally orders 4 wagons every day; competes out for space in certain train with a non-regular Customer B, which books a larger quantity of wagons following an irregular pattern. In the situation presented in Figure 24, the non-regular customer is the first in booking its required services for Tuesday, whereas the loyal customer books its needs in the second place. If maximum train capacity was limited to 15 wagons, the loyal customer would not be able to fit its required wagons into that train.

This situation may happen when the loyal customer only has planned internally its wagons requirements but has not actually made the booking with Green Cargo. The loyal customer may consider that, as its orders follow a periodic order pattern, there is no possibility of other companies can make use of its expected ordering slots.

As a result of the Customer B non forecasted booking, Customer A's slow booking, and the booking system rule of first booker getting the first available transport, Customer A would not be able to transport its 4 wagons on Tuesday. Those four wagons belonging to customer A would have to be delayed until the next available transport time. Figure 25 shows the situation in which the four wagons expected to be transported on Tuesday are finally transported on Wednesday.

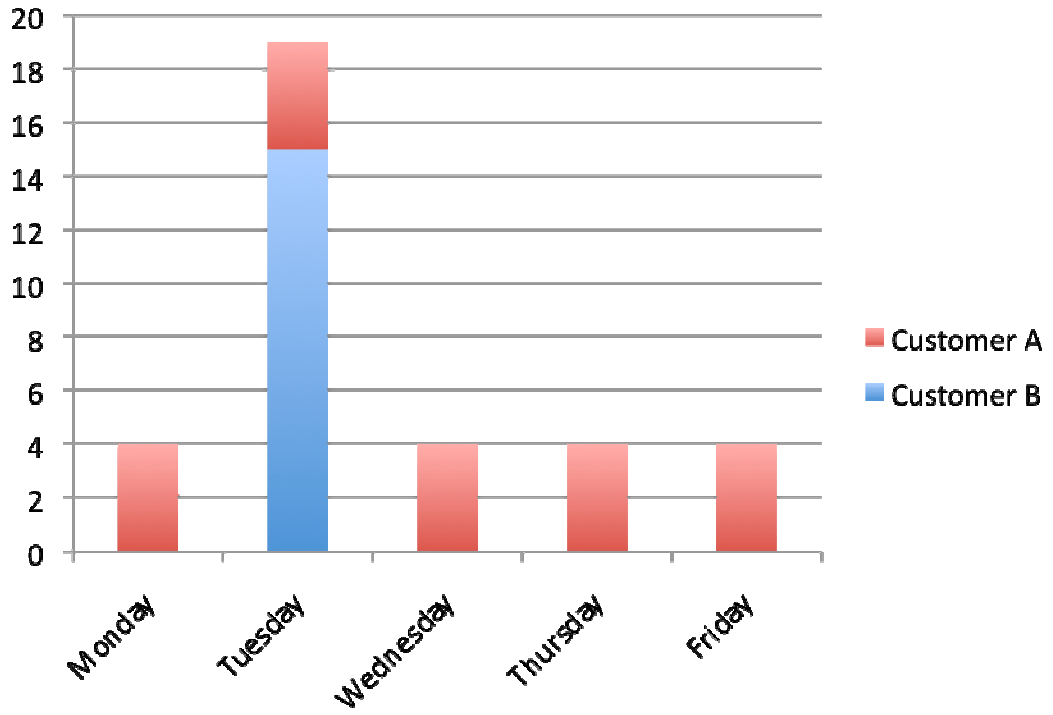


Figure 24: Customer A marked with slightly transparent grey stating planned amount of wagons to order; Customer B marked with green stating actually ordered wagons

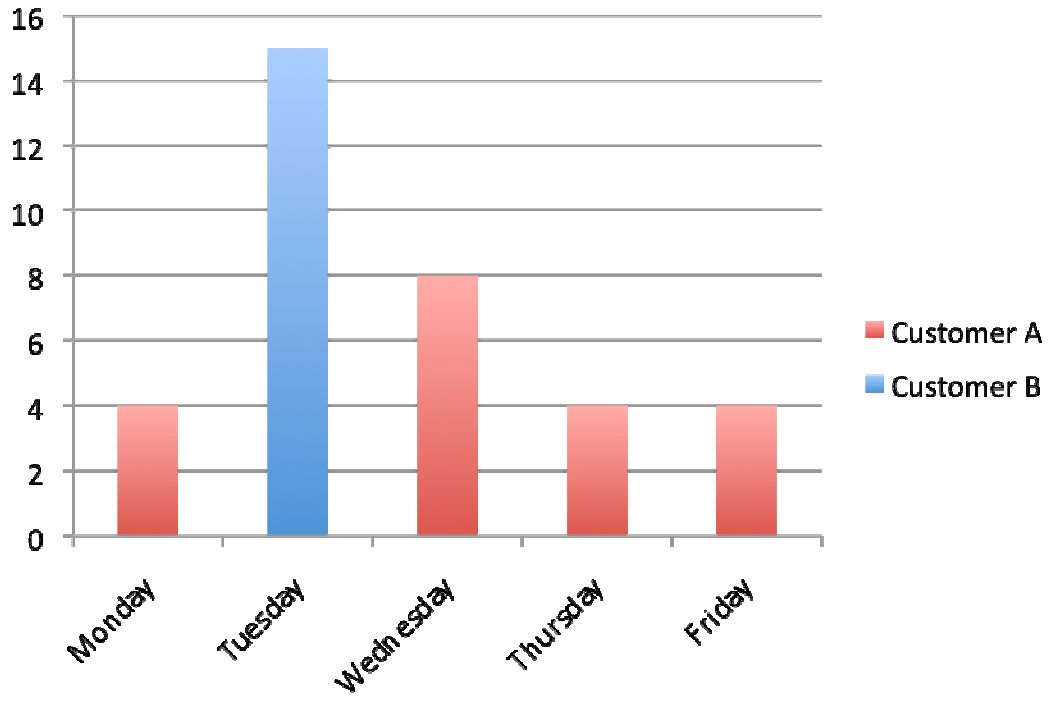


Figure 25: Customer A marked with grey stating actually ordered wagons which has now been forced to be delayed from Tuesday to Wednesday; Customer B again marked with green stating actually ordered wagons

According to the new purposed priority system, Green Cargo should prioritize regular customers with regular orders patterns over non-regular ones. Loyal customers allow Green Cargo to plan its activities with more time in advance, stimulating the possibility of establishing a more even traffic flow during the weekdays.

Green Cargo should establish some beneficial policies to stimulate customers to become part of the regular group and book their orders with more time in advance. A possible way to increase the number of regular customers would lie on offering more economic fares when booking with longer advance period and following regular patterns. If those ideas were applied and following with the previous example, if Customer A faced more economic fees when booking its regular needs with more time in advance, this customer will probably join to possibility.

If the suggested priority policy was introduced, the non-regular customer could not fit its 16 required wagons on the train travelling on Tuesday, because the 4 wagons required by the loyal customer would have already been allocated in the train. In that case, Customer B wagon needs would be spread out in different days. Probably, this situation would make Customer B study its possibilities of becoming a loyal customer.

6 Staff optimization areas: current situation and analysis of the possible improvements

This Chapter aims to provide information on how to optimize Green Cargo staff requirements, aspect identified as one of the most important ones to analyze by this company. First of all, this section presents some general aspects related to staff. Later on, two possible improvement concepts related to this category will be presented and analyzed. These two improvement concepts are: "Optimization of staff in single shunting stations" and "Optimization of reserve staff for larger Main-Sites". In addition, this section presents a new concept intended to help to optimize staff requirements: "The co-operational shunting pool".

6.1 General aspects regarding staff

This section presents several aspects related to staff necessary to understand the analysis regarding how to optimize staff requirements in Green Cargo. These general aspects are the "Main-Site" concept and its limitations, the different types of operators

6.1.1 The "Main-Site" concept

A Main-Site is a station from which it is possible to reach the near locations and get back to the main site within the working hours. At present, Green Cargo has a total of 33 operated Main-Sites all over Sweden, all with stationed staff. Nevertheless, during the last 25 years Green Cargo has worked in the reduction of the number of main sites, having reached the 70 main site stations in the late 80s.[8]

Green Cargo legislation, agreed with the company union, points out that drivers are allowed to drive a maximum of 5 hours without a break, aspect which represents the real limitation on how large area around a Main-Site that can be accessed.

6.1.1.1 Types of "Main-Sites"

According to Green Cargo, main sites can be categorized in four different groups: Traffic, Capillary, Sorting and Stopgap locations.

[8] Ulf Wikström, Agreement Specialist, Green Cargo, Interview, 2013-02-19

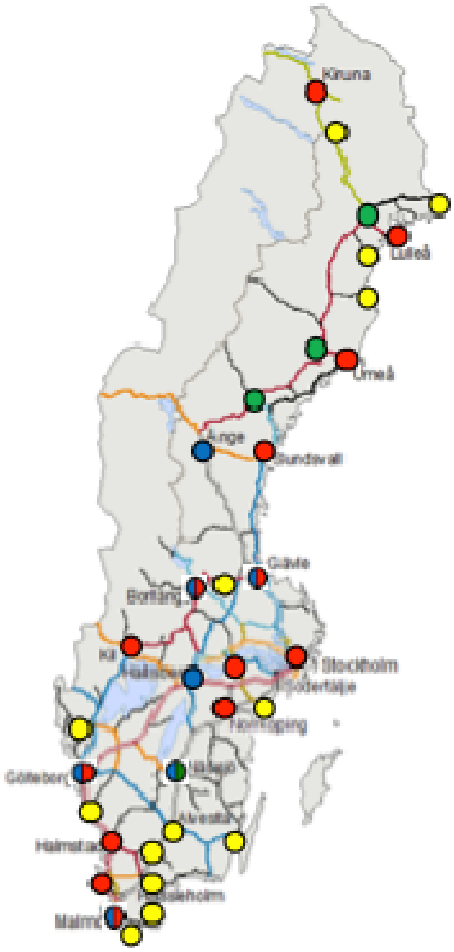


Figure 26: Illustration of Sweden and the current Main-Site locations

Traffic location - red: This category represents those stations from which cargo traffic is gathered and trains are created. Traffic location main sites can be located in those industrial areas in which many companies are placed, or next to a harbor in which many import/export activities are performed. It will be necessary to have personnel stationed in this type of stations in a long-term time perspective.

Capillary location - yellow: This category includes stations from which cargo traffic is started and developed, in the same way as traffic location main sites do. The main difference is that this type of main sites presents a strong customer dependency. Those stations must be aware of its dependency of the customers they serve, and act proactive before the customer does. Those locations present minor traffic volume.

Sorting location - blue: Main-Sites in this category represent little or none traffic of their own. Nevertheless, they are located in strategic geographic positions and they make possible to sort wagons on them. Those stations require personnel stationed on them in a long-term perspective. Ånge represents a good example of sorting location, as the limitation for cargo weight is 1100 tons above this point and 1600 tons below.

Stopgap location – green: Stations under this category present little or none traffic volume, but their geographical locations make them suitable to represent a place to switch drivers. This type of locations is required as long as Green Cargo legislation regarding maximum driving periods, agreed with the company union, is not modified.

6.1.1.2 Important aspects and limitations

Section 6: optimization of Green Cargo staff requirements, analyzes how to optimize Green Cargo staff requirements by determining the most accurate distributions for both employees and main sites all over Sweden.

Green Cargo makes use of different information in order to determine the most feasible main sites to be optimized. This information includes aspects such as:

- The number of needed employees for each main site and the real number of employees on each of them.
- Green customers locations.
- Green Cargo agreed services with each customer.

Another important aspect to consider is the different types of main site stations. Traffic and Sorting location stations are not possible to be cancelled in the short term as they represent an important role in maintaining an efficient rail network. On contrary, Capillary and Stopgap location stations do not represent any long term critical purpose and could be cancelled.

When analyzing the possible improvements linked to the staff optimization category, it is necessary to consider several aspects. The main goal of this category lies on optimizing staff requirements by establishing as centralized main site stations as possible. If the geographical distribution of the main sites and their linked stations was omitted, the most feasible and desirable main stations to be cancelled would be those with a lower number of employees.

Nevertheless, it is important to remember is that the real goal of this category is not having as few Main-Sites as possible, the main goal lies on creating an efficient and flexible rail network. This goal can be achieved in different ways. In some situations, the most profitable option lies on centralizing all the operators from small main sites in a nearby larger Main Site. Therefore, those small main sites could be cancelled. On contrary, in other situations, Green Cargo is benefited from having spread staff in small main sites. The cancellation of those small Main-Sites would diminish Green Cargo operational working area in and could imply the loss of some customers placed in that area.

The current need for Main-Site locations can quickly change as the capillary location sites, which are linked to specific customers, can be established or cancelled in a short time period according to customer demands and requirements. Green Cargo should be flexible enough to adapt to those changes in a short time period. If a new customer required the establishment of a new main site was contacted, Green Cargo should be able to start up this site in a short time period. In this way, it would be avoid that customer decided to work with a competitor firm.

Decisions regarding where to place Green Cargo employees as well as analysis of the current Main-Sites distribution can be done in by using simulation software. This software creates an optimized solution for the Main-Site network according to Green Cargo and customer requirements. Green Cargo disposes of this software, but unfortunately, it is not used very often because it is very time consuming. One of the causes of the scarce utilization of this software is the lack of Green Cargo resources (see more in Section 7.2.1). It is definitely suggested for Green Cargo to use this

optimization software more often, especially considering the importance of creating a flexible Main-Site network adapted to customer demands. In that way, it would be possible to determine the most profitable main sites distribution and operators allocation for Green Cargo.

6.1.2 Green Cargo operators: shunters, drivers and shunter-drivers

It is expected that within the next five years, around 100 of Green Cargo's operational staff employees will retire yearly[8]. Green Cargo operational staff is typically divided into shunters and drivers, but there is also a third category which represents those drivers that are able to do shunting. Below, short explanations of the three different groups of operators are presented:

- **Shunters**: this group is mainly in charge of connecting and disconnecting wagons according to the order lists created by the RPC department. Those order lists are based on the customer bookings registered by Hallsberg Customer Service office. The totality of shunter operators is trained to perform radio control shunting.

- **Drivers:** this group is in charge of driving locomotives with empty and/or loaded wagons following the routes given by Hallsberg. This group is not trained to perform shunting operations, and according to the Green Cargo headquarters, it does not represent any problem because currently the number of driver-shunters is enough to cover the company's requirements.[2] On contrary, under one of the shunters-drivers planning person's view, it would be necessary for all the drivers, especially the new ones, to be able to do shunting processes.[6]

- **Drivers-shunters**: this is the key group when dealing with the concept of single shunting at main stations. It is common that some of the current Green Cargo drivers used to work as shunters before they advanced and participated in an internal education program to become drivers. Consequently, this group of drivers is also able to perform shunting operations. It is necessary to consider that this group of operators cannot work with a very extended list of areas, because it would be impossible for them to learn the particularities of all of them.[6]

When it comes to the drivers that have advanced from formally being shunters, it's obviously very beneficial for the company to have them doing shunting in their old areas because of their previous area knowledge. Placing the newly graduated drivers back in their old areas with the same tasks is not always very welcomed by the driver. The main reasons for shunters to make the decision to advance to a driver is that he wants new challenges, new work tasks as well as higher salary.[7]

[8] Ulf Wikström, Agreement Specialist, Green Cargo, Interview, 2013-02-19

[2] Marcin Tubylewicz, Strategic Production Development Manager, Green Cargo, Interview

[6] Per Svensson, Group leader, Green Cargo, Interview, 2013-02-14, 2013-02-21

[7] Lars-Åke Ingmarsson, Driver, Green Cargo, Interview, 2013-02-14

6.1.3 Shunters and drivers schedule planning

Shunters need local knowledge on each the yards in which they operate. This knowledge includes aspects such as special training for dealing with specific types of dangerous goods and knowledge on the local tracks as well as on the different types of locomotives used in certain site. Operators are preferably allocated to their known areas, especially in single shunting operations, to avoid the continuous training of shunters and drivers regarding special needs different working areas. Another constraint to take into consideration is that different locomotives types require different education, so it is necessary to allocate each train to the right operator.

Green Cargo drivers' and shunters' schedules are done in Hallsberg by a planner person who matches a suitable driver with both a suitable engine as well as shift, making sure the driver has the local area knowledge necessary.[6] Once the working shift outlines for the different stations are created, they are sent to the local stations for minor modifications, which are performed by the local drivers and shunters leaders. Those minor changes are necessary because the planning person in Hallsberg has no local knowledge of the specific areas and the specific needs for the shifts.[9] Concerning tasks involving the yard for shunters and drivers, the union will be involved in the planning of the shifts.[6]

Modifications in drivers' shifts schedules have to be done at least with six weeks in advance, whereas the modification of shunters schedule requires a longer period. This aspect makes the drivers shifts much more flexible and therefore, makes it preferable to have drivers doing the assigned shunting work on the stationed yard as it would be possible to match the customer demands quicker if there is a need to change the schedule.[6]

6.1.4 Legislation regarding working hours

When determining the shifting allocation of drivers and shunters, it is necessary to consider other legal aspects affecting this aspect. The European Unions legislations have to be followed while the regulations by the Swedish legislation can be bent slightly with an agreement of Green Cargo's Union (See Section 4.4.7). Because of that, Green Cargo's working hour legislation is not in phase with the Swedish regulations but it is still within the limits of the European Union's legislation.

The Swedish legislation states that in case of daytime work, the maximum standard time per week is 40 hours, whereas if the work takes place at nighttime, maximum standard time per week is reduced to 36 hours. In addition, 45 weekly working hours are accepted for certain week, provided that the following week the operator does not work more than 15 hours.[8]

Green Cargo also has their own regulations regarding the maximum drivers working shifts: a maximum of 10 hours per day, plus a 1 hour break in within this interval which has a maximum of 5 hours. In case of a longer shift was required, first of all this aspect should be dealt with the union. Driver would receive an extra salary in

[6] Per Svensson, Group leader, Green Cargo, Interview, 2013-02-14, 2013-02-21

[9] Driver, formerly Tactical Local Driver Planner at Green Cargo, Interview, 2013-02-19

[8] Ulf Wikström, Agreement Specialist, Green Cargo, Interview, 2013-02-19

compensation for the extra working time.[6] In addition, an operator cannot work for more than 10 hours within a 14 hours period[8].

6.1.5 Shunters and drivers training

Some sites transporting dangerous cargo present several safety legislations and rules that have to be followed. Shunting operators working in those sites need an extra special training regarding the dangerous cargo they will be allowed to shunt and work with. In addition, those operators need to gain the general knowledge of the site in which they perform their activities. These aspects make longer the education process for those operators working in sites in which dangerous cargo is transported.[8]

Green Cargo has subcontracting shunting at some locations in Sweden. When this occurs, Green Cargo only makes sure that the subcontracting companies have the suitable education and does not personally train and show them how the work is done in a specific area. Under these circumstances accidents are more common than within the own Green Cargo organization.[6]

6.2 Staff optimization area 1: optimization of staff in single shunting stations

This improvement area achieves to increase Green Cargo efficiency by optimizing the number of needed operators to carry out the shunting processes. Several factors are taken into consideration to properly analyze the situation such as customer service, safety, salary and moral.

6.2.1 The single shunting concept

The "Single shunting" concept is very linked with the already presented idea of main sites. The concept of optimization staff requirements by using single shunting implies to remove the stationed shunters from the nearby station and make a certain driver to drive from the Main site to each nearby location and do the shunting by himself.

Single shunting concept was firstly introduced in Sweden in the late 80s. Later, concept later expanded to the rest of the European countries. During its initial period in Sweden, employees showed a strong opposition to this concept because of the associated job losses as well as the reduction in drivers' job category. Drivers did not want to perform shunting operations. Green Cargo finally came to an agreement with the Union despite of its initial discontentment about the loss of shunting jobs as well as the loss of prestige for the drivers. One of the main advantages agreed in relation to single shunting was those drivers performing some shunting operations would not

[6] Per Svensson, Group leader, Green Cargo, Interview, 2013-02-14, 2013-02-21

[8] Ulf Wikström, Agreement Specialist, Green Cargo, Interview, 2013-02-19

have to drive so many hours and would not be away from home as many nights as a normal driver.[8]

The greatest restriction for the single shunting concept is the regulation regarding the hours a driver is allowed to drive, aspect which really limits the maximum distance away from a Main-Site to which it is possible to perform single shunting. This technique can only be used if the nearby stations do not present too complex shunting needs and if those stations are on a reasonable distance from the main site. This distance must allow the driver to have time to drive from the main station to the single shunting station, shunt and drive back within the working day hours.

The single shunting technique is possible to apply in those Main-Sites connected with small traffic stations. In that case, instead of setting a shunter operator in the low volume traffic station for the whole day, the train driver would be in charge of doing the whole shunting process on his own with the only help of a locomotive equipped with remote control system. This concept has already been implemented to some extent, and one of the future plans for Green Cargo would be to continue expanding this technique where possible.

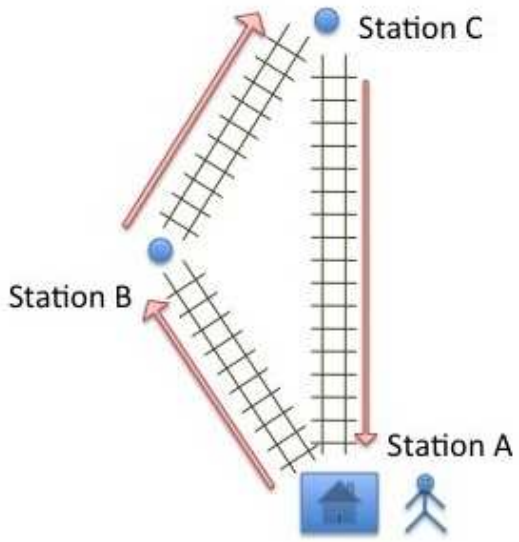


Figure 27: Single shunting presented by one large Main-Site Station A and two small stations Station B and B with no stationed staff

Figure 27, presents an example of the single shunting technique. Station A is main site station with stationed workers, whereas Station B and Station C represent two small size locations without any stationed employees. A shunter-driver belonging to the main site (Station A) drives to Station B, station in which he does the assigned and necessary shunting activities before driving to Station C. This shunter-driver also performs on his own the required shunting activities in Station C before coming back to Station A with the planned cargo from the nearby stations. In this case, if single shunting was not performed, two employees would be required in Stations B and C. The introduction of the single shunting concept in this example would give Green Cargo the possibility of avoid the work of the employees in Stations B and C, both locations presenting low activity rates. In this way, staff requirements are optimized.

[8] Ulf Wikström, Agreement Specialist, Green Cargo, Interview, 2013-02-19

In order to analyze how the single shunting is managed at present, Hyltebruk site was visited on February 14th 2013. In this location, the single shunting technique was successfully implemented in January 2013 but previously, Hyltebruk had its own stationed employees. At present, former Hyltebruk employees are allocated in Halmstad and travel to their previous associated site by means of the single shunting concept when it is required.

After studying the current drivers schedules, two main driver working-turns were identified.

- The first working turn is related to the night time work. In this case, the driver is mainly in charge of driving the train between several destinations, although he/she can also perform some shunting activities.[6]
- The second working turn, taking place during day hours, may include driver both driving and shunting alone in small stations (single shunting) or driving and shunting with the help of other shunter operators.[6]

When planning single shunting schedules, it would be interesting to consider drivers and shunters preferences. As shunting process requires really high physical demands, and according to shunter group testimony, the best solution lies on setting the shunting activities in the beginning of the work day, followed by the driving periods.

6.2.2 Remote controlled locomotives: a requirement in single shunting

The single shunting concept is closely linked with locomotives equipped with remote control system. At present 222 out of Green Cargo's 470 engines are equipped with the remote controlled equipment. Green Cargo future plan is to equip most of the engines with this technology to increase both the safety, flexibility and the efficiency. (Åkerströms, 2013)

Single shunting activities require a radio controlled engine, whereas traditional shunting technique only requires the work of at least two shunters, which can contact each other via with radio contact. When traditional shunting is performed, shunters have to work very closely together and they have a high dependency on each other. While one shunter drives the engine from inside the engine, the other shunter performs the physical job linked to the shunting process and acts "as the eyes" of the shunter stuck in the engine room, giving him indications on how locomotive should be moved. On contrary, in the actual remote control used in single shunting operations, locomotive is driven from outside the engine room by using a transmitter positioned on the operator's abdomen. Locomotive control is executed by a joystick, as it can be seen in Figure 28.

[6] Per Svensson, Group leader, Green Cargo, Interview, 2013-02-14, 2013-02-21

Figure 28: A shunter using a control transmitter to remotely control an engine. (Åkerströms, 2013)

As the shunting represent a very time consuming activity, the introduction of the remote controlled locomotives has considerably increased the effectiveness of the shunting process. This increased efficiency represents a good way for Green Cargo to keep up with the competitors and be able to offer competitive services on the Swedish and continental European markets. (Åkerströms, 2013)

Green Cargo is really concerned about ensuring that shunting personnel have the right knowledge regarding radio control. Depending on the frequency with which personnel perform shunting operations, it would be enough for them to take some control tests, or retaking the whole radio control education.[1]

Personnel will keep their radio control qualifications if they do more than 6 shunting operations requiring this specific technique in a half a year period. In that case, these operators would only take some control tests every two years.[9] On contrary, if the condition of 6 passes per half a year is not fulfilled, operators should retake all the education. Although this is not a normal situation, it has appeared the situation in which an injured operator has had to retake the radio control education after a long recovery period.[6]

6.2.3 Working hours and salary

At present, Green Cargo limitations regarding shifts length are affected by those agreements between management and the company union, and can be summarized in these three aspects:

· Maximum working shift length is 10 hours per day, plus 1 hour break within this interval.

· Maximum working period before a break is 5 hours.

· In a 14 hours interval, maximum working time is 10 hours.

[1] Anders Lester, Quality and Organisational Development Manager, Green Cargo, Interview
[9] Driver, formerly Tactical Local Driver Planner at Green Cargo, Interview, 2013-02-19
[6] Per Svensson, Group leader, Green Cargo, Interview, 2013-02-14, 2013-02-21

As it has been mentioned before, main sites and single shunting concepts are intimately related to those time limitations. According to this, a single shunting station cannot be located more than 5 hours distance from its associated Main-Site minus the actual shunting time, fact that causes a significant constraint when talking about the single shunting concept. If Green Cargo management and union reached a new agreement allowing lengthening the current 5 hours limit of straight driving, the feasible covered area around the Main Sites could be expanded. Consequently, it would be possible to reduce the number of Main-Sites as well as increase the volume of single shunting stations, optimizing in that way Green Cargo staff requirements.

The possibility of educating the totality of Green Cargo shunters to become drivers, being able to perform single shunting operations would increase the flexibility of this company. Nevertheless, this option is not economically feasible for Green Cargo, both for the associated costs linked to the training education and for the different salaries categories of drivers and shunters. Green Cargo could not afford only having shunter-drivers in all the shunting yards: shunters are needed because their salaries are 25% lower than the drivers' ones.

Driver salaries are only dependent on during what period of the day activities are carried out, and it is not considered the fact of whether the driver performs shunting operations or not. In that case, nightly salaries are considerably higher than daily salaries because of the inconvenient working hours, although the required physical effort is higher in case of performing both shunting and driving operations during working hours.[6]

6.2.4 Customer service

The traditional idea of having shunters permanently allocated on certain station presents some benefits: shunters have a very detailed knowledge of the area in which they operate and they a close relationship with the customers connected to the site. In those situations, customers have close relationships with shunters because the same operators always perform the shunting activities. This situation is definitely beneficial for those customers with high service demands, assuring the existence of shunting operators available to service them when required.

If instead of having permanent allocated operators in certain small location, shunting activities are performed following the single shunting technique, it is not possible to have so close relation between Green Cargo operators and customers. Nevertheless, and besides this fact, in those small stations presenting low activity rates it is preferred to introduce the single shunting concept instead of working with permanent shunters placed in those locations. The implementation of the single shunting idea on those stations allows Green Cargo to optimize its staff needs.

In the past, all sites in Halland disposed of a permanent shunter, but at present, the smaller stations have become single shunting stations. One example of this modification is the Hylte site, serving Stora Enso.[6]

[6] Per Svensson, Group leader, Green Cargo, Interview, 2013-02-14, 2013-02-21

Figure 29 shows the overview of Stora Enso's factory Hyltebruk in Hylte. The railroad located on the upper side of the factory on the photo runs all the way up to the plant. Rail tracks go all the way into the Stora Enso's building to ease the loading process of the paper rules into the freight wagons.

Figure 29: An airplane shot of the Stora Enso factory Hyltebruk in Hylte. (Stora Enso, 2013)

In some occasions, customers operating in single shunting stations which previously disposed of permanent placed shunters still have really high demands on Green Cargo services. In this case, customers expect shunter-drivers to be a type of customer coordinators, as the ones placed in Hallsberg. Customers consider that those shunter-drivers are part of the information flow of Green Cargo but, nevertheless, those shunter-drivers have no information regarding the contractual relations between Green Cargo and a customer in question. This fact makes very difficult for the drivers to determine what the reasonable demands from the customer are.[6]

Because of this fact, although theoretically shunter-drivers would only be in charge of doing the single shunting operations, sometimes they are forced to answer to some customer questions and requests. This situation is especially stressful for the driver, because apart from answering to customer calls, driver has to drive the engine, perform the shunting operations as well as keep telephone contact with the RPC division.[6]

It would be suggested to make very clear guidelines for the customers and drivers regarding which services have agreed with Green Cargo. In addition, customers should receive a list those suitable contact person to contact in case their wishes changed. This fact would help to solve the presented problems: on one hand, drivers could focus on performing the shunting activities and would be aware of which services are included in the agreement with each customer. On the other hand, customers would be able to contact directly with a suitable Green Cargo employee who solve its doubts in a fast and efficient way.

[6] Per Svensson, Group leader, Green Cargo, Interview, 2013-02-14, 2013-02-21

6.2.4.1 Single shunting: economic advantages for Green Cargo and customers

The introduction of the single shunting concept where possible facilitates the creation of a system in which customers pay for the services they actual use. This idea is considered to be beneficial both for the company and for the customers. At present, some companies might actually pay for full shunters service although they do not really require this service. In this situation, the full time shunting service is unwanted and a represents a waste of money both for customers and Green Cargo, which has to pay the shunter salary. The possible introduction of the single shunting in this station would benefit both customers and Green Cargo.

The opposite situation is represented by a customer operating in a small station and requiring permanent shunters on site. In this way, this firm would have high flexibility to perform shunting operations and the possibility of direct contact and help. In this case, this single customer could purchase Green Cargo the work of a full time shunter.

6.2.5 Contact of shunter-drivers with operational departments

After the implementation of the single shunting technique in stations like Hylte, the documentation of the tracks of the station has began to be done manually, instead of in a digital way as it used to be done in the past. This change was produced because shunter-drivers do not want to spend time going back and forth several times to the on-site facility holding the computer and fax machine needed to keep in contact with RPC. At present, when single shunting technique is used, once the shunting operations are finished operator reports at once to RPC via computer or fax all those activities performed in the yard. This report includes aspects such as tracks updating or the allocation of the wagons.[6]

There is a project and plan to implement tablets or hand computers as a direct link between the shunting-driver as the RPC division[1]. This project would represent a very useful and helpful approach which would ease significantly the communication between both groups.

If this project was implemented, the manual tasks of keeping the tracks updated as well as the reception of information from RPC could be done without forcing the shunter-driver to visit the onsite facility. This idea would allow the shunter-driver to save that time required to update data to RPC from the on-site facility, would decrease misunderstandings and would increase the safety in single shunting processes. The use of the tablet would reduce the number of phone calls received by the shunter-drivers while performing shunting activities, allowing those operators to focus on their tasks. It is highly suggested for Green Cargo to implement this idea as soon as possible, not only for single shunting processes, but also for the normal shunting and driving processes. Usual drivers and shunters would benefit from the same advantages presented in this paragraph.

[6] Per Svensson, Group leader, Green Cargo, Interview, 2013-02-14, 2013-02-21

[1] Anders Lester, Quality and Organisational Development Manager, Green Cargo, Interview

6.2.6 Safety aspects: single shunting and traditional shunting

Safety is very important for the workers to be able to perform a productive job. Only when the operator feels safe in his work environment he can invest his full potential capacity to perform the best at his work task.

Apart from the possibilities of optimize staff requirements, extra safety is another important advantage linked to the single shunting concept. When traditional shunting processes are performed, misunderstandings between the shunters, drivers and the tower on the yard are not uncommon. (Åkerströms, 2013)

In traditional shunting technique, several shunters connected to each other via radio control work together. The shunter placed outside the locomotive indicates the shunter in charge of driving the locomotive, how the locomotive should be moved to perform the shunting operations properly. This situation requires a very high trust level between both shunters, as they have to put their lives in each others hands when shunting wagons. When talking about single shunting, this situation does no longer appear as the shunter-driver does not have to rely on other persons.[7] When the single shunting technique is performed, the operator constantly knows his position as well as the location of the engine he is controlling. Being able to determine your own position is always more reliable than having someone on a radio being the eyes of the operation, as it happens in the traditional shunting operations. Any possible misunderstandings related to radio contact between traditional shunters are also eliminated if an only person does the whole shunting process.[6] Even though the single shunting technique requires the shunter-driver to work alone, this type of operators feels they work in a very safe environment. In several ways, they fell safer when performing single shunting activities instead of traditional shunting.[7]

When dealing with shunter-drivers performing single shunting activities on their own, according to Green Cargo safety regulations, those operators must have a safety phone with them in all the moments. If this phone is not vertically held, an alarm would be activated and a direct connection to SOS alarm is established. This implies that if the driver falls over and the phone is kept in a horizontal position, the emergency alarm would be activated. In addition, the phone has GPS control, aspect that would help locate a driver if necessary.[6] Unfortunately, the safety phones do not work as accurately as desired when the driver is located inside solid factory facilities, usual situation when a shunter-driver collects wagons from a customer.[7] In addition, the safety phones sometimes give off false alarms. Those safety phones are also used by traditional shunters and drivers, and the general feeling among all those groups is that they feel much safer carrying this device telephone with them at every time in the yard.[6]

Another safety precaution adopted by Green Cargo when dealing with single shunting is the fact planners try to schedule some extra time to perform the shunting. In this way, the shunter-driver performing shunting operations alone would avoid to feel stressed.[6]

It is suggested for Green Cargo to look into the fact that the safety phones do not work in all locations and try to solve this problem. Even if nothing can be done to improve this situation, it would be helpful to map out those locations suffering from this

[7] Lars-Åke Ingmarsson, Driver, Green Cargo, Interview, 2013-02-14

[6] Per Svensson, Group leader, Green Cargo, Interview, 2013-02-14, 2013-02-21

problem and make everyone involved on them aware of the radio silence. This fact is especially important for those people in working in same location or the emergency contact group which would be involved in case of an accident or emergency.

As it has been presented, the single shunting concept is considered to increase the safety levels in shunting operations, especially linked to the use of the locomotive remote control system. Because of that, it is definitely recommended to implement the single shunting activities from a safety point of why. The only down side related to the single shunting concept the high amount of time a driver doing single shunting spends alone. In the long run, not to have much human contact can result in a lonely feeling for operators performing single shunting operations, and it is possible that the enjoyment of their works is affected. Regular drivers also share this problem, as they too spend a high amount of time driving the train from one location to the other without any company.

It is considered as an advantage the possibility of face-to-face contact with the customer on site, in order to increase the human contact during the shunter-driver work shift. In addition, shunter-drivers performing single shunting activities are likely to have contact with other employees when visiting the main-site locations.

Nevertheless, it is considered that safety aspect is a more important problem when dealing with traditional shunting operations, performed by several workers working together. Green Cargo should further investigate those aspects linked to the fact of placing operators safety into other operators hands, as it currently happens in traditional shunting operations. This situation requires high trust levels among the coworkers. The fact that shunters might not feel complete safe should be investigated to the fullest, and Green Cargo should put efforts in creating both team and trust building among coworkers and consequently assure both higher safety, productivity and work satisfaction. (Gayk, 2012)

In addition, it would be really recommended for Green Cargo to implement the use of remote controlled locomotives when performing traditional shunting operations. In this way, problems linked to the lack of trust among shunters would be avoided, and shunting processes could be performed in a safer way. Considering that the totality of shunters has knowledge regarding the use of remote controlled locomotives and many of the engines are equipped with this option, this suggestion would not be difficult to implement.

6.3 Staff optimization area 2: Centralization of reserve staff in large Main-Sites

Each of the 33 Green Cargo Main-Sites all over Sweden has, at least, one stationed worker. Nevertheless, most Main-Site locations have a higher volume of stationed workers on them. The shunters and drivers leader of each main site is the one who decides how many stationed shunters are needed for certain location to function smoothly. Each main site counts on with certain reserve operators available to work when a regular operator is absent from his job. Some of the causes of these absences are sickness, training courses or personal issues. The idea of having standby reserve workers allows Green Cargo to guarantee both high quality services to the customers as well as provide high safety for their employees. If certain employee is absent from its regular job, another reserve operator will cover this vacancy.

The idea of reserve staff centralization can be applied in those main stations linked to a higher importance Main-Site. At present, all main stations dispose of a certain number of employees plus a number of reserve shunters to cover possible absences. In many cases, reserve operators activity is not normally required, aspect that causes an important resources waste. Green Cargo has to pay those reserve employees although they finally do not perform any activity.

The proposed improvement lies on placing and centralizes all reserve operators belonging to those smaller main sites in the closest larger main site. When a reserve operator was needed in any of the smaller main sites, this person could move to the required station within a workday. This reserve shunter operator could travel where required by car or any other means of transport, and come back to his correspondent main site by the end of the day. The main advantage associated to centralization of reserve operators in a large site lies on a reduction of the total volume of reserve shunters.

A small site proportionally implies much higher costs than those with a higher number of employees. For example, if one employee gets ill in a 5 people station, it implies a 20% reduction in the operator volume; whereas in case of a bigger station, with 100 employees, the absence of one employee only entails a 1% reduction in operator volume. The implementation of the centralization of reserve staff where feasible would allow Green Cargo to reduce these problems.[8]

Figure 30 and Figure 31 present an example of the centralization of reserve staff employees in certain large main site. Figure 30 shows four main site stations: three of them dispose of the regular work of 6 shunters (red) and 3 reserve shunters (blue), whereas the biggest main site disposes of 14 regular shunters plus 5 reserve shunters.

Instead of having reserve workers distributed among all four main sites, all reserve shunters could be centralized in a collective pool in the largest Main-Site. When required, those reserve shunters would move from the collective pool to the required main station. In this example, the smaller main site locations are placed respecting the Green Cargo Union agreement, which states that those small stations must be possible to reach at maximum in a 5-hour driving distance. The centralization concept has already been introduced at some locations, but Green Cargo would like to analyze the future possible expansion of this concept.

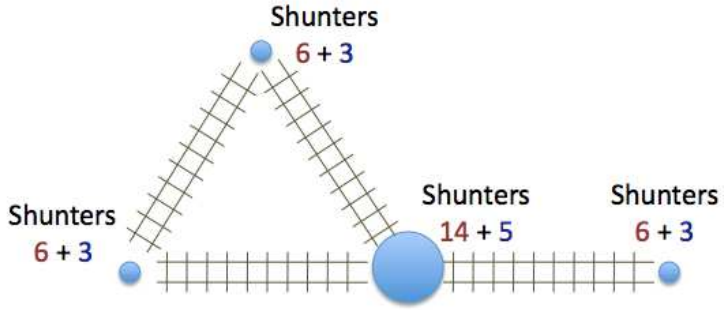


Figure 30: Distribution of shunters and reserve workers before centralization

[8] Ulf Wikström, Agreement Specialist, Green Cargo, Interview, 2013-02-19

As it is showed in Figure 30, those 4 main stations represent a total volume 14 reserve standby workers. If all reserve shunters were placed in the biggest main site location, it would be possible to decrease the total number of reserve shunters from 14 to maybe just 8, as seen in Figure 31. Considering reserve shunters activities are not normally required, the reduction of 6 reserve shunters after implementing the centralization idea would not imply any major negative consequence for Green Cargo and would allow to establish a more efficient layout.

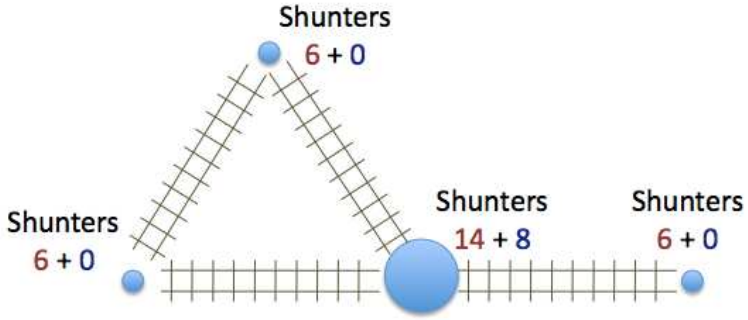


Figure 31: Distribution of shunters and reserve workers after centralization

6.3.1 Specific required training for each location

The idea of centralizing staff would only require some extra education for those shunters placed in a collective reserve shunting pool. Shunters should be trained to perform shunting activities in those stations dependant to the centralized site. Normally, it only takes a few shifts to gain the knowledge regarding new locations areas because basic shunting activities are the same in most locations. The centralization concept would not be suggested in those stations dealing with dangerous cargo, because it would require that all employees working as reserve shunters acquired really specific safety education. This idea is not considered to be neither efficient nor profitable for Green Cargo, because company should pay the specific training courses.

6.4 Co-operational shunting pool: a new improvement possibility

In some situations, Green Cargo is forced to keep some permanent employees in small stations presenting low activity rates. This situation is caused because the distance between the closer main site and that small station is too high to be covered in a single day, aspect that inhibits the possible implementation of the single shunting concept.

Unfortunately, if this scenario emerges Green Cargo is forced to place workers in the remote locations even though maybe just 1-2 hours of work are daily required. A possible solution to this situation would be the creation of a co-operational shunting pool together with other rail companies suffering the same problem. In this way,

freight companies would share the services of that co-operational shunting pool and sharing the total expenses linked to its activities. Another possibility for Green Cargo would lay on the creation of its own pool of shunters. This pool would be used by Green Cargo when needed and rent to other companies working in that location when its services are not required.

The use of a co-operational shunting pool could make profitable to maintain the service to those customers placed small locations impossible to reach by using the single shunting concept. If total costs linked to keeping a permanent shunting pool in the mentioned type of locations were shared among different companies, companies such as Green Cargo would reduce its total costs linked to operate in those small and unconnected locations.

The co-operational idea among freight companies can be also applied when dealing with medium size and remote stations. In those cases in which it is not possible to implement the idea of reserve workers centralization because of the high distance between two stations (See Section 6.3), the following idea could be implemented. It could be created a co-operational shunting pool used as reserve shunters for several freight companies at the same time.

7 Other improvement areas

This Chapter provides information of suggested improvements areas that are not stated in the purpose. The analysis carried out in Green Cargo in order to analyze those previously presented improvement categories related to capacity and staff optimization has created opportunities to determine further improvement. These new improvement areas have been grouped into three categories: staff, capacity and communication.

7.1 Other staff improvements

Green Cargo is very interested in optimizing its staff volume requirements dealing with ideas such as centralizing drivers and shunters or expanding the single shunting concept, that is to say, driver is also in charge of performing shunting operations in small stations. All those concepts have been previously presented in Section 6.

Nevertheless, Green Cargo should also consider the possibilities of increasing the efficiency of its own employees way of working. A detected and common problem that has been pointed out is the lack of control in the fulfillment of the working-hours, especially the shunting operators. In some occasions, once shunting operators have performed all the shunting activities required for them according to those specific train daily needs, they decided to finish their working day before the end of their working shift. Then, those trains previously prepared by the shunting operators will be driven until their required destinations.

The lack of control in the fulfillment of the working hours implies several problems for Green Cargo. The first and most evident one lies on the fact that the firm pays those operators for working hours that have not been done, with its economic associated losses. Another consequence linked to this situation is the fact that if prior train departure, there is any change in the requirements of the train (by means of adding or taking out some wagons) and shunting operators have already abandon their work positions, it would be impossible to adapt that train to those new needs. Finally, if those operators were required in case of emergency and they would not be fulfilling their work position, situation could lead to really negative consequences.

It is important to point that this problem is not only a common feature regarding shunting operators. It is known that other office personnel do not fulfill completely their working hours in some situations. In order to improve this problem, it would be suggested that Green Cargo implemented a system in which operators and office workers should log in and log out when, respectively, they begin and end their working hours. In that way, it will be possible to assure the fulfillment of the working periods.

7.1.1 Future suggestion: expansion of the current holiday calendar

Green Cargo's current staff volume is approximately 10% over what is really required only because of the need of fitting staff summer holiday periods[8]. This fact suggests that an expansion of the current holiday period would be a great theoretical possibility for optimizing Green Cargo staff needs.

At present, all employees enjoy 4 vacation weeks between June, July and August. The required staff needed during those months make necessary to over dimension the real yearly operators requirements. The company has an over staff of approximately of 10%, which is translated into about 150 employees. In addition of this over staff volume, Green Cargo also needs to perform some summer contracts to retired employees to mitigate the lack of shunters and drivers during this period.

A possible suggestion to improve this situation would lie on the idea of expanding the holiday period, for example from 15 May to 15 September. An extension of the summer vacation period would make possible to reduce the current overstaffed number of operators. Nevertheless, it is believed that Green Cargo Union would most likely not agree to this arrangement on the basis that it would be too early and too late to have summer vacation in May and September. This argument will be especially powerful for those employees placed in the Northern parts of Sweden suffering a colder climate, for which a holiday during May or September would not be associated with better weather conditions.

Despite this, it is believed that this idea could be implemented in some measure if Green Cargo management agreed with its Union some kind of benefit for those operators taking holidays in those extended holiday period.

7.2 Other capacity improvements

After analyzing how Green Cargo plans and manages its capacity needs as well as its activities, it has been possible to identify several problems which should be seriously considered and tried to be solved. In that way, company resources and capacity utilization could be optimized.

One of the detected problems is linked to the low daily utilization level of Green Cargo locomotives. The average daily utilization time of each engine, also including the standby time required during the shunting processes, is close to 5 hours.[6] It is consider that this utilization time could be increased, avoiding in that way the need of purchasing more locomotives. Previous to achieve this, it would be necessary to solve problems which are presented in the next lines.

7.2.1 Software

As it has been presented in Section 5.1.3.2., Green Cargo disposes of a great number of software, more than 80, to plan and control its activities. At present, many of those

[8] Ulf Wikström, Agreement Specialist, Green Cargo, Interview, 2013-02-19

[6] Per Svensson, Group leader, Green Cargo, Interview, 2013-02-14, 2013-02-21

software are not used according to all their offered potentialities besides Green Cargo is aware about the company would be benefited if taking more advantage of them. Software cannot be used more than currently because of the lack of personal resources and time.[12] Two clear examples of this problem are software MultiRail and FLEET.

Multirail is a very powerful and expensive software acquired by Green Cargo some years in advance. Although it was expected to become a very helpful program, it has not helped this company as much as expected because of program is not used as much as it could be. FLEET, which main function is planning and allocating Green Cargo wagons, currently is almost no used because this software does only dispose of a small proportion of the company wagons in its database.

In addition, another important problem for Green Cargo lies on the lack of communication between the different software, what makes necessary a lot of manual work to transfer information from one to another. Planners recognize they spend a significant part of their time in manual software changes[10,12]. For example when a train that are already introduced in Platå needs to be cancelled, its necessary to cancel it manually both in Trafikverket's website and in Platå, because connections are not automatic[10,]. Green Cargo should put more effort in automating and improving the information flow among its software, as well as trying to make more use of the possibilities they offer.

7.2.2 Differences between planned activities and real life

The locomotive planning is made by using software such as Plato or TrainPlan, in which it is possible to determine in a theoretical way where each locomotive is placed in every moment. Unfortunately, theoretical estimations of the position of a certain engine does not always correspond with the reality.

Locomotives are not equipped with GPS control systems, and many times especially when adverse climate conditions, it is not possible to determine their position. This fact may cause really important problems. For example, if an engine expected to arrive to certain station to fulfill the next required deliveries does not appear and it is not possible to find, Green Cargo would suffer delays in its deliveries as well as will need to find the position of that locomotive in any other way. Even in normal climate situations, Green Cargo workers have to do a manual control of which locomotives are placed in each station at every time, what implies an important amount of time, and could be done automatically if a GPS system was introduced in each locomotive and linked to a central system[6].

Apart from sharing the previous problems with locomotive position identification, wagon allocation presents even more disadvantages linked to the fact that, unlike locomotives, not all wagons are included in Green Cargo database. RPC department, in charge of allocating wagons to each train, plan them theoretically according to

[12] Fredrik Andersen, Organizational Specialist in Planning, Green Cargo, Interview, 2013-03-04

[10] Håkan Lind, Short-time Planner, Green Cargo, Interview, 2013-02-19

[12] Fredrik Andersen, Organizational Specialist in Planning, Green Cargo, Interview, 2013-03-04

[6] Per Svensson, Group leader, Green Cargo, Interview, 2013-02-14, 2013-02-21

those wagons that should be in each location at certain time. Nevertheless, in many occasions when performing shunting operations it has been the situation in which the expected wagons are not in the yard. It is strongly recommended for Green Cargo to update its data base with all its wagons as well as introducing in each station certain system capable to detect the arrival and departure of each wagon, and hence know its location in every moment.

7.3 Communication improvements

In addition to the lack of communication between software, aspect which significantly reduces the efficiency in Green Cargo planning and daily activities, other areas presenting of the company also present this problem.

Communication among different departments, especially with the most short term and operational planning areas, does not seem to be very fluent. This aspect causes undesirable misunderstandings, such as that related to optimization of train capacity criteria. Strategic and Tactical departments dispose of several software to determine the most feasible and profitable train allocation to fulfill customer requirements.

Later on, those train allocation decisions are sent to the operational departments, such as RPC, in charge of controlling the shunting processes and train arrivals and departures. Nevertheless, in some occasions, final train allocations are modified because of unforeseen changes and possibly even cancelations of trains. Operators often consider it that train traffic is optimized if wagons can be sent to the same destination with a single train instead of several trains with lower capacity rates. Nevertheless, they are not conscious of the important problems linked to the last minute modification of the planned routes. If planned routes are not followed, planning employees are forced to adapt other trains routes as best as possible to solve the unexpected change.

Although Green Cargo employees dispose of a really broad document database containing important information about the company, as the previous paragraph indicates, this does not seem to be an efficient communication way with employees. In order to solve those misunderstandings and hence avoid the redoing of planning tasks, it is suggested that Green Cargo gives employees in different areas some periodic lessons, for example once a year, to inform them about the main policies of the company and the new future plans.

Another aspect that Green Cargo should take into consideration is the general lack of knowledge within the different departments (except in the most strategic areas), regarding how the company is structured and what responsibilities are includes in what department. Many employees do not have any idea about how company manages and plans its activities, and do not know any information out from their department. These aspects cause a slow information flow among the different departments, because in case of a problem, workers do not know which person or department that should be contacted. In many occasions end customers directly ask his operators or him about some aspects linked the conditions of the contractual relation between Green Cargo and those firms. Nevertheless, they have no information regarding what Green Cargo previously agreed with those customers, what can delay the answer to customers.

One more aspect to mention is that only a small proportion of Green Cargo employees working in administration have observed a shunting process or visited a yard. This fact makes employees not to have a realistic idea of which are the usual problems faced by shunters and drivers. In addition, this fact may lead to establish activities or future plans not feasible under the operational point of view. For this reasons, it is suggested that all Green Cargo employees visit in any occasion some of those stations with which they work, to gain a clearer view of the reality. This suggestion would not cost important economic costs for the company and is considered to become very useful for employees.

8 Discussion and conclusion

The analysis presented in the previous sections, focused in determine how to better the two improvement areas pointed out by Green Cargo as the most important ones: capacity and staff; have allowed us to identify several proposals and ideas which would significantly improve Green Cargo activities and processes.

While analyzing those chapters related to capacity optimization: optimization of train capacity, reduction of the uneven flow of cargo trains and peak reduction of the train traffic, it has been noticed the high close links between these three categories. In many occasions, it resulted very difficult to analyze those chapters in an independent way because many aspects were common in all three groups. One of Green Cargo expectations of this thesis was the election of that improvement category considered as the most profitable and better to implement. Nevertheless, the high relation between capacity optimization areas make us considered that Green Cargo should better focus on the further implementation of concepts such as “local planning” or “anchor blocks”, instead of on focusing of improving a specific capacity area.

Green Cargo is aware of its improvement needs, and works actively in plan and develop new concepts which helps them to optimize its processes and activities. It is considered that some of those purposed concepts, such as “local planning” and “anchor blocks” would be really useful to improve Green Cargo current way of working. Because of the increase of passenger train companies in Swedish rail industry in the next years (Trafikverket), freight rail companies will have to give priority to those new firms and even will be forced to lose some rail time slots that will be awarded to passenger companies. In addition, freight companies are highly dependent of its customer needs and expected delivery times, aspect that significantly constraints Green Cargo possibilities. All that reasons really necessary for Green Cargo to optimize the utilization of its available resources and determine new possibilities for improving its way of working.

One of our suggestions for Green Cargo lies of focusing in “Local planning”. This concept, presented in Section 5.3.4, would allow Green Cargo to increase as much as possible its train routes in those yellow and green categorized railroads. In that way, it would be possible to avoid and create alternative routes to those red railroads mainly used by passenger trains during day hour. This idea would allow reducing those Green Cargo expenses associated to high Trafikverket fees linked to the utilization of red railroads.

Another aspect considered very important for Green Cargo to work with is the establishment of customer priority levels, idea presented in Section 5.4.3. At present, Green Cargo does not have an efficient customers priority system, what causes that in some occasions some deliveries that would be more profitable to transport cannot be shipped because other orders, providing less profit has already been taken. Green Cargo should look more into its profitability, and choose those customers providing higher revenues but at the same time, rewarding customer loyalty. “Anchor block” concept is also linked to this idea. As Green Cargo points, some of their considered as anchor block companies may not represent anymore this role for the company. It is necessary Green Cargo carries out its idea of determining which its real “anchor block” customers are, being able to determine which of those customers are not profitable to work with.

The “layer on layer” concept, developed to optimize Green Cargo resources utilization by adapting its planned routes to the changing market requirements is considered to be a very useful approach under a theoretical point of view. Nevertheless, it is consider that its practical implementation involves several important constraints. On one hand, Green Cargo need to consider those fees that will be introduced by Trafikverket for booking certain rail time slot. It implies that those “layers” which Green Cargo decides to cancel for not being required will imply certain expenses for the firm. Depending on the amount of finance those fees involve, Green Cargo should consider whether “layer on layer” idea still results profitable for the firm. On the other hand, if Green Cargo cancels many of its booked railroad slots, Trafikverket may decide to adjudge those railroad time slots to Green Cargo competitors in the future. All those reasons lead us to recommend Green Cargo the need of improve its forecasting estimations, aspect in which this company is currently working actively, instead of introducing the “layer on layer” concept.

These are the improvement areas considered as more feasible to work with regarding capacity optimization target. On contrary, according to our criteria the introduction of a new blocking policy should not be a priority for Green Cargo. This idea would imply a deep restructuration of Green Cargo ways of working and would require high efforts to implement it. Green Cargo should take into consideration its own limitations: for example, at present the company does not have enough resources for fully exploit some of its software programs, such as MultiRail, and communication problems are also very important.

In addition, the possible introduction of this new blocking policy is considered to be risky because some of those “dedicated train” customers may not accept the possibility of not disposing of their own trains. Those companies could decide to rescind their contract with Green Cargo and work with other Green Cargo competitor firms offering those conditions they desire. It is strongly recommended that Green Cargo first focuses on solving all those extra problems presented in Section 7, such as lack of communication among departments and low exploitation and lack of communication among their software. Solving those problems would not require high investment levels and would significantly improve company efficiency. Only when those problems have been solved, Green Cargo should really consider whether to implement or not the new proposed booking policy.

Apart from the capacity optimization improvement areas discussed in the previous lines, Green Cargo also could increase its efficiency levels by optimizing its staff requirements. One of the improvement options regarding staff, “single shunting”, has already been successfully implemented in several stations in Sweden. The main potential improvement associated to this idea lies on turning small Main-Site stations with few employees and low activity rates into single shunting stations dependant on a close Main-Site station. In that case, all shunters and drivers belonging to the former Main-Site yard would be allocated in its new associated Main-Site. It is highly recommended that Green Cargo tries to expand the “single shunting” concept in as many locations as possible in order to optimize its staff needs. Unfortunately, there might not be much more feasible locations in which those possibilities can be implemented.

One possible obstacle to the implementation of the “single shunting” concept lies on the opposition of some groups of shunters and drivers. Some operators began their careers in Green Cargo working as shunters and later on decide advance to become

drivers. Some of the operators belonging to this group do not agree with the idea of continue doing shunting operations again after having done the education to become drivers. In addition, "single shunting" activities, normally performed during the day; are less rewarded than the nightly driver salaries.

Green Cargo should work on modifying the opinion of the workers regarding what are the duties and tasks of a driver. This suggestion is something the company should work with more closely. It is necessary to consider that this process could require a long period to be accomplished. It is also important to inform the drivers regarding the expected work task development, such as the introduction of the "single shunting" in some stations, and the reason why Green Cargo has decided to do those changes.

The "single shunting" technique, intimately linked to locomotives equipped with remote control system, allows establishing more safety shunting processes. It is strongly suggested that Green Cargo also introduced the remote control system in its traditional shunting processes. In that way, it would be possible to avoid those situations in which shunters safety depends on other shunters decisions (see section 6.2.6.) Although this suggestion is not strictly linked with the optimization of the staff requirements, a safer environment would reduce Green Cargo accidentality rate and would create better working conditions for shunters.

The "staff centralization" idea and the co-operational shunting pool suggestion would also allow Green Cargo to optimize its staff requirements. These ideas would allow Green Cargo to make the most of its employees working hours, and hence establishing more efficient working processes. It is strongly suggested for Green Cargo to implement those aspects whenever it is considered as possible. Once implemented, those aspects would be expected to provide Green Cargo short-term profit.

In the upcoming five years approximately 100 operators will be retired every year[8], it is highly suggested for Green Cargo to focus on optimizing its staff requirements by implementing the "single shunting" or "staff optimization" where possible during the next five years. In that way, the achieved staff reduction after the implementation of the mentioned improvements would not imply any layoff and could be explained with those employees expected to retire.

All those ideas represent the main conclusions obtained after analyzing those improvement areas suggested by Green Cargo. All information presented in this report should be considered as an analysis and discussion of the main potentials and limitations linked to each of the purposed improvement areas. Green Cargo, considering this information as well as its confidential data should make its own assessment regarding which areas are considered as the best ones to focus on.

[8] Ulf Wikström, Agreement Specialist, Green Cargo, Interview, 2013-02-19

9 References

Åkerströms. (2013, 02 24). *Green Cargo switches driverless freight trains*. Retrieved 02 24, 2013, from Åkerströms: http://www.akerstroms.com/en/locomote/green-cargo__645

Abrahamsson, E. (2010). Höghastihetsbanor - ett samhällsbygge för stärkt utveckling och konkurrenskraft. *Swedish National Road and Transport Research Institute* (1), 13.

Abril, M., Barber, F., Ingolotti, L., Salido, M. A., Tormos, P., & Lova, A. (2008). *An Assessment of Railway Capacity* . Valencia: Elsevier.

Bowersox, D. J. (2000). The Strategic Benefits of Logistics Alliances. *Harvard Business Review* , 36.

Commission of the European Communities. (2001). *White Paper: European transport policy for 2010.* Brussels: European Union.

Cordeau, J.-F., Toth, P., & Vigo, D. (1998). A Survey of Optimization Models for Train Routing and Scheduling. *Transportation Science* , 380-404.

Crainic, T. G. (1998). *A Survey of Optimization Models for Long-Haul Freight Transportation* . Montréal: Department of Management and Technology.

Crevier, B., Cordeau, J.-F., & Savard, G. (2012). Integrated operations planning and revenue management for rail freight transportation. *Transportation Research Part B* , 100–119 .

Ejvegård, R. (2003). *Vetenskaplig metod.* Lund: Studentlitteratur AB.

Eliasson, A. (2010). *Kvantitative metod från början.* Lund: Studentlitteratur AB.

European Union. (2011). *EU Transport in figures 2011.* Luxembourg: Publications Office of the European Union.

European Union. (2012). *EU Transport in Figures.* Luxembourg: Publications Office of the European Union.

European Union. (2012). *EU Transport in Figures 2012.* Luxembourg: Publications Office of the European Union.

Gayk, R. (2012, 05 22). The Absence of Trust in Dysfunctional Teams. *FireRescue* , 12-13.

Gibson, S. (2003). Allocation of capacity in the rail industry. *Utilities Policy* , 39-42.

Gold, R. L. (1958). *Roles in Sociological Field Observations* . Oxford: Oxford University Press.

Green Cargo. (2012). *Års- och hållbarhetsredovisning.* Solna: Erlanders.

Green Cargo. (2011). *Vitaboken.* Solna: Green Cargo.

Hakim, C. (2000). *Research design: Sucessful designs for social and economic research.* London: Routledge.

Holme, I. M., Solvang, B. K., Fløistad, G., Kjeldstadli, K., & O'Gorman, D. (1997). *Forskningsmetodik : Om kvalitativa och kvantitativa metoder.* Lund: Studentlitteratur AB.

Joborn, M., Crainic, T. G., Gendreau, M., Holmberg, K., & Lundgren, J. T. (2004). Economies of Scale in Empty Freight Car Distribution in Scheduled Railways. *Transportation Science* , 121 - 134 .

Klarner, P. (2010). *The Rhythm of Change.* Weisbaden: GWV Fachverlage GmbH.

Kwon, O. K., Martland, C. D., & Sussman, J. M. (1998). *Routing and scheduling temporal and heterogeneous freight car traffic on rail networks.* The Korea Transport Institute. Seoul: Transportation Research Part E.

Leenders, M. R., Mauffette-Leenders, L. A., & Erskine, J. A. (2001). *Writing Cases.* London: Ivey Publishing.

Narisetty, A. K., Richard, J. P., Ramcharan, D., Murphy, D., Minks, G., & Fuller, J. (2008). An optimization model for empty freight car assignment at Union Pacific Railroad. *Interfaces* , 89-102.

Pricewaterhouse Coopers. (2008). *European Union_Preparatory study for an impact assessment for a rail network giving priority to freight.* European Commission.

Racunica, I., & Wynter, L. (2005). Optimal location of intermodal freight hubs . *Transportation Research Part B* , 453-477.

Schroeder, M., Braun, I., & Schniede, E. (2000). *Revenue management strategies in the railway industry.* München: Technical University of Braunschweig.

Stora Enso. (2013, 01 08). *Välkommen till Hylte Bruk.* Retrieved 03 16, 2013, from Stora Enso: http://www.storaenso.com/about-us/mills/sweden/hylte-mill/Pages/HylteBrukSV.aspx

Trafikverket. (2012a). *Järnvägens behov av ökad kapacitet.* Borlänge: Trafikverket.

Trafikverket. (2013). *Järnvägsnätsbeskrivning.* Borlänge: Trafikverket.

Trafikverket. (2012b). *Kapacitetsbrister i järnvägsnätet.* Borlänge: Trafikverket.

Vierth, I. (2012, 10 08). *Forskningsprojekt testar tyngre och längre tåg* . Retrieved 03 01, 2013, from Swedish National Road and Transport Research Institute: http://www.vti.se/sv/nyheter/forskningsprojekt-testar-tyngre-och-langre-tag-/

Vierth, I., Mellin, A., Hylén, B., Karlsson, J., Karlsson, R., & Johansson, M. (2012). *Kartläggning av järnvägstrafiken i Sverige.* Linköping : Swedish National Road and Transport Research Institute.

VTI. (2011, 11 25). *Går det att effektivisera järnvägssystemet med längre och tyngre godståg?* Retrieved 03 01, 2013, from Swedish National Road and Transport Research Institute: http://www.vti.se/sv/nyheter/gar-det-att-effektivisera-jarnvagssystemet-med-langre-och-tyngre-godstag/

Wiegmans, B. W., & Doners, R. T. (2007). Benchmarking European Rail Freight Transport Companies . *Transportation Journal* , 19-34.

Yin, R. K. (2003). *Case Study Reserach: Design and Methods* (3rd ed.). Thousand Oaks: Sage Publications.